**ANNA UNIVERSITY, CHENNAI**

**NON-AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY**

**REGULATIONS 2021**

# B.TECH. PLASTICS TECHNOLOGY

**CHOICE BASED CREDIT SYSTEM**

## 1. PROGRAMME OUTCOMES (POs):

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

## 2. PROGRAM SPECIFIC OUTCOMES (PSOs):

On completion of B.Tech Plastics Technology, the graduates will

1. Apply the fundamental knowledge acquired from basic sciences, engineering sciences and computational platforms to design and develop plastics products.
2. Take up challenging positions in design, development and manufacturing of sustainable plastics products with environmental concern.
3. Become an entrepreneur with sound knowledge in core and management related courses.

## 3. MAPPING OF COURSE OUTCOMES AND PROGRAMME OUTCOMES

| | | COURSE NAME | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO8 | PO9 | PO10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YEAR 1 | SEMESTER 1 | Professional English - I | 1.6 | 2.2 | 1.8 | 2.2 | 1.5 | 3 | 3 | 3 | 1.6 | 3 | 3 | 3 | - | - | - |
| | | Matrices and Calculus | 3 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | - | - | - |
| | | Engineering Physics | 3 | 3 | 1.6 | 1.2 | 1.8 | 1 | - | - | - | - | - | 1 | - | - | - |
| | | Engineering Chemistry | 2.8 | 1.3 | 1.6 | 1 | - | 1.5 | 1.8 | - | | - | - | 1.5 | - | - | - |
| | | Problem Solving and Python Programming | 2 | 3 | 3 | 3 | 2 | - | - | - | - | - | 2 | 2 | 3 | 3 | |
| | | தமிழர் மரபு /Heritage of Tamils | | | | | | | | | | | | | | | |
| | | Problem Solving and Python Programming Laboratory | 2 | 3 | 3 | 3 | 2 | - | - | - | - | - | 2 | 2 | 3 | 3 | |
| | | Physics and Chemistry Laboratory | 3<br>2.6 | 2.4<br>1.3 | 2.6<br>1.6 | 1<br>1 | 1<br>1 | <br>1.4 | <br>1.8 | <br>- | <br>- | <br>- | <br>- | <br>1.3 | <br>- | <br>- | <br>- |
| | | English Laboratory | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| | SEMSTER 2 | Professional English - II | 3 | 3 | 3 | 3 | 2.75 | 3 | 3 | 3 | 2.2 | 3 | 3 | 3 | - | - | - |
| | | Statistics and Numerical Methods | 3 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | - | - | - |
| | | Basic Electrical, Electronics and Instrumentation Engineering | 2 | 1 | 1 | | | | | 1 | | | | | - | - | - |
| | | Engineering Graphics | 3 | 1 | 2 | | 2 | | | | | 3 | | 2 | 2 | 2 | |
| | | தமிழரும் தொழில்நுட் பமும் / Tamils and Technology | | | | | | | | | | | | | | | |
| | | Engineering Practices Laboratory | **3** | **2** | | | **1** | **1** | **1** | | | | | **2** | **2** | **1** | **1** |
| | | Basic Electrical, Electronics and Instrumentation Engineering Laboratory | 1.6 | 1.4 | 0.8 | 1.6 | | | | 1.2 | 1.6 | | | | | | |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Communication Laboratory / Foreign Language $ | 2.4 | 2.8 | 3 | 3 | 1.8 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| YEAR 2 | SEMESTER 3 | Probability and Statistics | 2 | 3 | 3 | 3 | 2 | 1 | - | 1 | 1 | 1 | 2 | 2 | | | |
| | | Fundamentals of Chemical Engineering | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | - | 1 | - | 2 | 1 | 1 | 2 |
| | | Plastics Materials I | 3 | 2 | 2 | 2 | - | 1 | 3 | 1 | - | 1 | - | 2 | 2 | 2 | 3 |
| | | Polymer Chemistry | 3 | 2 | 2 | 2 | 2 | 1 | 3 | 1 | - | 1 | - | 2 | 2 | 2 | 3 |
| | | Polymer Physics | 2 | 2 | 2 | 2 | 2 | 1 | 3 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| | | Solid Mechanics for Technologists | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | - | 1 | - | 2 | 1 | 1 | 2 |
| | | Chemical Engineering Lab | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | - | 2 | 1 | 1 | 2 |
| | | Polymer Chemistry Lab | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | - | 2 | 2 | 2 | 2 |
| | | Professional Development$ | 1 | 2 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 1 | 2 | | | |
| | SEMESTER 4 | Additives and Compounding | 2.5 | 2.5 | 2.5 | 1 | 1 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| | | Polymer Rheology and Fluid Mechanics | 2.2 | 2.2 | 2.2 | 1 | 1 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| | | Plastics Materials II | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 3 | 2 |
| | | Plastics Moulds and Dies Technology | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 3 |
| | | Plastics Processing | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 3 | 3 |
| | | Environmental Sciences and Sustainability | 2 | 2 | 2 | 2 | 1 | 2 | 3 | 2 | - | 1 | 1 | 2 | 2 | 3 | 2 |
| | | Polymer Science Lab | 2 | 2 | 3 | 3 | 2 | 1 | 3 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| | | Plastics Processing Lab | 2 | 2 | 2 | 2 | 2 | 1 | 3 | 1 | 2 | 2 | - | 2 | 2 | 2 | 2 |
| YEAR 3 | SEMESTER 5 | Plastics Testing and Characterization | 2 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| | | Plastics Testing and Characterization lab | 2 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 |
| | SEMEST | Plastics Product Testing | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 1 | - | 2 | - | 2 | 2 | 1 | 2 |
| | | Plastics Product | 3 | 2 | 1.33 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | - | 2 | 3 | 2 | 2 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Testing Lab | | | | | | | | | | | | | | | |
| YEAR 4 | SEMESTER 7 | Plastics Product Design | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 1 | - | 1 | - | 2 | 3 | 2 | 3 |
| | | Plastics Recycling and Waste Management | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | - | 1 | 2 | 2 | 3 | 3 | 3 |
| | | CAD/CAM/CAE Lab | 3 | 3 | 3 | 3 | 3. | 1 | 2 | 1 | 2 | 2 | - | 3 | 3 | 3 | 2 |

**1-Low,2-Medium,3-High,"-"-no correlation**

**ANNA UNIVERSITY, CHENNAI**
**NON-AUTONOMOUS COLLEGES AFFILIATED COLLEGES**
**REGULATIONS 2021**
**BASED CREDIT SYSTEM**
**B. TECH. PLASTICS TECHNOLOGY**
**CURRICULUM AND SYLLABUS FOR SEMESTERS I TO VIII SEMESTERS**

**SEMESTER I**

| S. No. | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | IP3151 | Induction Programme | - | - | - | - | - | 0 |
| **THEORY** | | | | | | | | |
| 2. | HS3152 | Professional English - I | HSMC | 3 | 0 | 0 | 3 | 3 |
| 3. | MA3151 | Matrices and Calculus | BSC | 3 | 1 | 0 | 4 | 4 |
| 4. | PH3151 | Engineering Physics | BSC | 3 | 0 | 0 | 3 | 3 |
| 5. | CY3151 | Engineering Chemistry | BSC | 3 | 0 | 0 | 3 | 3 |
| 6. | GE3151 | Problem Solving and Python Programming | ESC | 3 | 0 | 0 | 3 | 3 |
| 7. | GE3152 | தமிழர் மரபு /Heritage of Tamils | HSMC | 1 | 0 | 0 | 1 | 1 |
| **PRACTICALS** | | | | | | | | |
| 8. | GE3171 | Problem Solving and Python Programming Laboratory | ESC | 0 | 0 | 4 | 4 | 2 |
| 9. | BS3171 | Physics and Chemistry Laboratory | BSC | 0 | 0 | 4 | 4 | 2 |
| 10. | GE3172 | English Laboratory $ | EEC | 0 | 0 | 2 | 2 | 1 |
| | | | **TOTAL** | **16** | **1** | **10** | **27** | **22** |

$ Skill Based Course

**SEMESTER II**

| S. No. | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | HS3252 | Professional English - II | HSMC | 2 | 0 | 0 | 2 | 2 |
| 2. | MA3251 | Statistics and Numerical Methods | BSC | 3 | 1 | 0 | 4 | 4 |
| 3. | PH3258 | Physics of Materials | BSC | 3 | 0 | 0 | 3 | 3 |
| 4. | BE3252 | Basic Electrical, Electronics and Instrumentation Engineering | ESC | 3 | 0 | 0 | 3 | 3 |
| 5. | CY3201 | Physical and Organic Chemistry | BSC | 3 | 0 | 0 | 3 | 3 |
| 6. | GE3251 | Engineering Graphics | ESC | 2 | 0 | 4 | 6 | 4 |
| 7. | GE3252 | தமிழரும் தொழில்நுட்பமும் / Tamils and Technology | HSMC | 1 | 0 | 0 | 1 | 1 |
| 8. | | NCC Credit Course Level 1# | - | 2 | 0 | 0 | 2 | 2 |
| **PRACTICALS** | | | | | | | | |
| 9. | GE3271 | Engineering Practices Laboratory | ESC | 0 | 0 | 4 | 4 | 2 |
| 10. | BE3272 | Basic Electrical, Electronics and Instrumentation Engineering Laboratory | ESC | 0 | 0 | 4 | 4 | 2 |
| 11. | GE3272 | Communication Laboratory / Foreign Language $ | EEC | 0 | 0 | 4 | 4 | 2 |
| | | | **TOTAL** | **17** | **1** | **16** | **34** | **26** |

#NCC Credit Course level 1 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.
$ Skill Based Course

**SEMESTER III**

| S. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | MA3391 | Probability and Statistics | BSC | 3 | 1 | 0 | 4 | 4 |
| 2. | PT3301 | Fundamentals of Chemical Engineering | PCC | 3 | 0 | 0 | 3 | 3 |
| 3. | PT3302 | Plastics Materials I | PCC | 3 | 0 | 0 | 3 | 3 |
| 4. | PT3303 | Polymer Chemistry | PCC | 3 | 0 | 0 | 3 | 3 |
| 5. | PT3304 | Polymer Physics | PCC | 3 | 0 | 0 | 3 | 3 |
| 6. | PT3305 | Solid Mechanics for Technologists | ESC | 3 | 0 | 0 | 3 | 3 |
| **PRACTICALS** | | | | | | | | |
| 7. | PT3311 | Chemical Engineering Laboratory | ESC | 0 | 0 | 4 | 4 | 2 |
| 8. | PT3312 | Polymer Chemistry Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| 9. | GE3361 | Professional Development[$] | EEC | 0 | 0 | 2 | 2 | 1 |
| | | | **TOTAL** | **18** | **1** | **10** | **29** | **24** |

$ Skill Based Course

**SEMESTER IV**

| S. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | PT3401 | Additives and Compounding | PCC | 3 | 0 | 0 | 3 | 3 |
| 2. | PT3402 | Fluid Mechanics and Polymer Rheology | ESC | 3 | 0 | 0 | 3 | 3 |
| 3. | PT3403 | Plastics Materials II | PCC | 3 | 0 | 0 | 3 | 3 |
| 4. | PT3404 | Plastics Moulds and Dies Technology | PCC | 3 | 0 | 0 | 3 | 3 |
| 5. | PT3405 | Plastics Processing | PCC | 3 | 0 | 0 | 3 | 3 |
| 6. | GE3451 | Environmental Sciences and Sustainability | BSC | 2 | 0 | 0 | 2 | 2 |
| 7. | | NCC Credit Course Level 2[#] | | 3 | 0 | 0 | 3 | 3 # |
| **PRACTICALS** | | | | | | | | |
| 8. | PT3411 | Polymer Science Laboratory | PCC | 0 | 0 | 3 | 3 | 1.5 |
| 9. | PT3412 | Plastics Processing Laboratory | PCC | 0 | 0 | 3 | 3 | 1.5 |
| 10. | PT3512 | Industrial Training / Internship I* | EEC | - | - | - | - | - |
| | | | **TOTAL** | **17** | **0** | **6** | **23** | **20** |

# NCC Credit Course level 2 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

*Four weeks industrial training/internship carries two credits. Industrial training/internship during IV Semester Summer Vacation will be evaluated in V semester

**SEMESTER V**

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | PT3501 | Plastics Testing and Characterization | PCC | 3 | 0 | 0 | 3 | 3 |
| 2. | | Professional Elective I | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | | Professional Elective II | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | | Professional Elective III | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | | Professional Elective IV | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | | Mandatory Course-I[&] | MC | 3 | 0 | 0 | 3 | Non-Credit Course |
| **PRACTICALS** | | | | | | | | |
| 7. | PT3511 | Plastics Testing and Characterization Laboratory | PCC | 0 | 0 | 3 | 3 | 1.5 |
| 8. | PT3512 | Industrial Training / Internship I* | EEC | 0 | 0 | 0 | 0 | 2 |
| | | | **TOTAL** | **18** | **0** | **3** | **21** | **18.5** |

[&] Mandatory Course-I is a Non-credit Course (Student shall select one course from the list given under MC-I)

*Four weeks industrial training/internship carries two credits. Industrial training/internship during IV Semester Summer Vacation will be evaluated in V semester

**SEMESTER VI**

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | PT3601 | Plastics Product Testing | PCC | 3 | 0 | 0 | 3 | 3 |
| 2. | | Open Elective – I* | OEC | 3 | 0 | 0 | 3 | 3 |
| 3. | | Professional Elective V | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | | Professional Elective VI | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | | Professional Elective VII | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | | Professional Elective VIII | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | | NCC Credit Course Level 3[#] | | 3 | 0 | 0 | 3 | 3 # |
| 8. | | Mandatory Course--II[&] | MC | 3 | 0 | 0 | 3 | Non-Credit Course |
| **PRACTICALS** | | | | | | | | |
| 9. | PT3611 | Plastics Product Testing Laboratory | PCC | 0 | 0 | 3 | 3 | 1.5 |
| 10. | PT3612 | Seminar and Comprehension | EEC | 0 | 0 | 4 | 4 | 2 |
| 11. | PT3712 | Industrial Training / Internship II[##] | EEC | - | - | - | - | - |
| | | | **TOTAL** | **21** | **0** | **7** | **28** | **21.5** |

*Open Elective – I shall be chosen from the emerging technologies.

[##]Four weeks industrial training/internship carries two credits. Industrial training/Internship during VI Semester Summer Vacation will be evaluated in VII semester

[&] Mandatory Course-II is a Non-credit Course (Student shall select one course from the list given under MC- II)

[#] NCC Credit Course level 3 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

**SEMESTER VII/VIII***

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | PT3701 | Plastics Product Design | PCC | 3 | 0 | 0 | 3 | 3 |
| 2. | PT3702 | Plastics Recycling and Waste Management | PCC | 3 | 0 | 0 | 3 | 3 |
| 3. | GE3791 | Human values and Ethics | HSMC | 2 | 0 | 0 | 2 | 2 |
| 4. | | Elective- Management # | HSMC | 3 | 0 | 0 | 3 | 3 |
| 5. | | Open Elective – II** | OEC | 3 | 0 | 0 | 3 | 3 |
| 6. | | Open Elective – III*** | OEC | 3 | 0 | 0 | 3 | 3 |
| 7. | | Open Elective – IV*** | OEC | 3 | 0 | 0 | 3 | 3 |
| **PRACTICALS** | | | | | | | | |
| 8. | PT3711 | CAD/CAM/CAE Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| 9. | PT3712 | Industrial Training/Internship II## | EEC | - | - | - | - | 2 |
| | | | **TOTAL** | **20** | **0** | **4** | **24** | **24** |

*If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.

**Open Elective – II shall be chosen from the emerging technologies.

***Open Elective III and IV (Shall be chosen from the list of open electives offered by other Programmes

# Elective- Management shall be chosen from the Elective Management courses

##Four weeks industrial training/internship carries two credits. Industrial training/Internship during VI Semester Summer Vacation will be evaluated in VII semester

**SEMESTER VIII/VII***

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **PRACTICALS** | | | | | | | | |
| 1. | PT3811 | Project Work / Internship# | EEC | 0 | 0 | 20 | 20 | 10 |
| | | | **TOTAL** | **0** | **0** | **20** | **20** | **10** |

*If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.

#15 weeks of continuous Internship in an organization carries 10 credits.

**TOTAL CREDITS: 166**

**ELECTIVE – MANAGEMENT COURSES**

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | GE3751 | Principles of Management | HSMC | 3 | 0 | 0 | 3 | 3 |
| 2. | GE3752 | Total Quality Management | HSMC | 3 | 0 | 0 | 3 | 3 |
| 3. | GE3753 | Engineering Economics and Financial Accounting | HSMC | 3 | 0 | 0 | 3 | 3 |
| 4. | GE3754 | Human Resource Management | HSMC | 3 | 0 | 0 | 3 | 3 |
| 5. | GE3755 | Knowledge Management | HSMC | 3 | 0 | 0 | 3 | 3 |
| 6. | GE3792 | Industrial Management | HSMC | 3 | 0 | 0 | 3 | 3 |

**MANDATORY COURSES I***

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS |
|---|---|---|---|---|---|---|---|
| | | | | L | T | P | |
| 1. | MX3081 | Introduction to Women and Gender Studies | MC | 3 | 0 | 0 | 3 |
| 2. | MX3082 | Elements of Literature | MC | 3 | 0 | 0 | 3 |
| 3. | MX3083 | Film Appreciation | MC | 3 | 0 | 0 | 3 |
| 4. | MX3084 | Disaster Risk Reduction and Management | MC | 3 | 0 | 0 | 3 |

* Mandatory Courses are offered as Non –Credit Courses

**MANDATORY COURSES II***

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS |
|---|---|---|---|---|---|---|---|
| | | | | L | T | P | |
| 1. | MX3085 | Well Being with Traditional Practices -Yoga, Ayurveda and Siddha | MC | 3 | 0 | 0 | 3 |
| 2. | MX3086 | History of Science and Technology in India | MC | 3 | 0 | 0 | 3 |
| 3. | MX3087 | Political and Economic Thought for a Humane Society | MC | 3 | 0 | 0 | 3 |
| 4. | MX3088 | State, Nation Building and Politics in India | MC | 3 | 0 | 0 | 3 |
| 5. | MX3089 | Industrial Safety | MC | 3 | 0 | 0 | 3 |

* Mandatory Courses are offered as Non –Credit Courses

## PROFESSIONAL ELECTIVE COURSES : VERTICALS

| **Vertical I Advanced Polymeric Materials** | **Vertical II Design and Manufacturing** | **Vertical III Processing Technology** | **Vertical IV Management** |
|---|---|---|---|
| Composite Materials | Advanced Mould Manufacturing | Advanced Extrusion Processing | Product Design and Cost Estimation |
| Plastics in Electronics | Additive Manufacturing | Advanced Injection Moulding | Engineering Statistics and Quality Control |
| Biodegradable Polymers | Fiber technology | Advanced Blow Moulding | Circular Economy and Extended Producer Responsibility |
| Polymers in Biomedical Engineering | Plastics Packaging Technology | Polyurethane Technology | Pollution, Regulatory Norms and Control Equipment |
| Adhesives, Paints and Coatings | Rubber Technology | Instrumentation and Process Control | Fintech and Block Chain |
| Polymers in Transportation | Design and Manufacture of Composites | Automation in Polymer Processing | Entrepreneurship Development |
| Biopolymers and Green Composite | Finite Element Methods | Foam Technology | Intellectual Property Rights (IPR) |
| Polymer Blends and Alloys | PVC Technology | Machining and Joining of Plastics | Engineering Management |

**Registration of Professional Elective Courses from Verticals:**

Refer to the regulations 2021, Clause 6.3. (Amended on 27.07.2023)

## PROFESSIONAL ELECTIVE COURSES : VERTICALS

### VERTICAL 1: ADVANCED POLYMERIC MATERIALS

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | PT3001 | Composite Materials | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | PT3002 | Plastics in Electronics | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | PT3003 | Biodegradable Polymers | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | PT3004 | Polymers in Biomedical Engineering | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | PT3005 | Adhesives, Paints and Coatings | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | PT3006 | Polymers in Transportation | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | PT3007 | Biopolymers and Green Composite | PEC | 3 | 0 | 0 | 3 | 3 |
| 8. | PT3008 | Polymer Blends and Alloys | PEC | 3 | 0 | 0 | 3 | 3 |

### VERTICAL 2: DESIGN AND MANUFACTURING

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | PT3009 | Advanced Mould Manufacturing | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | PT3010 | Additive Manufacturing | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | PT3011 | Fibre technology | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | PT3012 | Plastics Packaging Technology | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | PT3013 | Rubber Technology | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | PT3014 | Design and Manufacture of Composites | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | PT3015 | Finite Element Methods | PEC | 3 | 0 | 0 | 3 | 3 |
| 8. | PT3016 | PVC Technology | PEC | 3 | 0 | 0 | 3 | 3 |

## VERTICAL 3: PROCESSING TECHNOLOGY

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | PT3017 | Advanced Extrusion Processing | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | PT3018 | Advanced Injection Moulding Technology | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | PT3019 | Advanced Blow Moulding | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | PT3020 | Polyurethane Technology | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | PT3021 | Instrumentation and Process Control | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | PT3022 | Automation in Polymer Processing | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | PT3023 | Foam Technology | PEC | 3 | 0 | 0 | 3 | 3 |
| 8. | PT3024 | Machining and Joining of Plastics | PEC | 3 | 0 | 0 | 3 | 3 |

## VERTICAL 4: MANAGEMENT

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | PT3025 | Product Design and Cost Estimation | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | PT3026 | Engineering Statistics and Quality Control | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | PT3027 | Circular Economy and Extended Producer Responsibility | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | PT3028 | Pollution, Regulatory Norms and Control equipment | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | PT3029 | Fintech and Block Chain | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | PT3030 | Entrepreneurship Development | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | PT3031 | Intellectual Property Rights (IPR) | PEC | 3 | 0 | 0 | 3 | 3 |
| 8. | PT3032 | Engineering Management | PEC | 3 | 0 | 0 | 3 | 3 |

## OPEN ELECTIVES

Students shall choose the open elective courses, such that the course contents are not similar to any other course contents/title under other course categories.

### OPEN ELECTIVE I AND II
### (EMERGING TECHNOLOGIES)

To be offered other than Faculty of Information and Communication Engineering

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | OCS351 | Artificial Intelligence and Machine Learning Fundamentals | OEC | 2 | 0 | 2 | 4 | 3 |
| 2. | OCS352 | IoT Concepts and Applications | OEC | 2 | 0 | 2 | 4 | 3 |
| 3. | OCS353 | Data Science Fundamentals | OEC | 2 | 0 | 2 | 4 | 3 |
| 4. | CCS333 | Augmented Reality / Virtual Reality | OEC | 2 | 0 | 2 | 4 | 3 |

### OPEN ELECTIVES – III

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | OHS351 | English for Competitive Examinations | OEC | 3 | 0 | 0 | 3 | 3 |
| 2. | OCE353 | Lean Concepts, Tools And Practices | OEC | 3 | 0 | 0 | 3 | 3 |
| 3. | OMG352 | NGOs and Sustainable Development | OEC | 3 | 0 | 0 | 3 | 3 |
| 4. | OMG353 | Democracy and Good Governance | OEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CME365 | Renewable Energy Technologies | OEC | 3 | 0 | 0 | 3 | 3 |
| 6. | OME354 | Applied Design Thinking | OEC | 3 | 0 | 0 | 3 | 3 |
| 7. | MF3003 | Reverse Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 8. | OPR351 | Sustainable Manufacturing | OEC | 3 | 0 | 0 | 3 | 3 |
| 9. | AU3791 | Electric and Hybrid Vehicle | OEC | 3 | 0 | 0 | 3 | 3 |
| 10. | OAS352 | Space Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 11. | OIM351 | Industrial Management | OEC | 3 | 0 | 0 | 3 | 3 |
| 12. | OIE354 | Quality Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 13. | OSF351 | Fire Safety Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 14. | OMR351 | Mechatronics | OEC | 3 | 0 | 0 | 3 | 3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 15. | ORA351 | Foundation of Robotics | OEC | 3 | 0 | 0 | 3 | 3 |
| 16. | OAE352 | Fundamentals of Aeronautical engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 17. | OGI351 | Remote Sensing Concepts | OEC | 3 | 0 | 0 | 3 | 3 |
| 18. | OAI351 | Urban Agriculture | OEC | 3 | 0 | 0 | 3 | 3 |
| 19. | OEN351 | Drinking Water Supply and Treatment | OEC | 3 | 0 | 0 | 3 | 3 |
| 20. | OEE352 | Electric Vehicle Technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 21. | OEI353 | Introduction to PLC Programming | OEC | 3 | 0 | 0 | 3 | 3 |
| 22. | OFD352 | Traditional Indian Foods | OEC | 3 | 0 | 0 | 3 | 3 |
| 23. | OFD353 | Introduction to Food Processing | OEC | 3 | 0 | 0 | 3 | 3 |
| 24. | OPY352 | IPR for Pharma Industry | OEC | 3 | 0 | 0 | 3 | 3 |
| 25. | OTT351 | Basics of Textile Finishing | OEC | 3 | 0 | 0 | 3 | 3 |
| 26. | OTT352 | Industrial Engineering for Garment Industry | OEC | 3 | 0 | 0 | 3 | 3 |
| 27. | OTT353 | Basics of Textile Manufacture | OEC | 3 | 0 | 0 | 3 | 3 |
| 28. | OPE351 | Introduction to Petroleum Refining and Petrochemicals | OEC | 3 | 0 | 0 | 3 | 3 |
| 29. | CPE334 | Energy Conservation and Management | OEC | 3 | 0 | 0 | 3 | 3 |
| 30. | OCH351 | Nano Technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 31. | OCH352 | Functional Materials | OEC | 3 | 0 | 0 | 3 | 3 |
| 32. | OEC351 | Signals and Systems | OEC | 3 | 0 | 0 | 3 | 3 |
| 33. | OEC352 | Fundamentals of Electronic Devices and Circuits | OEC | 3 | 0 | 0 | 3 | 3 |
| 34. | CBM348 | Foundation Skills in Integrated Product Development | OEC | 3 | 0 | 0 | 3 | 3 |
| 35. | CBM333 | Assistive Technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 36. | OMA352 | Operations Research | OEC | 3 | 0 | 0 | 3 | 3 |
| 37. | OMA353 | Algebra and Number Theory | OEC | 3 | 0 | 0 | 3 | 3 |
| 38. | OMA354 | Linear Algebra | OEC | 3 | 0 | 0 | 3 | 3 |
| 39. | OBT352 | Basics of Microbial Technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 40. | OBT353 | Basics of Biomolecules | OEC | 3 | 0 | 0 | 3 | 3 |
| 41. | OBT354 | Fundamentals of Cell and Molecular Biology | OEC | 3 | 0 | 0 | 3 | 3 |

## OPEN ELECTIVES – IV

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | OHS352 | Project Report Writing | OEC | 3 | 0 | 0 | 3 | 3 |
| 2. | OCE354 | Basics of Integrated Water Resources Management | OEC | 3 | 0 | 0 | 3 | 3 |
| 3. | OMA355 | Advanced Numerical Methods | OEC | 3 | 0 | 0 | 3 | 3 |
| 4. | OMA356 | Random Processes | OEC | 3 | 0 | 0 | 3 | 3 |
| 5. | OMA357 | Queuing and Reliability Modelling | OEC | 3 | 0 | 0 | 3 | 3 |
| 6. | OMG354 | Production and Operations Management for Entrepreneurs | OEC | 3 | 0 | 0 | 3 | 3 |
| 7. | OMG355 | Multivariate Data Analysis | OEC | 3 | 0 | 0 | 3 | 3 |
| 8. | CME343 | New Product Development | OEC | 3 | 0 | 0 | 3 | 3 |
| 9. | OME355 | Industrial Design & Rapid Prototyping Techniques | OEC | 2 | 0 | 2 | 4 | 3 |
| 10. | MF3010 | Micro and Precision Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 11. | OMF354 | Cost Management of Engineering Projects | OEC | 3 | 0 | 0 | 3 | 3 |
| 12. | AU3002 | Batteries and Management System | OEC | 3 | 0 | 0 | 3 | 3 |
| 13. | AU3008 | Sensors and Actuators | OEC | 3 | 0 | 0 | 3 | 3 |
| 14. | OAS353 | Space Vehicles | OEC | 3 | 0 | 0 | 3 | 3 |
| 15. | OIM352 | Management Science | OEC | 3 | 0 | 0 | 3 | 3 |
| 16. | OIM353 | Production Planning and Control | OEC | 3 | 0 | 0 | 3 | 3 |
| 17. | OIE353 | Operations Management | OEC | 3 | 0 | 0 | 3 | 3 |
| 18. | OSF352 | Industrial Hygiene | OEC | 3 | 0 | 0 | 3 | 3 |
| 19. | OSF353 | Chemical Process Safety | OEC | 3 | 0 | 0 | 3 | 3 |
| 20. | OML352 | Electrical, Electronic and MAGNETIC Materials | OEC | 3 | 0 | 0 | 3 | 3 |
| 21. | OML353 | Nanomaterials and applications | OEC | 3 | 0 | 0 | 3 | 3 |
| 22. | OMR352 | Hydraulics and Pneumatics | OEC | 3 | 0 | 0 | 3 | 3 |
| 23. | OMR353 | Sensors | OEC | 3 | 0 | 0 | 3 | 3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 24. | ORA352 | Concepts in Mobile Robots | OEC | 3 | 0 | 0 | 3 | 3 |
| 25. | MV3501 | Marine Propulsion | OEC | 3 | 0 | 0 | 3 | 3 |
| 26. | OMV351 | Marine Merchant Vessels | OEC | 3 | 0 | 0 | 3 | 3 |
| 27. | OMV352 | Elements of Marine Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 28. | CRA332 | Drone Technologies | OEC | 3 | 0 | 0 | 3 | 3 |
| 29. | OGI352 | Geographical Information System | OEC | 3 | 0 | 0 | 3 | 3 |
| 30. | OAI352 | Agriculture Entrepreneurship Development | OEC | 3 | 0 | 0 | 3 | 3 |
| 31. | OEN352 | Biodiversity Conservation | OEC | 3 | 0 | 0 | 3 | 3 |
| 32. | OEE353 | Introduction to Control Systems | OEC | 3 | 0 | 0 | 3 | 3 |
| 33. | OEI354 | Introduction to Industrial Automation Systems | OEC | 3 | 0 | 0 | 3 | 3 |
| 34. | OFD354 | Fundamentals of Food Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 35. | OFD355 | Food safety and Quality Regulations | OEC | 3 | 0 | 0 | 3 | 3 |
| 36. | OPY353 | Nutraceuticals | OEC | 3 | 0 | 0 | 3 | 3 |
| 37. | OTT354 | Basics of Dyeing and Printing | OEC | 3 | 0 | 0 | 3 | 3 |
| 38. | FT3201 | Fibre Science | OEC | 3 | 0 | 0 | 3 | 3 |
| 39. | OTT355 | Garment Manufacturing Technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 40. | OCH353 | Energy Technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 41. | OCH354 | Surface Science | OEC | 3 | 0 | 0 | 3 | 3 |
| 42. | OPE353 | Industrial safety | OEC | 3 | 0 | 0 | 3 | 3 |
| 43. | OPE354 | Unit Operations in Petro Chemical Industries | OEC | 3 | 0 | 0 | 3 | 3 |
| 44. | OEC353 | VLSI Design | OEC | 3 | 0 | 0 | 3 | 3 |
| 45. | CBM370 | Wearable devices | OEC | 3 | 0 | 0 | 3 | 3 |
| 46. | CBM356 | Medical Informatics | OEC | 3 | 0 | 0 | 3 | 3 |
| 47. | OBT355 | Biotechnology for Waste Management | OEC | 3 | 0 | 0 | 3 | 3 |
| 48. | OBT356 | Lifestyle Diseases | OEC | 3 | 0 | 0 | 3 | 3 |
| 49. | OBT357 | Biotechnology in Health Care | OEC | 3 | 0 | 0 | 3 | 3 |

## SUMMARY

| Name of the Programme | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| S.No | Subject Area | Credits per Semester | | | | | | | | Total Credits |
| | | I | II | III | IV | V | VI | VII/VIII | VIII/VII | |
| 1 | HSMC | 4 | 3 | | | | | 5 | | 12 |
| 2 | BSC | 12 | 10 | 4 | 2 | | | | | 28 |
| 3 | ESC | 5 | 13 | 5 | 3 | | | | | 27 |
| 4 | PCC | | | 14 | 15 | 4.5 | 4.5 | 8 | | 46 |
| 5 | PEC | | | | | 12 | 12 | | | 24 |
| 6 | OEC | | | | | | 3 | 9 | | 12 |
| 7 | EEC | 1 | | 1 | | 2 | 2 | 2 | 10 | 17 |
| 8 | Non-Credit /(Mandatory) | | | | | √ | √ | | | |
| Total | | 22 | 26 | 24 | 20 | 18.5 | 21.5 | 24 | 10 | 166 |

## Enrollment for B.E. / B. Tech. (Honours) / Minor degree (Optional)

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E./B.Tech. (Honours) Minor degree.

For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only.

For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes, Moreover, for minor degree the student can register for courses from any one of the following verticals also.
Complete details are available in clause 4.10 (Amendments) of Regulations 2021.

**VERTICALS FOR MINOR DEGREE (**IN ADDITIONS TO ALL THE VERTICALS OF OTHER PROGRAMMES)

| **Vertical I Fintech and Block Chain** | **Vertical II Entrepreneurship** | **Vertical III Public Administration** | **Vertical IV Business Data Analytics** | **Vertical V Environment and Sustainability** |
|---|---|---|---|---|
| Financial Management | Foundations of Entrepreneurship | Principles of Public Administration | Statistics For Management | Sustainable infrastructure Development |
| Fundamentals of Investment | Team Building & Leadership Management for Business | Constitution of India | Datamining For Business Intelligence | Sustainable Agriculture and Environmental Management |
| Banking, Financial Services and Insurance | Creativity & Innovation in Entrepreneurship | Public Personnel Administration | Human Resource Analytics | Sustainable Bio Materials |
| Introduction to Blockchain and its Applications | Principles of Marketing Management For Business | Administrative Theories | Marketing And Social Media Web Analytics | Materials for Energy Sustainability |
| Fintech Personal Finance and Payments | Human Resource Management for Entrepreneurs | Indian Administrative System | Operation And Supply Chain Analytics | Green Technology |
| Introduction to Fintech | Financing New Business Ventures | Public Policy Administration | Financial Analytics | Environmental Quality Monitoring and Analysis |
| - | - | - | - | Integrated Energy Planning for Sustainable Development |
| - | - | - | - | Energy Efficiency for Sustainable Development |

**(Choice of courses for Minor degree is to be made from any one vertical of other programmes or from anyone of the following verticals)**

## VERTICAL 1: FINTECH AND BLOCK CHAIN

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CMG331 | Financial Management | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CMG332 | Fundamentals of Investment | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CMG333 | Banking, Financial Services and Insurance | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CMG334 | Introduction to Blockchain and its Applications | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CMG335 | Fintech Personal Finance and Payments | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CMG336 | Introduction to Fintech | PEC | 3 | 0 | 0 | 3 | 3 |

## VERTICAL 2: ENTREPRENEURSHIP

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CMG337 | Foundations of Entrepreneruship | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CMG338 | Team Building & Leadership Management for Business | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CMG339 | Creativity & Innovation in Entrepreneurship | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CMG340 | Principles of Marketing Management For Business | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CMG341 | Human Resource Management for Entrepreneurs | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CMG342 | Financing New Business Ventures | PEC | 3 | 0 | 0 | 3 | 3 |

**VERTICAL 3: PUBLIC ADMINISTRATION**

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CMG343 | Principles of Public Administration | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CMG344 | Constitution of India | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CMG345 | Public Personnel Administration | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CMG346 | Administrative Theories | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CMG347 | Indian Administrative System | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CMG348 | Public Policy Administration | PEC | 3 | 0 | 0 | 3 | 3 |

**VERTICAL 4: BUSINESS DATA ANALYTICS**

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CMG349 | Statistics For Management | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CMG350 | Datamining For Business Intelligence | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CMG351 | Human Resource Analytics | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CMG352 | Marketing And Social Media Web Analytics | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CMG353 | Operation And Supply Chain Analytics | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CMG354 | Financial Analytics | PEC | 3 | 0 | 0 | 3 | 3 |

**VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY**

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CES331 | Sustainable infrastructure Development | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CES332 | Sustainable Agriculture and Environmental Management | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CES333 | Sustainable Bio Materials | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CES334 | Materials for Energy Sustainability | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CES335 | Green Technology | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CES336 | Environmental Quality Monitoring and Analysis | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | CES337 | Integrated Energy Planning for Sustainable Development | PEC | 3 | 0 | 0 | 3 | 3 |
| 8. | CES338 | Energy Efficiency for Sustainable Development | PEC | 3 | 0 | 0 | 3 | 3 |

**IP3151 INDUCTION PROGRAMME**

This is a mandatory 2 week programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.

The induction programme has been introduced by AICTE with the following objective:

“Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed.”

“One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character. “

Hence, the purpose of this programme is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

(i) Physical Activity

This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc.

(ii) Creative Arts

Every student would choose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it everyday for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, grow into engineering design later.

(iii) Universal Human Values

This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and dont's, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing.

Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for the student for the full duration of the UG programme.

(iv) Literary Activity

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

(v) Proficiency Modules

This would address some lacunas that students might have, for example, English, computer familiarity etc.

(vi) Lectures by Eminent People

Motivational lectures by eminent people from all walks of life should be arranged to give the students exposure to people who are socially active or in public life.

(vii) Visits to Local Area

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.

(viii) Familiarization to Dept./Branch & Innovations

They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

(ix) Department Specific Activities

About a week can be spent in introducing activities (games, quizzes, social interactions, small experiments, design thinking etc.) that are relevant to the particular branch of Engineering / Technology / Architecture that can serve as a motivation and kindle interest in building things (become a maker) in that particular field. This can be conducted in the form of a workshop. For example, CSE and IT students may be introduced to activities that kindle computational thinking, and get them to build simple games. ECE students may be introduced to building simple circuits as an extension of their knowledge in Science, and so on. Students may be asked to build stuff using their knowledge of science.

**Induction Programme is totally an activity based programme and therefore there shall be no tests / assessments during this programme.**

**REFERENCES:**

Guide to Induction program from AICTE

| **HS3152** | **PROFESSIONAL ENGLISH I** | **L T P C** |
|---|---|---|
| | | **3 0 0 3** |

**OBJECTIVES :**

- To improve the communicative competence of learners
- To learn to use basic grammatic structures in suitable contexts
- To acquire lexical competence and use them appropriately in a sentence and understand their meaning in a text
- To help learners use language effectively in professional contexts
- To develop learners' ability to read and write complex texts, summaries, articles, blogs, definitions, essays and user manuals.

**UNIT I INTRODUCTION TO EFFECTIVE COMMUNICATION 1**

What is effective communication? (Explain using activities) Why is communication critical for excellence during study, research and work? What are the seven C's of effective communication? What are key language skills? What is effective listening? What does it involve? What is effective speaking? What does it mean to be an excellent reader? What should you be able to do? What is effective writing? How does one develop language and communication skills? What does the course focus on? How are communication and language skills going to be enhanced during this course? What do you as a learner need to do to enhance your English language and communication skills to get the best out of this course?

**INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION 8**

Reading - Reading brochures (technical context), telephone messages / social media messages relevant to technical contexts and emails. Writing - Writing emails / letters introducing oneself. Grammar - Present Tense ( simple and progressive); Question types: Wh/ Yes or No/ and Tags. Vocabulary - Synonyms; One word substitution; Abbreviations & Acronyms (as used in technical contexts).

**UNIT II NARRATION AND SUMMATION 9**

Reading - Reading biographies, travelogues, newspaper reports, Excerpts from literature, and travel & technical blogs. Writing - Guided writing-- Paragraph writing Short Report on an event (field trip etc.) Grammar –Past tense (simple); Subject-Verb Agreement; and Prepositions. Vocabulary - Word forms (prefixes& suffixes); Synonyms and Antonyms. Phrasal verbs.

**UNIT III DESCRIPTION OF A PROCESS / PRODUCT 9**

Reading – Reading advertisements, gadget reviews; user manuals. Writing - Writing definitions; instructions; and Product /Process description. Grammar - Imperatives; Adjectives; Degrees of comparison; Present & Past Perfect Tenses. Vocabulary - Compound Nouns, Homonyms; and Homophones, discourse markers (connectives & sequence words).

**UNIT IV CLASSIFICATION AND RECOMMENDATIONS 9**

Reading – Newspaper articles; Journal reports –and Non Verbal Communcation ( tables, pie charts etc,. ). Writing – Note-making / Note-taking (*Study skills to be taught, not tested); Writing recommendations; Transferring information from non verbal ( chart , graph etc, to verbal mode)
Grammar – Articles; Pronouns - Possessive & Relative pronouns. Vocabulary - Collocations; Fixed / Semi fixed expressions.

**UNIT V EXPRESSION 9**

Reading – Reading editorials; and Opinion Blogs; Writing – Essay Writing (Descriptive or narrative). Grammar – Future Tenses, Punctuation; Negation (Statements & Questions); and Simple, Compound & Complex Sentences. Vocabulary - Cause & Effect Expressions – Content vs Function words.

**TOTAL : 45 PERIODS**

**LEARNING OUTCOMES :**

At the end of the course, learners will be able

- To use appropriate words in a professional context
- To gain understanding of basic grammatical structures and use them in right context.
- To read and interpret information presented in tables, charts and other graphic forms
- To write definitions, descriptions, narrations and essays on various topics

**TEXT BOOKS :**

1. English for Engineers & Technologists Orient Blackswan Private Ltd. Department of English, Anna University, (2020 edition)
2. English for Science & Technology Cambridge University Press, 2021.
   Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

**REFERENCE BOOKS:**

1. Technical Communication – Principles And Practices By Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.
2. A Course Book On Technical English By Lakshminarayanan, Scitech Publications (India) Pvt. Ltd.
3. English For Technical Communication (With CD) By Aysha Viswamohan, Mcgraw Hill Education, ISBN : 0070264244.
4. Effective Communication Skill, Kulbhusan Kumar, RS Salaria, Khanna Publishing House.
5. Learning to Communicate – Dr. V. Chellammal, Allied Publishing House, New Delhi,2003.

**ASSESSMENT PATTERN**

Two internal assessments and an end semester examination to test students' reading and writing skills along with their grammatical and lexical competence.

**CO-PO & PSO MAPPING**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| **1** | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 1 | 3 | - | 3 | - | - | - |
| **2** | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 1 | 3 | - | 3 | - | - | - |
| **3** | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | - | - | - |
| **4** | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | - | - | - |
| **5** | 2 | 3 | 3 | 3 | - | 3 | 3 | 3 | 2 | 3 | - | 3 | - | - | - |
| **AVg.** | 1.6 | 2.2 | 1.8 | 2.2 | 1.5 | 3 | 3 | 3 | 1.6 | 3 | 3 | 3 | - | - | - |

- 1-low, 2-medium, 3-high, '-"- no correlation
- **Note:** The average value of this course to be used for program articulation matrix.

**MA3151 MATRICES AND CALCULUS L T P C**
**3 1 0 4**

**COURSE OBJECTIVES:**

- To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
- To familiarize the students with differential calculus.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To make the students understand various techniques of integration.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.

**UNIT I MATRICES 9+3**

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley - Hamilton theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms – Applications : Stretching of an elastic membrane.

**UNIT II DIFFERENTIAL CALCULUS 9+3**

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules (sum, product, quotient, chain rules) - Implicit differentiation - Logarithmic differentiation - Applications : Maxima and Minima of functions of one variable.

**UNIT III FUNCTIONS OF SEVERAL VARIABLES 9+3**

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Applications : Maxima and minima of functions of two variables and Lagrange's method of undetermined multipliers.

**UNIT IV INTEGRAL CALCULUS 9+3**

Definite and Indefinite integrals - Substitution rule - Techniques of Integration : Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals - Applications : Hydrostatic force and pressure, moments and centres of mass.

**UNIT V MULTIPLE INTEGRALS 9+3**

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals – Applications : Moments and centres of mass, moment of inertia.

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

At the end of the course the students will be able to

CO1 :Use the matrix algebra methods for solving practical problems.
CO2 :Apply differential calculus tools in solving various application problems.
CO3 :Able to use differential calculus ideas on several variable functions.
CO4 :Apply different methods of integration in solving practical problems.
CO5 :Apply multiple integral ideas in solving areas, volumes and other practical problems.

**TEXT BOOKS :**


1. Kreyszig.E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. Grewal.B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition , 2018.
3. James Stewart, " Calculus : Early Transcendentals ", Cengage Learning, 8th Edition, New Delhi, 2015. [For Units II & IV - Sections 1.1, 2.2, 2.3, 2.5, 2.7 (Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1 (Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8 ].


**REFERENCES :**


1. Anton. H, Bivens. I and Davis. S, " Calculus ", Wiley, 10th Edition, 2016
2. Bali. N., Goyal. M. and Watkins. C., " Advanced Engineering Mathematics ", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
3. Jain . R.K. and Iyengar. S.R.K., " Advanced Engineering Mathematics ", Narosa Publications, New Delhi, 5th Edition, 2016.
4. Narayanan. S. and Manicavachagom Pillai. T. K., " Calculus " Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.

5. Ramana. B.V., " Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
6. Srimantha Pal and Bhunia. S.C, " Engineering Mathematics " Oxford University Press, 2015.
7. Thomas. G. B., Hass. J, and Weir. M.D, " Thomas Calculus ", 14th Edition, Pearson India, 2018.

| | PO 01 | PO 02 | PO 03 | PO 04 | PO 05 | PO 06 | PO 07 | PO 08 | PO 09 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | - | - | - |
| **CO2** | 3 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | - | - | - |
| **CO3** | 3 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | - | - | - |
| **CO4** | 3 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | - | - | - |
| **CO5** | 3 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | - | - | - |
| **Avg** | 3 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | - | - | - |

**PH3151** **ENGINEERING PHYSICS** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- To make the students effectively to achieve an understanding of mechanics.
- To enable the students to gain knowledge of electromagnetic waves and its applications.
- To introduce the basics of oscillations, optics and lasers.
- Equipping the students to be successfully understand the importance of quantum physics.
- To motivate the students towards the applications of quantum mechanics.

**UNIT I MECHANICS** **9**

Multi-particle dynamics: Center of mass (CM) – CM of continuous bodies – motion of the CM – kinetic energy of system of particles. Rotation of rigid bodies: Rotational kinematics – rotational kinetic energy and moment of inertia - theorems of M .I –moment of inertia of continuous bodies – M.I of a diatomic molecule - torque – rotational dynamics of rigid bodies – conservation of angular momentum – rotational energy state of a rigid diatomic molecule - gyroscope - torsional pendulum – double pendulum –Introduction to nonlinear oscillations.

**UNIT II ELECTROMAGNETIC WAVES** **9**

The Maxwell's equations - wave equation; Plane electromagnetic waves in vacuum, Conditions on the wave field - properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - polarization - Producing electromagnetic waves - Energy and momentum in EM waves: Intensity, waves from localized sources, momentum and radiation pressure - Cell-phone reception. Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence.

**UNIT III OSCILLATIONS, OPTICS AND LASERS** **9**

Simple harmonic motion - resonance –analogy between electrical and mechanical oscillating systems - waves on a string - standing waves - traveling waves - Energy transfer of a wave - sound waves - Doppler effect. Reflection and refraction of light waves - total internal reflection - interference –Michelson interferometer –Theory of air wedge and experiment. Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein's coefficients - population inversion - Nd-YAG laser, $CO_2$ laser, semiconductor laser –Basic applications of lasers in industry.

**UNIT IV BASIC QUANTUM MECHANICS 9**

Photons and light waves - Electrons and matter waves –Compton effect - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization –Free particle - particle in a infinite potential well: 1D,2D and 3D Boxes- Normalization, probabilities and the correspondence principle.

**UNIT V APPLIED QUANTUM MECHANICS 9**

The harmonic oscillator(qualitative)- Barrier penetration and quantum tunneling(qualitative)- Tunneling microscope - Resonant diode - Finite potential wells (qualitative)- Bloch's theorem for particles in a periodic potential –Basics of Kronig-Penney model and origin of energy bands.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

After completion of this course, the students should be able to

CO1 : Understand the importance of mechanics.
CO2 : Express their knowledge in electromagnetic waves.
CO3 : Demonstrate a strong foundational knowledge in oscillations, optics and lasers.
CO4 : Understand the importance of quantum physics.
CO5 : Comprehend and apply quantum mechanical principles towards the formation of energy bands.

**TEXT BOOKS:**


1. D.Kleppner and R.Kolenkow. An Introduction to Mechanics. McGraw Hill Education (Indian Edition), 2017.
2. E.M.Purcell and D.J.Morin, Electricity and Magnetism, Cambridge Univ.Press, 2013.
3. Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, Concepts of Modern Physics, McGraw-Hill (Indian Edition), 2017.


**REFERENCES:**


1. R.Wolfson. Essential University Physics. Volume 1 & 2. Pearson Education (Indian Edition), 2009.
2. Paul A. Tipler, Physic – Volume 1 & 2, CBS, (Indian Edition), 2004.
3. K.Thyagarajan and A.Ghatak. Lasers: Fundamentals and Applications, Laxmi Publications, (Indian Edition), 2019.
4. D.Halliday, R.Resnick and J.Walker. Principles of Physics, Wiley (Indian Edition), 2015.
5. N.Garcia, A.Damask and S.Schwarz. Physics for Computer Science Students. Springer-Verlag,


**CO's-PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 3 | 2 | 1 | 1 | 1 | - | - | - | - | - | - | - | - | - |
| 2 | 3 | 3 | 2 | 1 | 2 | 1 | - | - | - | - | - | - | - | - | - |
| 3 | 3 | 3 | 2 | 2 | 2 | 1 | - | - | - | - | - | 1 | - | - | - |
| 4 | 3 | 3 | 1 | 1 | 2 | 1 | - | - | - | - | - | - | - | - | |
| 5 | 3 | 3 | 1 | 1 | 2 | 1 | - | - | - | - | - | - | - | - | - |
| AVG | 3 | 3 | 1.6 | 1.2 | 1.8 | 1 | - | - | - | - | - | 1 | - | - | - |

**1-Low,2-Medium,3-High,"-"-no correlation**

**Note: the average value of this course to be used for program articulation matrix.**

**CY3151 ENGINEERING CHEMISTRY L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To inculcate sound understanding of water quality parameters and water treatment techniques.
- To impart knowledge on the basic principles and preparatory methods of nanomaterials.
- To introduce the basic concepts and applications of phase rule and composites.
- To facilitate the understanding of different types of fuels, their preparation, properties and combustion characteristics.
- To familiarize the students with the operating principles, working processes and applications of energy conversion and storage devices.

**UNIT I WATER AND ITS TREATMENT 9**

Water: Sources and impurities, Water quality parameters: Definition and significance of-color, odour, turbidity, pH, hardness, alkalinity, TDS, COD and BOD, flouride and arsenic. Municipal water treatment: primary treatment and disinfection (UV, Ozonation, break-point chlorination). Desalination of brackish water: Reverse Osmosis. Boiler troubles: Scale and sludge, Boiler corrosion, Caustic embrittlement, Priming &foaming. Treatment of boiler feed water: Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) and External treatment – Ion exchange demineralization and zeolite process.

**UNIT II NANOCHEMISTRY 9**

Basics: Distinction between molecules, nanomaterials and bulk materials; Size-dependent properties (optical, electrical, mechanical and magnetic); Types of nanomaterials: Definition, properties and uses of – nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro spinning. Applications of nanomaterials in medicine, agriculture, energy, electronics and catalysis.

**UNIT III PHASE RULE AND COMPOSITES 9**

Phase rule: Introduction, definition of terms with examples. One component system - water system; Reduced phase rule; Construction of a simple eutectic phase diagram - Thermal analysis; Two component system: lead-silver system - Pattinson process.

Composites: Introduction: Definition & Need for composites; Constitution: Matrix materials (Polymer matrix, metal matrix and ceramic matrix) and Reinforcement (fiber, particulates, flakes and whiskers). Properties and applications of: Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites. Hybrid composites - definition and examples.

**UNIT IV FUELS AND COMBUSTION 9**

Fuels: Introduction: Classification of fuels; Coal and coke: Analysis of coal (proximate and ultimate), Carbonization, Manufacture of metallurgical coke (Otto Hoffmann method). Petroleum and Diesel: Manufacture of synthetic petrol (Bergius process), Knocking - octane number, diesel oil - cetane number; Power alcohol and biodiesel.

Combustion of fuels: Introduction: Calorific value - higher and lower calorific values, Theoretical calculation of calorific value; Ignition temperature: spontaneous ignition temperature, Explosive range; Flue gas analysis - ORSAT Method. $CO_2$ emission and carbon foot print.

**UNIT V ENERGY SOURCES AND STORAGE DEVICES 9**

Stability of nucleus: mass defect (problems), binding energy; Nuclear energy: light water nuclear power plant, breeder reactor. Solar energy conversion: Principle, working and applications of solar cells; Recent developments in solar cell materials. Wind energy; Geothermal energy; Batteries: Types of batteries, Primary battery - dry cell, Secondary battery - lead acid battery and lithium-ion-battery; Electric vehicles; working principles Fuel cells: $H_2$-$O_2$ fuel cell, microbial fuel cell; Supercapacitors: Storage principle, types and examples.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

At the end of the course, the students will be able:

CO1 :To infer the quality of water from quality parameter data and propose suitable treatment methodologies to treat water.

CO2 :To identify and apply basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technology applications.

CO3 :To apply the knowledge of phase rule and composites for material selection requirements.

CO4 :To recommend suitable fuels for engineering processes and applications.

CO5 :To recognize different forms of energy resources and apply them for suitable applications in energy sectors.

**TEXT BOOKS:**


1. P. C. Jain and Monica Jain, "Engineering Chemistry", 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2018.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
3. S.S. Dara, "A Text book of Engineering Chemistry", S. Chand Publishing, 12th Edition, 2018.


**REFERENCES:**


1. B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday, "Text book of nanoscience and nanotechnology", Universities Press-IIM Series in Metallurgy and Materials Science, 2018.
2. O.G. Palanna, "Engineering Chemistry" McGraw Hill Education (India) Private Limited, 2nd Edition, 2017.
3. Friedrich Emich, "Engineering Chemistry", Scientific International PVT, LTD, New Delhi, 2014.
4. ShikhaAgarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, Second Edition, 2019.
5. O.V. Roussak and H.D. Gesser, Applied Chemistry-A Text Book for Engineers and Technologists, Springer Science Business Media, New York, 2nd Edition, 2013.


**CO-PO & PSO MAPPING**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 2 | 2 | 1 | - | 1 | 1 | - | - | - | - | 1 | - | - | - |
| 2 | 2 | - | - | 1 | - | 2 | 2 | - | - | - | - | - | - | - | - |
| 3 | 3 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 4 | 3 | 1 | 1 | - | - | 1 | 2 | - | - | - | - | - | - | - | - |
| 5 | 3 | 1 | 2 | 1 | - | 2 | 2 | - | - | - | - | 2 | - | - | - |
| Avg. | 2.8 | 1.3 | 1.6 | 1 | - | 1.5 | 1.8 | - | | - | - | 1.5 | - | - | - |

- 1-low, 2-medium, 3-high, '-"- no correlation

**GE3151 PROBLEM SOLVING AND PYTHON PROGRAMMING L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To understand the basics of algorithmic problem solving.
- To learn to solve problems using Python conditionals and loops.
- To define Python functions and use function calls to solve problems.
- To use Python data structures - lists, tuples, dictionaries to represent complex data.
- To do input/output with files in Python.

**UNIT I COMPUTATIONAL THINKING AND PROBLEM SOLVING 9**

Fundamentals of Computing – Identification of Computational Problems -Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

**UNIT II DATA TYPES, EXPRESSIONS, STATEMENTS 9**

Python interpreter and interactive mode, debugging; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

**UNIT III CONTROL FLOW, FUNCTIONS, STRINGS 9**

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

**UNIT IV LISTS, TUPLES, DICTIONARIES 9**

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.

**UNIT V FILES, MODULES, PACKAGES 9**

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file, Voter's age validation, Marks range validation (0-100).

**TOTAL : 45 PERIODS**

**OUTCOMES:**

**Upon completion of the course, students will be able to**

CO1: Develop algorithmic solutions to simple computational problems.
CO2: Develop and execute simple Python programs.
CO3: Write simple Python programs using conditionals and looping for solving problems.
CO4: Decompose a Python program into functions.
CO5: Represent compound data using Python lists, tuples, dictionaries etc.
CO6: Read and write data from/to files in Python programs.

**TEXT BOOKS:**


1. Allen B. Downey, "Think Python : How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and programming", 1st Edition, BCS Learning & Development Limited, 2017.

**REFERENCES:**


1. Paul Deitel and Harvey Deitel, “Python for Programmers”, Pearson Education, 1st Edition, 2021.
2. G Venkatesh and Madhavan Mukund, “Computational Thinking: A Primer for Programmers and Data Scientists”, 1st Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data‘‘, Third Edition, MIT Press , 2021
4. Eric Matthes, “Python Crash Course, A Hands - on Project Based Introduction to Programming”, 2nd Edition, No Starch Press, 2019.
5. https://www.python.org/
6. Martin C. Brown, “Python: The Complete Reference”, 4th Edition, Mc-Graw Hill, 2018.


**COs- PO’s & PSO’s MAPPING**

| CO’s | PO’s | | | | | | | | | | | | PSO’s | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 3 | 3 | 3 | 2 | - | - | - | - | - | 2 | 2 | 3 | 3 | - |
| 2 | 3 | 3 | 3 | 3 | 2 | - | - | - | - | - | 2 | 2 | 3 | - | - |
| 3 | 3 | 3 | 3 | 3 | 2 | - | - | - | - | - | 2 | - | 3 | - | - |
| 4 | 2 | 2 | - | 2 | 2 | - | - | - | - | - | 1 | - | 3 | - | - |
| 5 | 1 | 2 | - | - | 1 | - | - | - | - | - | 1 | - | 2 | - | - |
| 6 | 2 | 2 | - | - | 2 | - | - | - | - | - | 1 | - | 2 | - | - |
| **AVg.** | **2** | **3** | **3** | **3** | **2** | - | - | - | - | - | **2** | **2** | **3** | **3** | - |

**1 - low, 2 - medium, 3 - high, ‘-' - no correlation**

**GE3152 தமிழர் மரபு L T P C**
**1 0 0 1**

**அலகு I மொழி மற்றும் இலக்கியம்**: **3**

இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

**அலகு II மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை**: **3**

நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள்– பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

**அலகு III நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள் 3**

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

**அலகு IV தமிழர்களின் திணைக் கோட்பாடுகள் 3**

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

**அலகு V இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு 3**

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

**TOTAL : 15 PERIODS**

**TEXT-CUM-REFERENCE BOOKS**


1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

**GE3152 HERITAGE OF TAMILS L T P C**
**1 0 0 1**

**UNIT I LANGUAGE AND LITERATURE 3**

Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

**UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3**

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

**UNIT III FOLK AND MARTIAL ARTS 3**

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

**UNIT IV THINAI CONCEPT OF TAMILS 3**

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

**UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE 3**

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

**TOTAL: 15 PERIODS**

**TEXT-CUM-REFERENCE BOOKS**


1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay)

(Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

**GE3171 PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATOR L T P C**
**0 0 4 2**

**OBJECTIVES:**

- To understand the problem solving approaches.
- To learn the basic programming constructs in Python.
- To practice various computing strategies for Python-based solutions to real world problems.
- To use Python data structures - lists, tuples, dictionaries.
- To do input/output with files in Python.

**EXPERIMENTS:**

Note: The examples suggested in each experiment are only indicative. The lab instructor is expected to design other problems on similar lines. The Examination shall not be restricted to the sample experiments listed here.

1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same. (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.)
2. Python programming using simple statements and expressions (exchange the values of two variables, circulate the values of n variables, distance between two points).
3. Scientific problems using Conditionals and Iterative loops. (Number series, Number Patterns, pyramid pattern)
4. Implementing real-time/technical applications using Lists, Tuples. (Items present in a library/Components of a car/ Materials required for construction of a building –operations of list & tuples)
5. Implementing real-time/technical applications using Sets, Dictionaries. (Language, components of an automobile, Elements of a civil structure, etc.- operations of Sets & Dictionaries)
6. Implementing programs using Functions. (Factorial, largest number in a list, area of shape)
7. Implementing programs using Strings. (reverse, palindrome, character count, replacing characters)
8. Implementing programs using written modules and Python Standard Libraries (pandas, numpy. Matplotlib, scipy)
9. Implementing real-time/technical applications using File handling. (copy from one file to another, word count, longest word)
10. Implementing real-time/technical applications using Exception handling. (divide by zero error, voter's age validity, student mark range validation)
11. Exploring Pygame tool.
12. Developing a game activity using Pygame like bouncing ball, car race etc.

**TOTAL: 60 PERIODS**

**OUTCOMES:**

On completion of the course, students will be able to:

CO1: Develop algorithmic solutions to simple computational problems
CO2: Develop and execute simple Python programs.
CO3: Implement programs in Python using conditionals and loops for solving problems..
CO4: Deploy functions to decompose a Python program.

CO5: Process compound data using Python data structures.
CO6: Utilize Python packages in developing software applications.

**TEXT BOOKS:**

1. Allen B. Downey, “Think Python : How to Think like a Computer Scientist”, 2nd Edition, O’Reilly Publishers, 2016.
2. Karl Beecher, “Computational Thinking: A Beginner's Guide to Problem Solving and Programming”, 1st Edition, BCS Learning & Development Limited, 2017.

**REFERENCES:**

1. Paul Deitel and Harvey Deitel, “Python for Programmers”, Pearson Education, 1st Edition, 2021.
2. G Venkatesh and Madhavan Mukund, “Computational Thinking: A Primer for Programmers and Data Scientists”, 1st Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data‘‘, Third Edition, MIT Press , 2021
4. Eric Matthes, “Python Crash Course, A Hands - on Project Based Introduction to Programming”, 2nd Edition, No Starch Press, 2019.
5. https://www.python.org/
6. Martin C. Brown, “Python: The Complete Reference”, 4th Edition, Mc-Graw Hill, 2018.

**COs- PO’s & PSO’s MAPPING**

| CO’s | PO’s | | | | | | | | | | | | PSO’s | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| **1** | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | 3 | 2 | 3 | 3 | - |
| **2** | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | 3 | 2 | 3 | - | - |
| **3** | 3 | 3 | 3 | 3 | 2 | - | - | - | - | - | 2 | - | 3 | - | - |
| **4** | 3 | 2 | - | 2 | 2 | - | - | - | - | - | 1 | - | 3 | - | - |
| **5** | 1 | 2 | - | - | 1 | - | - | - | - | - | 1 | - | 2 | - | - |
| **6** | 2 | - | - | - | 2 | - | - | - | - | - | 1 | - | 2 | - | - |
| **AVg.** | **2** | **3** | **3** | **3** | **2** | - | - | - | - | - | **2** | **2** | **3** | **3** | - |

**1 - low, 2 - medium, 3 - high, ‘-' - no correlation**

**BS3171 PHYSICS AND CHEMISTRY LABORATORY L T P C**
**0 0 4 2**

**PHYSICS LABORATORY : (Any Seven Experiments)**

**COURSE OBJECTIVES:**

- To learn the proper use of various kinds of physics laboratory equipment.
- To learn how data can be collected, presented and interpreted in a clear and concise manner.
- To learn problem solving skills related to physics principles and interpretation of experimental data.
- To determine error in experimental measurements and techniques used to minimize such error.
- To make the student as an active participant in each part of all lab exercises.

**LIST OF EXPERIMENTS**

1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of regular and irregular objects.
2. Simple harmonic oscillations of cantilever.
3. Non-uniform bending - Determination of Young’s modulus
4. Uniform bending – Determination of Young’s modulus

5. Laser- Determination of the wave length of the laser using grating
6. Air wedge - Determination of thickness of a thin sheet/wire
7. a) Optical fibre -Determination of Numerical Aperture and acceptance angle
   b) Compact disc- Determination of width of the groove using laser.
8. Acoustic grating- Determination of velocity of ultrasonic waves in liquids.
9. Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids
10. Post office box -Determination of Band gap of a semiconductor.
11. Photoelectric effect
12. Michelson Interferometer.
13. Melde's string experiment
14. Experiment with lattice dynamics kit.

**TOTAL: 30 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, the students should be able to

CO1 : Understand the functioning of various physics laboratory equipment.
CO2 : Use graphical models to analyze laboratory data.
CO3 : Use mathematical models as a medium for quantitative reasoning and describing physical reality.
CO4 : Access, process and analyze scientific information.
CO5 : Solve problems individually and collaboratively.

**CO's-PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 2 | 3 | 1 | 1 | - | - | - | - | - | - | - | - | - | - |
| 2 | 3 | 3 | 2 | 1 | 1 | - | - | - | - | - | - | - | - | - | - |
| 3 | 3 | 2 | 3 | 1 | 1 | - | - | - | - | - | - | - | - | - | - |
| 4 | 3 | 3 | 2 | 1 | 1 | - | - | - | - | - | - | - | - | - | - |
| 5 | 3 | 2 | 3 | 1 | 1 | - | - | - | - | - | - | - | - | - | - |
| AVG | 3 | 2.4 | 2.6 | 1 | 1 | | | | | | | | | | |

- **1-Low,2-Medium,3-High,"-"-no correlation**
- **Note: the average value of this course to be used for program articulation matrix.**

## CHEMISTRY LABORATORY: (Any seven experiments )

**OBJECTIVES:**

- To inculcate experimental skills to test basic understanding of water quality parameters, such as, acidity, alkalinity, hardness, DO, chloride and copper.
- To induce the students to familiarize with electroanalytical techniques such as, pH metry, potentiometry and conductometry in the determination of impurities in aqueous solutions.
- To demonstrate the analysis of metals and alloys.
- To demonstrate the synthesis of nanoparticles

**CHEMISTRY LABORATORY: (Any seven experiments to be conducted)**

1. Preparation of $Na_2CO_3$ as a primary standard and estimation of acidity of a water sample using the primary standard
2. Determination of types and amount of alkalinity in water sample.
   - Split the first experiment into two
3. Determination of total, temporary & permanent hardness of water by EDTA method.
4. Determination of DO content of water sample by Winkler's method.
5. Determination of chloride content of water sample by Argentometric method.
6. Estimation of copper content of the given solution by Iodometry.

7. Estimation of TDS of a water sample by gravimetry.
8. Determination of strength of given hydrochloric acid using pH meter.
9. Determination of strength of acids in a mixture of acids using conductivity meter.
10. Conductometric titration of barium chloride against sodium sulphate (precipitation titration)
11. Estimation of iron content of the given solution using potentiometer.
12. Estimation of sodium /potassium present in water using flame photometer.
13. Preparation of nanoparticles ($TiO_2$/ZnO/CuO) by Sol-Gel method.
14. Estimation of Nickel in steel
15. Proximate analysis of Coal

**TOTAL : 30 PERIODS**

**OUT COMES :**

- To analyse the quality of water samples with respect to their acidity, alkalinity, hardness and DO.
- To determine the amount of metal ions through volumetric and spectroscopic techniques
- To analyse and determine the composition of alloys.
- To learn simple method of synthesis of nanoparticles
- To quantitatively analyse the impurities in solution by electroanalytical techniques

**TEXT BOOKS :**

1. J. Mendham, R. C. Denney, J.D. Barnes, M. Thomas and B. Sivasankar, Vogel's Textbook of Quantitative Chemical Analysis (2009).

**CO-PO & PSO MAPPING**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | - | 1 | - | - | 2 | 2 | - | - | - | - | 2 | - | - | - |
| 2 | 3 | 1 | 2 | - | - | 1 | 2 | - | - | - | - | 1 | - | - | - |
| 3 | 3 | 2 | 1 | 1 | - | - | 1 | - | - | - | - | - | - | - | - |
| 4 | 2 | 1 | 2 | - | - | 2 | 2 | - | - | - | - | - | - | - | - |
| 5 | 2 | 1 | 2 | - | 1 | 2 | 2 | - | - | - | - | 1 | - | - | - |
| Avg. | 2.6 | 1.3 | 1.6 | 1 | 1 | 1.4 | 1.8 | - | - | - | - | 1.3 | - | - | - |

**• 1-low, 2-medium, 3-high, '-"- no correlation**

**GE3172 ENGLISH LABORATORY L T P C**
**0 0 2 1**

**OBJECTIVES :**

- To improve the communicative competence of learners
- To help learners use language effectively in academic /work contexts
- To develop various listening strategies to comprehend various types of audio materials like lectures, discussions, videos etc.
- To build on students' English language skills by engaging them in listening, speaking and grammar learning activities that are relevant to authentic contexts.
- To use language efficiently in expressing their opinions via various media.

**UNIT I INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION 6**

Listening for general information-specific details- conversation: Introduction to classmates - Audio / video (formal & informal); Telephone conversation; Listening to voicemail & messages; Listening and filling a form. Speaking - making telephone calls-Self Introduction; Introducing a friend; -

politeness strategies- making polite requests, making polite offers, replying to polite requests and offers- understanding basic instructions( filling out a bank application for example).

**UNIT II NARRATION AND SUMMATION 6**

Listening - Listening to podcasts, anecdotes / stories / event narration; documentaries and interviews with celebrities. Speaking - Narrating personal experiences / events-Talking about current and temporary situations & permanent and regular situations* - describing experiences and feelings- engaging in small talk- describing requirements and abilities.

**UNIT III DESCRIPTION OF A PROCESS / PRODUCT 6**

Listening - Listen to product and process descriptions; a classroom lecture; and advertisements about products. Speaking – Picture description- describing locations in workplaces- Giving instruction to use the product- explaining uses and purposes- Presenting a product- describing shapes and sizes and weights- talking about quantities(large & small)-talking about precautions.

**UNIT IV CLASSIFICATION AND RECOMMENDATIONS 6**

Listening – Listening to TED Talks; Listening to lectures - and educational videos. Speaking – Small Talk; discussing and making plans-talking about tasks-talking about progress- talking about positions and directions of movement-talking about travel preparations- talking about transportation-

**UNIT V EXPRESSION 6**

Listening – Listening to debates/ discussions; different viewpoints on an issue; and panel discussions. Speaking –making predictions- talking about a given topic-giving opinions- understanding a website-describing processes

**TOTAL : 30 PERIODS**

**LEARNING OUTCOMES:**

At the end of the course, learners will be able

- To listen to and comprehend general as well as complex academic ~~texts~~ information
- To listen to and understand different points of view in a discussion
- To speak fluently and accurately in formal and informal communicative contexts
- To describe products and processes and explain their uses and purposes clearly and accurately
- To express their opinions effectively in both formal and informal discussions

**ASSESSMENT PATTERN**

- One online / app based assessment to test listening /speaking
- End Semester **ONLY** listening and speaking will be conducted online.
- Proficiency certification is given on successful completion of listening and speaking internal test and end semester exam.

**CO-PO & PSO MAPPING**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| 2 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| 3 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| 4 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| 5 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| AVg. | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |

- 1-low, 2-medium, 3-high, '-"- no correlation
- **Note:** The average value of this course to be used for program articulation matrix.

**HS3252 PROFESSIONAL ENGLISH -II L T P C**
**2 0 0 2**

**OBJECTIVES :**

- To engage learners in meaningful language activities to improve their reading and writing skills
- To learn various reading strategies and apply in comprehending documents in professional context.
- To help learners understand the purpose, audience, contexts of different types of writing
- To develop analytical thinking skills for problem solving in communicative contexts
- To demonstrate an understanding of job applications and interviews for internship and placements

**UNIT I MAKING COMPARISONS 6**

Reading - Reading advertisements, user manuals, brochures; Writing – Professional emails, Email etiquette - Compare and Contrast Essay; Grammar – Mixed Tenses, Prepositional phrases

**UNIT II EXPRESSING CAUSAL RELATIONS IN SPEAKING AND WRITING 6**

Reading - Reading longer technical texts– Cause and Effect Essays, and Letters / emails of complaint, Writing - Writing responses to complaints. Grammar - Active Passive Voice transformations, Infinitive and Gerunds

**UNIT III PROBLEM SOLVING 6**

Reading - Case Studies, excerpts from literary texts, news reports etc. Writing – Letter to the Editor, Checklists, Problem solution essay / Argumentative Essay. Grammar – Error correction; If conditional sentences

**UNIT IV REPORTING OF EVENTS AND RESEARCH 6**

Reading –Newspaper articles; Writing – Recommendations, Transcoding, Accident Report, Survey Report Grammar – Reported Speech, Modals Vocabulary – Conjunctions- use of prepositions

**UNIT V THE ABILITY TO PUT IDEAS OR INFORMATION COGENTLY 6**

Reading – Company profiles, Statement of Purpose, (SOP), an excerpt of interview with professionals; Writing – Job / Internship application – Cover letter & Resume; Grammar – Numerical adjectives, Relative Clauses.

**TOTAL: 30 PERIODS**

**OUTCOMES:**

At the end of the course, learners will be able

- To compare and contrast products and ideas in technical texts.
- To identify and report cause and effects in events, industrial processes through technical texts
- To analyse problems in order to arrive at feasible solutions and communicate them in the written format.
- To present their ideas and opinions in a planned and logical manner
- To draft effective resumes in the context of job search.

**TEXT BOOKS :**


1. English for Engineers & Technologists (2020 edition) Orient Blackswan Private Ltd. Department of English, Anna University.
2. English for Science & Technology Cambridge University Press 2021.
3. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

**REFERENCE BOOKS:**


1. Raman. Meenakshi, Sharma. Sangeeta (2019). Professional English. Oxford university press. New Delhi.
2. Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, NewDelhi.
3. Learning to Communicate – Dr. V. Chellammal. Allied Publishers, New Delhi, 2003
4. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
5. Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990, Delhi.


**ASSESSMENT PATTERN**

Two internal assessments and an end semester examination to test students' reading and writing skills along with their grammatical and lexical competence.

**CO-PO & PSO MAPPING**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | - | - | - |
| 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | - | - | - |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | - | - | - |
| 4 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | - | - | - |
| 5 | - | - | - | - | - | - | - | - | 3 | 3 | 3 | 3 | - | - | - |
| AVg. | 3 | 3 | 3 | 3 | 2.75 | 3 | 3 | 3 | 2.2 | 3 | 3 | 3 | - | - | - |

- 1-low, 2-medium, 3-high, '-"- no correlation
- **Note:** The average value of this course to be used for program articulation matrix.

**MA3251 STATISTICS AND NUMERICAL METHODS L T P C**
**3 1 0 4**

**OBJECTIVES:**

- This course aims at providing the necessary basic concepts of a few statistical and numerical methods and give procedures for solving numerically different kinds of problems occurring in engineering and technology.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

**UNIT I TESTING OF HYPOTHESIS 9+3**

Sampling distributions - Tests for single mean, proportion and difference of means (Large and small samples) – Tests for single variance and equality of variances – Chi square test for goodness of fit – Independence of attributes.

**UNIT II DESIGN OF EXPERIMENTS 9+3**

One way and two way classifications - Completely randomized design – Randomized block design

– Latin square design - $2^2$ factorial design.

**UNIT III SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 9+3**

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method- Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigenvalues of a matrix by Power method and Jacobi's method for symmetric matrices.

**UNIT IV INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION 9+3**

Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of derivates using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

**UNIT V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 9+3**

Single step methods: Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge-Kutta method for solving first order differential equations - Multi step methods: Milne's and Adams - Bash forth predictor corrector methods for solving first order differential equations.

**TOTAL: 60 PERIODS**

**OUTCOMES:**

Upon successful completion of the course, students will be able to:

- Apply the concept of testing of hypothesis for small and large samples in real life problems.
- Apply the basic concepts of classifications of design of experiments in the field of agriculture.
- Appreciate the numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.
- Understandthe knowledge of various techniques and methods for solving first and second order ordinary differential equations.
- Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.

**TEXT BOOKS:**


1. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.
2. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.


**REFERENCES:**


1. Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014.
3. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 7th Edition, 2007.
4. Gupta S.C. and Kapoor V. K., " Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi, 12th Edition, 2020.
5. Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics ", Tata McGraw Hill Edition, 4th Edition, 2012.
6. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", 9th Edition, Pearson Education, Asia, 2010.

| | PO 01 | PO 02 | PO 03 | PO 04 | PO 05 | PO 06 | PO 07 | PO 08 | PO 09 | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | - | - | - |
| **CO2** | 3 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | - | - | - |
| **CO3** | 3 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | - | - | - |
| **CO4** | 3 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | - | - | - |
| **CO5** | 3 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | - | - | - |
| **Avg** | 3 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | - | - | - |

**PH3258 PHYSICS OF MATERIALS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To make the students to understand the basics of phase diagrams and various materials preparation techniques
- To equip the students to have a knowledge on different types of electron theory, basics of quantum mechanics and about superconductors
- To introduce the physics of semiconducting materials and applications of semiconductors in device fabrication
- To familiarize the students with the theory and applications of magnetic and dielectric materials
- To provide the students a sound platform towards learning about advanced materials and their applications.

**UNIT I PREPARATION OF MATERIALS 9**

Phases - phase rule – binary systems – tie line – lever rule – phase diagram – invariant reactions - nucleation – homogeneous and heterogeneous nucleation – free energy of formation of a critical nucleus – Thin films – preparation: PVD, CVD method – Nanomaterials Preparation: wet chemical, solvothermal, sol-gel method.

**UNIT II ELECTRICAL PROPERTIES OF MATERIALS 9**

Classical free electron theory - expression for electrical conductivity – thermal conductivity, - Wiedemann-Franz law - Quantum free electron theory – tunneling - degenerate states – Fermi-Dirac statistics – density of energy states – electron in periodic potential – electron effective mass – concept of hole. Superconducting phenomena, properties of superconductors – Meissner effect and isotope effect. Type I and Type II superconductors, High $T_c$ superconductors – Magnetic levitation and SQUIDS.

**UNIT III SEMICONDUCTING PROPERTIESMATERIALS 9**

Elemental Semiconductors - Compound semiconductors - Origin of band gap in solids (qualitative) - carrier concentration in metals - carrier concentration in an intrinsic semiconductor (derivation) – Fermi level – variation of Fermi level with temperature – electrical conductivity – band gap determination – carrier concentration in n-type and p-type semiconductors (derivation) – variation of Fermi level with temperature and impurity concentration – Hall effect – determination of Hall coefficient – LED - Solar cells.

**UNIT IV DIELECTRIC AND MAGNETIC MATERIALS 9**

Dielectric, Paraelectric and ferroelectric materials - Electronic, Ionic, Orientational and space charge polarization – Internal field and deduction of Clausius Mosotti equation – dielectric loss –

different types of dielectric breakdown – classification of insulating materials and their applications - Ferroelectric materials - Introduction to magnetic materials - Domain theory of ferromagnetism, Hysteresis, Soft and Hard magnetic materials – Anti-ferromagnetic materials – Ferrites, Giant Magneto Resistance materials.

**UNIT V NEW MATERIALS AND APPLICATIONS 9**

Ceramics – types and applications – Composites: classification, role of matrix and reinforcement – processing of fibre reinforced plastics and fibre reinforced metals – Metallic glasses – Shape memory alloys – Copper, Nickel and Titanium based alloys – grapheme and its properties – Relaxor ferroelectrics - Biomaterials – hydroxyapatite – PMMA – Silicone - Sensors: Chemical Sensors - Bio-sensors – Polymer semiconductors – Photoconducting polymers.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course, the students should be able to

CO1 : acquire knowledge of phase diagram, and thin film and nanomaterial preparation techniques

CO2 : familiarize with conducting materials, basic quantum mechanics, and properties and applications of superconductors.

CO3 : gain knowledge on semiconducting materials based on energy level diagrams, its types, temperature effect. Also, fabrication methods for semiconductor devices will be understood.

CO4 : realize with theories and applications of dielectric and ferromagnetic materials

CO5 : familiarize with ceramics, composites, metallic glasses, shape memory alloys, biomaterials and their important applications.

**TEXT BOOKS:**


1. W.D.Callitser and D.G.Rethwish. Materials Science and Engineering. John Wiley & Sons, 2014.
2. V.Raghavan. Materials Science and Engineering: A First Course. PHI Learning, 2015.
3. M.F.Ashby, P.J.Ferreira and D.L.Schodek. Nanomaterials, Nanotechnologies and Design: An Introduction for Engineers, 2011.


**REFERENCES:**


1. J.F.Shackelford. Introduction to Materials Science for Engineers. Pearson, 2015.
2. D.R. Askeland and W.J.Wright. Essentials of Materials Science and Engineering, Cengage Learning, 2013.
3. Charles Kittel, Introduction to Solid State Physics, Wiley India Edition, 2019.
4. Jean P.Mercier, G.Zambelli and W.Kurz, Introduction to Materials Science, Elsevier, 2002.
5. Yaser Dahman, Nanotechnology and Functional Materials for Engineers, Elsevier, 2017.


**CO's-PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 2 | 2 | 3 | 2 | 1 | 2 | 1 | - | - | - | 1 | - | - | - |
| 2 | 3 | 3 | 2 | - | - | 1 | - | - | - | - | - | - | - | - | - |
| 3 | 3 | 2 | 2 | 1 | - | 2 | 1 | - | - | - | - | 1 | - | - | - |
| 4 | 3 | 2 | - | 1 | 2 | 2 | 2 | - | - | - | - | 1 | - | - | - |
| 5 | 3 | - | 2 | - | 2 | 2 | 2 | - | - | - | - | 1 | - | - | - |
| AVG | 3 | 2.25 | 2 | 1.66 | 2 | 1.6 | 1.75 | 1 | | | | 1 | | | |

**1-Low,2-Medium,3-High,"-"-no correlation**

**Note: the average value of this course to be used for program articulation matrix.**

**BE3252 BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION ENGINEERING** **L T P C 3 0 0 3**

**OBJECTIVES :**

- To introduce the basics of electric circuits and analysis
- To impart knowledge in domestic wiring
- To impart knowledge in the basics of working principles and application of electrical machines
- To introduce analog devices and their characteristics
- To introduce the functional elements and working of sensors and transducers.

**UNIT I ELECTRICAL CIRCUITS** **9**

DC Circuits: Circuit Components: Conductor, Resistor, Inductor, Capacitor – Ohm's Law - Kirchhoff's Laws – Simple problems- Nodal Analysis, Mesh analysis with Independent sources only (Steady state)

Introduction to AC Circuits and Parameters: Waveforms, Average value, RMS Value, Instantaneous power, real power, reactive power and apparent power, power factor – Steady state analysis of RLC circuits (Simple problems only), Three phase supply – star and delta connection – power in three-phase systems

**UNIT II MAGNETIC CIRCUITS AND ELECTRICAL INSTALLATIONS** **9**

Magnetic circuits-definitions-MMF, flux, reluctance, magnetic field intensity, flux density, fringing, self and mutual inductances-simple problems.

Domestic wiring , types of wires and cables, earthing ,protective devices- switch fuse unit-Miniature circuit breaker-moulded case circuit breaker- earth leakage circuit breaker, safety precautions and First Aid

.

**UNIT III ELECTRICAL MACHINES** **9**

Construction and Working principle- DC Separately and Self excited Generators, EMF equation, Types and Applications. Working Principle of DC motors, Torque Equation, Types and Applications. Construction, Working principle and Applications of Transformer, Three phase Alternator, Synchronous motor and Three Phase Induction Motor.

**UNIT IV ANALOG ELECTRONICS** **9**

Resistor, Inductor and Capacitor in Electronic Circuits- Semiconductor Materials: Silicon &Germanium – PN Junction Diodes, Zener Diode –Characteristics Applications – Bipolar Junction Transistor-Biasing, JFET, SCR, MOSFET,IGBT – Types, I-V Characteristics and Applications, Rectifier and Inverters, harmonics

**UNIT V SENSORS AND TRANSDUCERS** **9**

Sensors, solenoids, pneumatic controls with electrical actuator, mechatronics, types of valves and its applications, electro-pneumatic systems, proximity sensors, limit switches, piezoelectric, hall effect, photo sensors,Strain gauge, LVDT, differential pressure transducer,optical and digital transducers, Smart sensors, Thermal Imagers.

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

After completing this course, the students will be able to

**CO1:** Compute the electric circuit parameters for simple problems
**CO2:** Explain the concepts of domestics wiring and protective devices
**CO3:** Explain the working principle and applications of electrical machines
**CO4:** Analyze the characteristics of analog electronic devices
**CO5:** Explain the types and operating principles of sensors and transducers

**TEXT BOOKS:**


1. D P Kothari and I.J Nagarath, "Basic Electrical and Electronics Engineering", McGraw Hill Education (India) Private Limited, Second Edition, 2020
2. A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, 2015.
3. S.K. Bhattacharya, Basic Electrical Engineering, Pearson Education, 2019
4. James A Svoboda, Richard C. Dorf, Dorf's Introduction to Electric Circuits, Wiley,2018


**REFERENCES:**


1. John Bird, "Electrical Circuit theory and technology", Routledge; 2017.
2. Thomas L. Floyd, 'Electronic Devices', 10th Edition, Pearson Education, 2018.
3. Albert Malvino, David Bates, '**Electronic Principles**, McGraw Hill Education; 7th edition, 2017
4. Muhammad H.Rashid, "Spice for Circuits and electronics", 4th Edition.,Cengage India,2019.
5. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw-Hill, New Delhi, 2010


**CO's, PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 2 | 1 | 1 | | | | | 1 | | | | | - | - | - |
| 2 | 2 | 1 | 1 | | | | | 1 | | | | | - | - | - |
| 3 | 2 | 1 | 1 | | | | | 1 | | | | | - | - | - |
| 4 | 2 | 1 | 1 | | | | | 1 | | | | | - | - | - |
| 5 | 2 | 1 | 1 | | | | | 1 | | | | | - | - | - |
| Avg. | 2 | 1 | 1 | | | | | 1 | | | | | - | - | - |

**CY3201 PHYSICAL AND ORGANIC CHEMISTRY L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To understand concepts of chemical thermodynamics and partial molar quantities
- To impart thorough knowledge on rubber and plastics
- To make the student conversant with adsorption and oxidation process
- To provide comprehensive information and exposure to synthesis of monomers
- To learn and understand the structure and reactivity in organic compounds

**UNIT I CHEMICAL THERMODYNAMICS 9**

Introduction to thermodynamics – Need for second law of thermodynamics, third law of thermodynamics and its validity - Entropy and probability - Maxwell relations - Gibbs – Helmholtz equation - Van't Hoff's equation - Chemical potential - Partial molar quantities, methods of calculation Ideal and non-ideal solutions Thermodynamic criteria of polymer solubility, solubility parameter.

**UNIT II RUBBER AND PLASTICS 9**

Introduction to rubber - latex - processing latex - mastication - compounding of rubber - vulcanizations of rubber - engineering polymers thermoforming - degradation stability and environment- synthetic rubbers preparation and applications of SBR - butyl rubber - nitrile rubber - neoprene and silicone rubber- plastic materials - classification of plastics (or resins) - moulding constituents of a plastic – fabrication techniques used for thermoplastic resin (moulding process)-important thermoplastic resins- natural resins - celluloses – polyethylene – PVC.

**UNIT III REACTION MECHANISMS 9**

Free radical substitutions, Electrophilic addition, Aromatic Electrophilic substitutions, Nucleophilic

additions, condensation reactions, nucleophilic substitutions in aliphatic compounds, cycloadditions, Rearrangements Beckmann, Curtius, Hofmann, cope and oxy-cope, Fries rearrangement reactions (Mechanism not required).

**UNIT IV MONOMERS IN POLYMER TECHNOLOGY 9**

Preparation, properties and uses of monomers: ethylene, propylene, isobutylene, butadiene, styrene, methyl methacrylate, diisocyanates, glycols, polyols, epichlorohydrin, Tetrafluoro ethylene, acrylonitrile, vinyl chloride, vinyl acetate, Caprolactam.

**UNIT V STRUCTURE AND REACTIVITY IN ORGANIC COMPOUNDS 9**

Bonding in Organic Compounds: alkane, alkene and alkyne - Structure-property relationships Electronic effects: inductive, mesomeric, electromeric and hyperconjugation. Free radicals, carbocations, carbanions, elementary ideas about stereo chemistry RS-nomenclature and EZ-nomenclature

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- Will be able to understand chemical thermodynamics and the influence of chemical potential
- Will be familiar in rubber and plastics
- Will be conversant in the reaction mechanisms in organic chemistry
- Will have the ability to synthesize the monomers for the use of man kind
- Can investigate on the structure and reactivity of organic compounds

**TEXT BOOKS**


1. Glasstone, S., and D. Lewis, “Elements of Physical Chemistry”, Macmillan, 1995.
2. Finar I.L., “Textbook of Organic Chemistry”, ELBS, 1996.
3. Gowariker V.R, Viswanathan N. V and Jayadev Sreedhar, “Polymer Science”, New Age International (P) Ltd, 2005


**REFERENCES:**


1. Maron and C.F. Pruton, “Physical Chemistry”, Macmillan, 4th Edition, 2017.
2. Morrison and Boyd, “Organic Chemistry”, Pearson, 2010.
3. Morawetz H., “Macromolecules in Solution”, R.E. Krieger Publishing Company, 1983.
4. Mishra Chandra, Plastic and Rubber Technology, CBS Publishers, 2021
5. Michael B. Smith and Jerry March, “March’s Advanced Organic Chemistry Reactions, Mechanisms And Structure” 6th Edition, Wiley-Interscience A John Wiley & Sons, Inc., Publication, 2007


**GE3251 ENGINEERING GRAPHICS L T P C**
**2 0 4 4**

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Drawing engineering curves.
- Drawing freehand sketch of simple objects.
- Drawing orthographic projection of solids and section of solids.
- Drawing development of solids
- Drawing isometric and perspective projections of simple solids.

**CONCEPTS AND CONVENTIONS (Not for Examination)**

Importance of graphics in engineering applications — Use of drafting instruments — BIS conventions and specifications — Size, layout and folding of drawing sheets — Lettering and dimensioning.

**UNIT I PLANE CURVES 6+12**

Basic Geometrical constructions, Curves used in engineering practices: Conics — Construction of ellipse, parabola and hyperbola by eccentricity method — Construction of cycloid — construction of involutes of square and circle — Drawing of tangents and normal to the above curves.

**UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE 6+12**

Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

**UNIT III PROJECTION OF SOLIDS AND FREEHAND SKETCHING 6+12**

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes and parallel to the other by rotating object method. Visualization concepts and Free Hand sketching: Visualization principles —Representation of Three Dimensional objects — Layout of views- Freehand sketching of multiple views from pictorial views of objects.

Practicing three dimensional modeling of simple objects by CAD Software(Not for examination)

**UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 6+12**

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other — obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids — Prisms, pyramids cylinders and cones.

Practicing three dimensional modeling of simple objects by CAD Software(Not for examination)

**UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS 6+12**

Principles of isometric projection — isometric scale —Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions - Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.

Practicing three dimensional modeling of isometric projection of simple objects by CAD Software(Not for examination)

**TOTAL: (L=30+P=60) 90 PERIODS**

**OUTCOMES:**

On successful completion of this course, the student will be able to

- Use BIS conventions and specifications for engineering drawing.
- Construct the conic curves, involutes and cycloid.
- Solve practical problems involving projection of lines.
- Draw the orthographic, isometric and perspective projections of simple solids.
- Draw the development of simple solids.

**TEXT BOOKS:**


1. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 53rd Edition, 2019.
2. Natrajan K.V., “A Text Book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2018.
3. Parthasarathy, N. S. and Vela Murali, “Engineering Drawing”, Oxford University Press, 2015

**REFERENCES:**


1. Basant Agarwal and Agarwal C.M., "Engineering Drawing", McGraw Hill, 2nd Edition, 2019.
2. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Publications, Bangalore, 27th Edition, 2017.
3. Luzzader, Warren.J. and Duff,John M., "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
4. Parthasarathy N. S. and Vela Murali, "Engineering Graphics", Oxford University, Press, New Delhi, 2015.
5. Shah M.B., and Rana B.C., "Engineering Drawing", Pearson Education India, 2nd Edition, 2009.
6. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2008.


**Publication of Bureau of Indian Standards:**

1. IS 10711 — 2001: Technical products Documentation — Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) — 2001: Technical products Documentation — Lettering.
3. IS 10714 (Part 20) — 2001 & SP 46 — 2003: Lines for technical drawings.
4. IS 11669 — 1986 & SP 46 —2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) — 2001: Technical drawings — Projection Methods.

**Special points applicable to University Examinations on Engineering Graphics:**

1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 1 | 2 | | 2 | | | | | 3 | | 2 | 2 | 2 | |
| 2 | 3 | 1 | 2 | | 2 | | | | | 3 | | 2 | 2 | 2 | |
| 3 | 3 | 1 | 2 | | 2 | | | | | 3 | | 2 | 2 | 2 | |
| 4 | 3 | 1 | 2 | | 2 | | | | | 3 | | 2 | 2 | 2 | |
| 5 | 3 | 1 | 2 | | 2 | | | | | 3 | | 2 | 2 | 2 | |
| **Avg** | **3** | **1** | **2** | | **2** | | | | | **3** | | **2** | **2** | **2** | |
| Low (1) ; Medium (2) ; High (3) | | | | | | | | | | | | | | | |

**GE3252 தமிழரும் தொழில்நுட்பமும் L T P C**
**1 0 0 1**

**அலகு I நெசவு மற்றும் பானைத் தொழில்நுட்பம் 3**

சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

**அலகு II வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம் 3**

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் -

மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.

**அலகு III உற்பத்தித் தொழில் நுட்பம் 3**

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

**அலகு IV வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம் 3**

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

**அலகு V அறிவியல் தமிழ் மற்றும் கணித்தமிழ் 3**

அறிவியல் தமிழின் வளர்ச்சி –கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

**TOTAL: 15 PERIODS**

**TEXT-CUM-REFERENCE BOOKS**


1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

**GE3252 TAMILS AND TECHNOLOGY L T P C**
**1 0 0 1**

**UNIT I WEAVING AND CERAMIC TECHNOLOGY 3**

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

**UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY 3**

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

**UNIT III MANUFACTURING TECHNOLOGY 3**

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold-Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

**UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY 3**

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

**UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING 3**

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

**TOTAL : 15 PERIODS**

**TEXT-CUM-REFERENCE BOOKS**


1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

**NCC Credit Course Level 1***

| **NX3251** | **(ARMY WING) NCC Credit Course Level - I** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | | **2** | **0** | **0** | **2** |
| **NCC GENERAL** | | | | | **6** |
| NCC 1 | Aims, Objectives & Organization of NCC | | | | 1 |
| NCC 2 | Incentives | | | | 2 |
| NCC 3 | Duties of NCC Cadet | | | | 1 |
| NCC 4 | NCC Camps: Types & Conduct | | | | 2 |
| **NATIONAL INTEGRATION AND AWARENESS** | | | | | **4** |
| NI 1 | National Integration: Importance & Necessity | | | | 1 |
| NI 2 | Factors Affecting National Integration | | | | 1 |
| NI 3 | Unity in Diversity & Role of NCC in Nation Building | | | | 1 |
| NI 4 | Threats to National Security | | | | 1 |
| **PERSONALITY DEVELOPMENT** | | | | | **7** |
| PD 1 | Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving | | | | 2 |
| PD 2 | Communication Skills | | | | 3 |
| PD 3 | Group Discussion: Stress & Emotions | | | | 2 |
| **LEADERSHIP** | | | | | **5** |
| L 1 | Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour 'Code | | | | 3 |
| L 2 | Case Studies: Shivaji, Jhasi Ki Rani | | | | 2 |
| **SOCIAL SERVICE AND COMMUNITY DEVELOPMENT** | | | | | **8** |
| SS 1 | Basics, Rural Development Programmes, NGOs, Contribution of Youth | | | | 3 |
| SS 4 | Protection of Children and Women Safety | | | | 1 |
| SS 5 | Road / Rail Travel Safety | | | | 1 |
| SS 6 | New Initiatives | | | | 2 |
| SS 7 | Cyber and Mobile Security Awareness | | | | 1 |

**TOTAL : 30 PERIODS**

**NCC Credit Course Level 1***

| **NX3252** | **(NAVAL WING) NCC Credit Course Level - I** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | | **2** | **0** | **0** | **2** |
| **NCC GENERAL** | | | | | **6** |
| NCC 1 | Aims, Objectives & Organization of NCC | | | | 1 |
| NCC 2 | Incentives | | | | 2 |
| NCC 3 | Duties of NCC Cadet | | | | 1 |
| NCC 4 | NCC Camps: Types & Conduct | | | | 2 |
| **NATIONAL INTEGRATION AND AWARENESS** | | | | | **4** |
| NI 1 | National Integration: Importance & Necessity | | | | 1 |
| NI 2 | Factors Affecting National Integration | | | | 1 |
| NI 3 | Unity in Diversity & Role of NCC in Nation Building | | | | 1 |
| NI 4 | Threats to National Security | | | | 1 |
| **PERSONALITY DEVELOPMENT** | | | | | **7** |

| | | |
|---|---|---|
| PD 1 | Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving | 2 |
| PD 2 | Communication Skills | 3 |
| PD 3 | Group Discussion: Stress & Emotions | 2 |
| **LEADERSHIP** | | **5** |
| L 1 | Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code | 3 |
| L 2 | Case Studies: Shivaji, Jhasi Ki Rani | 2 |
| **SOCIAL SERVICE AND COMMUNITY DEVELOPMENT** | | **8** |
| SS 1 | Basics, Rural Development Programmes, NGOs, Contribution of Youth | 3 |
| SS 4 | Protection of Children and Women Safety | 1 |
| SS 5 | Road / Rail Travel Safety | 1 |
| SS 6 | New Initiatives | 2 |
| SS 7 | Cyber and Mobile Security Awareness | 1 |

**TOTAL : 30 PERIODS**

## NCC Credit Course Level 1*

| **NX3253** | **(AIR FORCE WING) NCC Credit Course Level - I** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | | **2** | **0** | **0** | **2** |

| | | |
|---|---|---|
| **NCC GENERAL** | | **6** |
| NCC 1 | Aims, Objectives & Organization of NCC | 1 |
| NCC 2 | Incentives | 2 |
| NCC 3 | Duties of NCC Cadet | 1 |
| NCC 4 | NCC Camps: Types & Conduct | 2 |
| **NATIONAL INTEGRATION AND AWARENESS** | | **4** |
| NI 1 | National Integration: Importance & Necessity | 1 |
| NI 2 | Factors Affecting National Integration | 1 |
| NI 3 | Unity in Diversity & Role of NCC in Nation Building | 1 |
| NI 4 | Threats to National Security | 1 |
| **PERSONALITY DEVELOPMENT** | | **7** |
| PD 1 | Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving | 2 |
| PD 2 | Communication Skills | 3 |
| PD 3 | Group Discussion: Stress & Emotions | 2 |
| **LEADERSHIP** | | **5** |
| L 1 | Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code | 3 |
| L 2 | Case Studies: Shivaji, Jhasi Ki Rani | 2 |
| **SOCIAL SERVICE AND COMMUNITY DEVELOPMENT** | | **8** |
| SS 1 | Basics, Rural Development Programmes, NGOs, Contribution of Youth | 3 |
| SS 4 | Protection of Children and Women Safety | 1 |
| SS 5 | Road / Rail Travel Safety | 1 |
| SS 6 | New Initiatives | 2 |
| SS 7 | Cyber and Mobile Security Awareness | 1 |

**TOTAL : 30 PERIODS**

**GE3271 ENGINEERING PRACTICES LABORATORY L T P C**
**0 0 4 2**

**COURSE OBJECTIVES:**

- Drawing pipe line plan; laying and connecting various pipe fittings used in common household plumbing work; Sawing; planing; making joints in wood materials used in commonhousehold wood work.
- Wiring various electrical joints in common household electrical wire work.
- Welding various joints in steel plates using arc welding work; Machining various simple processes like turning, drilling, tapping in parts; Assembling simple mechanical assembly of common household equipments; Making a tray out of metal sheet using sheet metal work.
- Soldering and testing simple electronic circuits; Assembling and testing simple electronic components on PCB.

**GROUP – A (CIVIL & ELECTRICAL)**

**PART I CIVIL ENGINEERING PRACTICES 15**

**PLUMBING WORK:**

a) Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers,elbows and other components which are commonly used in household.
b) Preparing plumbing line sketches.
c) Laying pipe connection to the suction side of a pump
d) Laying pipe connection to the delivery side of a pump.
e) Connecting pipes of different materials: Metal, plastic and flexible pipes used inhousehold appliances.

**WOOD WORK:**

a) Sawing,
b) Planing and
c) Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.

Wood Work Study:

a) Studying joints in door panels and wooden furniture
b) Studying common industrial trusses using models.

**PART II ELECTRICAL ENGINEERING PRACTICES 15**

a) Introduction to switches, fuses, indicators and lamps - Basic switch board wiring with lamp, fan and three pin socket
b) Staircase wiring
c) Fluorescent Lamp wiring with introduction to CFL and LED types.
d) Energy meter wiring and related calculations/ calibration
e) Study of Iron Box wiring and assembly
f) Study of Fan Regulator (Resistor type and Electronic type using Diac/Triac/quadrac)
g) Study of emergency lamp wiring/Water heater

**GROUP – B (MECHANICAL AND ELECTRONICS)**

**PART III MECHANICAL ENGINEERING PRACTICES 15**

**WELDING WORK:**

a) Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding.
b) Practicing gas welding.

**BASIC MACHINING WORK:**

a) (simple)Turning.
b) (simple)Drilling.
c) (simple)Tapping.

**ASSEMBLY WORK:**

a) Assembling a centrifugal pump.
b) Assembling a household mixer.
c) Assembling an airconditioner.

**SHEET METAL WORK:**

a) Making of a square tray

**FOUNDRY WORK:**

a) Demonstrating basic foundry operations.

**PART IV ELECTRONIC ENGINEERING PRACTICES 15**

**SOLDERING WORK:**

a) Soldering simple electronic circuits and checking continuity.

**ELECTRONIC ASSEMBLY AND TESTING WORK:**

a) Assembling and testing electronic components on a small PCB.

**ELECTRONIC EQUIPMENT STUDY:**

a) Study an elements of smart phone..
b) Assembly and dismantle of LED TV.
c) Assembly and dismantle of computer/ laptop

**TOTAL : 60 PERIODS**

**COURSE OUTCOMES**:

Upon completion of this course, the students will be able to:

CO1 : Draw pipe line plan; lay and connect various pipe fittings used in common household plumbing work; Saw; plan; make joints in wood materials used in common household wood work.

CO2 : Wire various electrical joints in common household electrical wire work.

CO3 : Weld various joints in steel plates using arc welding work; Machine various simple processeslike turning, drilling, tapping in parts; Assemble simple mechanical assembly of common household equipments; Make a tray out of metal sheet using sheet metal work.

CO4 : Solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 2 | | | 1 | 1 | 1 | | | | | 2 | 2 | 1 | 1 |
| 2 | 3 | 2 | | | 1 | 1 | 1 | | | | | 2 | 2 | 1 | 1 |
| 3 | 3 | 2 | | | 1 | 1 | 1 | | | | | 2 | 2 | 1 | 1 |
| **Avg** | **3** | **2** | | | **1** | **1** | **1** | | | | | **2** | **2** | **1** | **1** |
| Low (1) ; Medium (2) ; High (3) | | | | | | | | | | | | | | | |

**BE3272 BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION ENGINEERING LABORATORY** **L T P C 0 0 4 2**

**COURSE OBJECTIVES:**

- To train the students in conducting load tests electrical machines
- To gain practical experience in experimentally obtaining the characteristics of electronic devices and rectifiers
- To train the students to measure three phase power and displacement

**LIST OF EXPERIMENTS**

1. Verification of ohms and Kirchhoff's Laws.
2. Three Phase Power Measurement
3. Load test on DC Shunt Motor.
4. Load test on Self Excited DC Generator
5. Load test on Single phase Transformer
6. Load Test on Induction Motor
7. Characteristics of PN and Zener Diodes
8. Characteristics of BJT, SCR and MOSFET
9. Design and analysis of Half wave and Full Wave rectifiers
10. Measurement of displacement of LVDT

. **TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

After completing this course, the students will be able to

**CO1:** Use experimental methods to verify the Ohm's law and Kirchhoff's Law and to measure three phase power
**CO2:** Analyze experimentally the load characteristics of electrical machines
**CO3:** Analyze the characteristics of basic electronic devices
**CO4:** Use LVDT to measure displacement

**CO's, PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 2 | 3 | 1 | 2 | | | | 1.5 | 2 | | | | - | - | - |
| 2 | 2 | 3 | 1 | 2 | | | | 1.5 | 2 | | | | - | - | - |
| 3 | 2 | 3 | 1 | 2 | | | | 1.5 | 2 | | | | - | - | - |
| 4 | 2 | 3 | 1 | 2 | | | | 1.5 | 2 | | | | - | - | - |
| Avg. | 1.6 | 1.4 | 0.8 | 1.6 | | | | 1.2 | 1.6 | | | | | | |

**GE3272 COMMUNICATION LABORATORY** **L T P C 0 0 4 2**

**OBJECTIVES**

- To identify varied group discussion skills and apply them to take part in effective discussions in a professional context.
- To analyse concepts and problems and make effective presentations explaining them clearly and precisely.
- To be able to communicate effectively through formal and informal writing.
- To be able to use appropriate language structures to write emails, reports and essays
- To give instructions and recommendations that are clear and relevant to the context

**UNIT I** **12**

Speaking-Role Play Exercises Based on Workplace Contexts, - talking about competition-discussing progress toward goals-talking about experiences- talking about events in life-discussing past events-Writing: writing emails ( formal & semi-formal).

**UNIT II** **12**

Speaking: discussing news stories-talking about frequency-talking about travel problems-discussing travel procedures- talking about travel problems- making arrangements-describing arrangements-discussing plans and decisions- discussing purposes and reasons- understanding common technology terms-Writing: - writing different types of emails.

**UNIT III** **12**

Speaking: discussing predictions-describing the climate-discussing forecasts and scenarios-talking about purchasing-discussing advantages and disadvantages- making comparisons-discussing likes and dislikes- discussing feelings about experiences-discussing imaginary scenarios Writing: short essays and reports-formal/semi-formal letters.

**UNIT IV** **12**

Speaking: discussing the natural environment-describing systems-describing position and movement- explaining rules-( example- discussing rental arrangements)- understanding technical instructions-Writing: writing instructions-writing a short article.

**UNIT V** **12**

Speaking: describing things relatively-describing clothing-discussing safety issues( making recommendations) talking about electrical devices-describing controlling actions- Writing:
job application( Cover letter + Curriculum vitae)-writing recommendations.

**TOTAL: 60 PERIODS**

**LEARNING OUTCOMES**

At the end of the course, learners will be able

- Speak effectively in group discussions held in ~~a~~ formal/semi formal contexts.
- Discuss, analyse and present concepts and problems from various perspectives to arrive at suitable solutions
- Write emails, letters and effective job applications.
- Write critical reports to convey data and information with clarity and precision
- Give appropriate instructions and recommendations for safe execution of tasks

**Assessment Pattern**

- One online / app based assessment to test speaking and writing skills
- Proficiency certification is given on successful completion of speaking and writing.

**CO-PO & PSO MAPPING**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 2 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| 2 | 2 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| 3 | 2 | 2 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| 5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| AVg. | 2.4 | 2.8 | 3 | 3 | 1.8 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |

- 1-low, 2-medium, 3-high, '-"- no correlation
- **Note:** The average value of this course to be used for program articulation matrix.

**MA3391 PROBABILITY AND STATISTICS L T P C**
**3 1 0 4**

**OBJECTIVES**

- This course aims at providing the required skill to apply the statistical tools in engineering problems.
- To introduce the basic concepts of probability and random variables.
- To introduce the basic concepts of two dimensional random variables.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of classifications of design of experiments which plays very important roles in the field of agriculture and statistical quality control.

**UNIT I PROBABILITY AND RANDOM VARIABLES 9 + 3**

Axioms of probability – Conditional probability – Baye's theorem - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions – Functions of a random variable.

**UNIT II TWO- DIMENSIONAL RANDOM VARIABLES 9 + 3**

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

**UNIT III ESTIMATION THEORY 9 + 3**

Unbiased estimators - Efficiency - Consistency - Sufficiency - Robustness - Method of moments - Method of maximum Likelihood - Interval estimation of Means - Differences between means, variations and ratio of two variances

**UNIT IV NON- PARAMETRIC TESTS 9 + 3**

Introduction - The Sign test - The Signed - Rank test - Rank - sum tests - The U test - The H test - Tests based on Runs - Test of randomness - The Kolmogorov Tests .

**UNIT V STATISTICAL QUALITY CONTROL 9 + 3**

Control charts for measurements ( $\bar{X}$ and R charts ) – Control charts for attributes ( p, c and np charts) – Tolerance limits - Acceptance sampling.

**TOTAL: 60 PERIODS**

**OUTCOMES:**

Upon successful completion of the course, students will be able to:

- Understand the fundamental knowledge of the concepts of probability and have knowledge of standard distributions which can describe real life phenomenon.
- Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.
- Apply the concept of testing of hypothesis for small and large samples in real life problems.
- Apply the basic concepts of classifications of design of experiments in the field of agriculture and statistical quality control.
- Have the notion of sampling distributions and statistical techniques used in engineering and management problems.

**TEXT BOOKS**


1. Johnson. R.A., Miller. I.R and Freund . J.E, " Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 9th Edition, 2016.
2. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata Mc Graw Hill, 4th Edition, 2007.
3. John E. Freund, "Mathematical Statistics", Prentice Hall, 5th Edition, 1992.

**REFERENCES:**


1. Gupta. S.C. and Kapoor. V. K., “Fundamentals of Mathematical Statistics”, Sultan Chand & Sons, New Delhi, 12th Edition, 2020.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences”, Cengage Learning, New Delhi, 8th Edition, 2014.
3. Ross. S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 5thEdition, Elsevier, 2014.
4. Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum’s Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 4th Edition, 2012.
5. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 9th Edition, 2010.

| | PO01 | PO02 | PO03 | PO04 | PO05 | PO06 | PO07 | PO08 | PO09 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | - | - | - |
| **CO2** | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | - | - | - |
| **CO3** | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | - | - | - |
| **CO4** | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | - | - | - |
| **CO5** | 3 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | - | - | - |
| **Overall CO** | 3 | 3 | 1 | 0.8 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | - | - | - |

**PT3301 FUNDAMENTALS OF CHEMICAL ENGINEERING L T P C**
**3 0 0 3**

**OBJECTIVES:**

To facilitate the students

- To learn the fundamental operation involved in chemical engineering
- To attain the knowledge in the subject of fluid flow
- To gain the ideas in the field of heat transfer operation
- To learn the mass diffusion in polymers by the study or mass transfer operations
- To acquire knowledge about various unit operations

**UNIT I FLUID FLOW 9**

Fluid Flow: Newtonian and Non-Newtonian fluid - Bernoulli's theorem-Hagen Poisuille equation, measurement of fluid flow- orifice meter, venturi meter and pitot tube.

**UNIT II MECHANICAL OPERATIONS 9**

Properties of solids - Sieve analysis; Laws of crushing, Crushers and grinders. Principle of separation and selection and details of equipment for screening, cyclones and hydro cyclones (Basic principles and equipment description only. Mathematical consideration not required)

**UNIT III HEAT TRANSFER 9**

Modes of heat transfer; Heat transfer by conduction - Fourier's law, conduction across composite walls. Heat transfer by natural & forced convection. Co current, counter current, shell & tube heat exchangers (Basic principles and equipment description only. Mathematical consideration not required)

**UNIT IV MASS TRANSFER 9**

Principles of diffusion, theory of diffusion, Two film theory and mass transfer coefficients Humidification - operation, humidity chart, equipment's - cooling towers and spray chambers Drying - Principles and definitions. Rate of batch drying- Equipment for drying (Basic principles and equipment description only. Mathematical consideration not required)

**UNIT V UNIT OPERATIONS 9**

Absorption - Principle and equipment (packed towers and plate columns). Distillation - flash distillation, and Binary distillation. Industrial equipment for distillation Adsorption - Principle and equipment for adsorption. (Basic principles and equipment description only. Mathematical consideration not required)

**TOTAL: 45 PERIODS**

**OUTCOMES**

Upon completion of the course, the student will be able to:

- Attain the knowledge in fluid flow behaviors and mechanical separation.
- Understand the conduction and convection modes of heat transfer.
- Understand the concept of distillation equipment in the process industries.
- Understand the fundamentals of chemical engineering
- Gain knowledge in various Unit Operations for Polymer processing

**TEXT BOOKS:**


1. W.L .Mc Cabe, J.C. Smith, "Unit Operations of Chemical Engineering", McGraw-Hill,7th edition 2014.
2. Shri. K.A. Gavhane, "Unit Operations I & II", NiraliPrakashan Publication, 2015.
3. Ghosal, S.K., Sanyal, S.K., Datta, S., "Introduction to Chemical Engineering", Tata McGraw-Hill Publishing Company Ltd., New Delhi(1997).

**REFERENCES:**


1. Richardson and Coulson, “Chemical Engineering”, Vol. 1, Elesvier, 6th Edition 2006.
2. J. M. Smith, H. C. Van Ness, M. M. Abbott and M. T. Swihart “Introduction to Chemical Engineering Thermodynamics” McGraw-Hill Education, 2 Perm Plaza, New York, NY, 8th Edition 2018


**MAPPING OF CO’S WITH PO’S**

| CO/ PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | - | 1 | - | 2 | 1 | 1 | 2 |
| CO 2 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | - | 1 | - | 2 | 1 | 1 | 2 |
| CO 3 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | - | 1 | - | 2 | 1 | 1 | 2 |
| CO 4 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | - | 1 | - | 2 | 1 | 1 | 2 |
| CO 5 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | - | 1 | - | 2 | 1 | 1 | 2 |
| Overall CO | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | - | 1 | - | 2 | 1 | 1 | 2 |

**1-low, 2-medium, 3-high, ‘-“- no correlation**

**PT3302 PLASTICS MATERIALS I L T P C**
**3 0 0 3**

**OBJECTIVES:**

To enable the students

- To learn about the general methods of preparation of individual class of plastics Materials
- To study about the general properties, processing behavior and applications of different Class of plastics materials
- To understand about the structure- property relation of different class of plastics materials.
- To familiar about properties and end application of different plastics materials
- To gain knowledge of thermoplastics for industrial applications.

**UNIT I INTRODUCTION 9**

Basic chemistry of polymers-nomenclature of polymers sources for raw materials. Methods of manufacturing –properties and applications of Natural Polymers - Shellac resin and natural rubber-Cellulosics-Cellulose nitrate, cellulose acetate, cellulose acetate butyrate, Ethyl cellulose and others.

**UNIT II COMMODITY THERMOPLASTICS-I 9**

Preparation- properties - and applications of Polyolefin-Polyethylene- LDPE -LLDPE- HDPE, HMWHDPE- UHMWHDPE–Cross-linked polyethylene- Chlorinated polyethylene –Polypropylene – Homo & Co polymer

**UNIT III COMMODITY THERMOPLASTICS-II 9**

Preparation - properties - and applications of Vinyl plastics - Polyvinyl chloride, C-PVC, Polyvinyl Acetate, Polyvinylidene chloride, polyvinyl alcohol. Polystyrene

**UNIT IV GENERAL PURPOSE THERMOSETS 9**

Preparation - properties - and applications of: Phenol formaldehyde (PF), Amino plastics: Urea50formaldehyde (UF) - Melamine formaldehyde (MF), unsaturated polyesters, Alkyd resins

**UNIT V ENGINEERING PLASTICS & ITS APPLICATIONS - I 9**

Preparation- properties - and applications: Styrene copolymers–High Impact Polystyrene (HIPS), Acrylonitrile Butadiene Styrene (ABS), Styrene acrylonitrile (SAN), Acrylic plastics–Polymethyl Methacrylate, Polyacrylonitrile , Ethylene Vinyl Acetate (EVA).

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completing this course, the student will be able to:

- Familiarize in natural polymer properties and its applications
- Acquire skills in selecting additives for plastic materials for specific applications
- Gain knowledge of manufacturing, properties and applications of poly olefins.
- Gain knowledge of manufacturing, properties and applications of vinyl halogenated olefin based plastic materials
- Gain knowledge of manufacturing, properties and applications of special purpose plastics

**TEXT BOOKS:**


1. J. A. Brydson, “Plastics Materials”, Butterworth- Heinemann - Oxford, 7th Ed., 2001.
2. Feldman.D and Barbalata. A, “Synthetic Polymers”, Chapman Hall, 1996.


**REFERENCES:**


1. Brydson John, **“**Plastic Materials”, 7Th Edition, Elsevier Science, ISBN: 9788181475817, 2014.
2. Johannes Karl Fink “Handbook of Engineering and Specialty Thermoplastics, Wiley-Scrivener; 1st edition, ISBN-13: 978-0470625835, 2010.
3. SubrataSengupta “Organic Chemistry” Oxford University Press; First edition, ISBN-13: 978-0199451647, 2014.
4. Rubin Irvin I “Handbook of Plastic Materials and Technology”Wiley India, ISBN-13: 978-8126552283, 2014


**MAPPING OF CO’S WITH PO’S**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | - | 1 | 3 | 1 | - | 1 | - | 2 | 2 | 2 | 3 |
| CO2 | 3 | 2 | 2 | 2 | - | 1 | 3 | 1 | - | 1 | - | 2 | 2 | 2 | 3 |
| CO3 | 3 | 2 | 2 | 2 | - | 1 | 3 | 1 | - | 1 | - | 2 | 2 | 2 | 3 |
| CO4 | 3 | 2 | 2 | 2 | - | 1 | 3 | 1 | - | 1 | - | 2 | 2 | 2 | 3 |
| CO5 | 3 | 2 | 2 | 2 | - | 1 | 3 | 1 | - | 1 | - | 2 | 2 | 2 | 3 |
| Overall CO | 3 | 2 | 2 | 2 | - | 1 | 3 | 1 | - | 1 | - | 2 | 2 | 2 | 3 |

**1-low, 2-medium, 3-high, ‘-“- no correlation**

**PT3303 POLYMER CHEMISTRY L T P C**
**3 0 0 3**

**OBJECTIVES:**

To make the student conversant with

- The basic concepts of polymers, classification of polymers, copolymer types and tactility.
- The kinetics & mechanism of different types addition polymerization and free radical copolymerization
- The kinetics & mechanism of two types of condensation polymerization and ring-opening polymerization
- Various types of polymerization techniques
- The molecular weight and its distribution and different methods of molecular weight determination.

**UNIT I BASIC CONCEPTS OF POLYMERS 9**

Basic concepts of polymers – - Monomers -degree of polymerization– significance of functionality – classification of polymers based on **:**source, structure, thermal processing behaviour, composition and structure, mechanism, intermolecular forces – nomenclature of polymers –tacticity – copolymers and its types **:**alternate, random, block and graft copolymers.

**UNIT II ADDITIONPOLYMERISATION 9**

Kinetics and mechanism of free radical polymerization: chain transfer, Inhibition and retardation– Kinetics and mechanism of cationic polymerisation and anionic polymerisation–livingpolymers– Ziegler-Nattacatalysts–coordinationpolymerisation–kineticsoffreeradicalcopolymerisation – copolymer equation – monomer reactivity ratio and its significance.

**UNIT III CONDENSATIONPOLYMERISATION 9**

Kinetics of poly-condensation reactions (acid catalysed and self-catalysed) – ring-opening polymerization – multi chain polymerization: branching, cross-linking–step-wisecopolymerization– methodsofsynthesizingcopolymers**:** statistical, alternate and block copolymers.

**UNIT IV POLYMERISATIONTECHNIQUES 9**

Classification of polymerisation techniques: homogenous and heterogeneous polymerisation – bulk or mass polymerisation – Tromms droff effect – solutionpolymerisation– suspensionpolymerisation–emulsionpolymerisation–interfacialpolymerisation– meltpolycondensation. Advanced Polymerization Techniques - Atom Transfer Radical Polymerization (ATRP), Group Transfer Polymerization (GTP), Reversible Addition Fragmentation Termination (RAFT).

**UNIT V MOLECULARWEIGHTANDITSDISTRIBUTION 9**

Molecular weight of polymer – number, weight and viscosity average molecular weights – molecular weight distribution (problems) – molecular weight determination: end-group analysis, colligative properties, osmometry, light scattering, gel permeation chromatography and viscometry.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon Completion of the Course the students will be able to

- Classify polymers based on various criteria and also name the polymers using proper nomenclature.
- Derive the rate equations and explain the mechanism of addition polymerisation reactions.
- Derive the rate equations and explain the mechanism of condensation polymerisation reactions.
- Describe the various polymerisation techniques.
- Elaborate on methods of molecular weight determination and calculate molecular weight of polymers

**TEXTBOOKS**


1. FredW.BillMeyer'TextbookofPolymerScience'JohnWiley&Sons, 2008.
2. George Odian "Principles of Polymerization" John Wiley & Sons, Inc., ISBN: 9780471274001, 2004.
3. Ravve, Principles of PolymerChemistry,Springer-VerlagNewYork,2012.
4. JoelR.Fried,"PolymerScienceandTechnology",PrenticeHall,2014.
5. Premamoy Ghosh'Polymer Science and Technology'TataMcGraw–Hill, 2011.
6. Charles E.Carraher Jr. Introduction to Polymer Chemistry, Fourth Edition, CRC Press, 2017.


**REFERENCES:**


1. HermanF.Mark,"EncyclopediaofPolymerScienceandTechnology",WileyInterscience;3rd Edition,2004.
2. R. J. Samuels, "Structured Polymer Properties", John Wiley & Sons, NewYork, 1974.
3. Premamoy Ghosh, —Polymer Science and Technology of Plastics and Rubbers‖, Tata McGraw- Hill, New Delhi, 1990.
4. AndrewJ. Peacock and Allison Calhoun, Polymer Chemistry: Properties and Application,Carl Hanser VerlagGmbH&Company,2012.
5. RobertJ.Young, Peter A.Lovell, Introduction to Polymers,ThirdEditionCRCPress,2011.


**MAPPING OF CO'S WITH PO'S**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 2 | 1 | 3 | 1 | - | 1 | - | 2 | 2 | 2 | 3 |
| CO2 | 3 | 2 | 2 | 2 | 2 | 1 | 3 | 1 | - | 1 | - | 2 | 2 | 2 | 3 |
| CO3 | 3 | 2 | 2 | 2 | 2 | 1 | 3 | 1 | - | 1 | - | 2 | 2 | 2 | 3 |
| CO4 | 3 | 2 | 2 | 2 | 2 | 1 | 3 | 1 | - | 1 | - | 2 | 2 | 2 | 3 |
| CO5 | 3 | 2 | 2 | 2 | 2 | 1 | 3 | 1 | - | 1 | - | 2 | 2 | 2 | 3 |
| Overall CO | 3 | 2 | 2 | 2 | 2 | 1 | 3 | 1 | - | 1 | - | 2 | 2 | 2 | 3 |

**1-low, 2-medium, 3-high, '-"- no correlation**

**PT3304 POLYMER PHYSICS L T P C**
**3 0 0 3**

**OBJECTIVES:**

**To enable the students to understand the**

- Physical and conformational properties of polymeric materials.
- Molecular arrangement in polymers and their orientation under the influence of stress.
- Solubility behavior of polymers.

**UNIT I FUNDAMENTALS OF POLYMER PHYSICS 9**

Potential energy and conformational energy of molecules - conformations and configurations, Tacticity, isomeric states and isomerism in polymers, stereoisomerism, geometric isomerism - Random coils and average end to end distance - (Derivation only)

**UNIT II THERMODYNAMIC PROPERTIES 9**

Laws of Thermodynamics - Freely jointed and freely rotating chain models - Entropy and enthalpy Energy driven and entropy driven elasticity - Thermo elasticity -Thermodynamic treatment - entropic and energetic contributions (Derivation only).

**UNIT III POLYMER CRYSTAL FORMATION 9**

Amorphous State - Transition temperatures- Glass transition temperature Theory- Factors influencing glass transition Temperature- Crystalline State - polymorphism – Polymer single crystals, lamellae, spherulites – Crystallinity -factors affecting crystallinity -X-ray diffraction.

**UNIT IV CHAIN ORIENTATION 9**

Chain orientation - Concept of chain orientation - orientation in amorphous and crystalline polymers - Uniaxial and biaxial orientation practical significance – Orientation processes: spinning Process – Optical Properties of polymers – Birefringence, Haze, Transparency.

**UNIT V POLYMER SOLUTIONS 9**

Polymer solutions - Terms and definitions, types of solutions - Hildebrand approach, Flory Huggins theory - Thermodynamic view of miscibility, upper critical solution temperature (UCST), lower critical solution temperature (LCST) - solubility parameter, determination of solubility parameter of polymers - theta conditions.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon Completion of the Course the students will be able to

- Understand molecular arrangement in polymers.
- Demonstrate the orientation processes in polymer.
- Demonstrate knowledge in solubility behavior of polymers

**TEXT BOOKS:**

1. Ulf W. Gedde, Polymer Physics, Springer – Science +Business Media, B.V. 1st Edition, 43 2001.
2. S. Glasstone and D. Lewis, Elements of Physical Chemistry, Textbook Publishers, 2003.

**REFERENCES:**

1. Michael Rubinstein, R. H. Colby, Polymer Physics – Oxford University Press, 2003.
2. David I. Bower “An Introduction to Polymer Physics” Cambridge University Press, ISBN: 9780511801280, 2012

**MAPPING OF CO’S WITH PO’S**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | 2 | 1 | 3 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO2 | 2 | 2 | 2 | 2 | 2 | 1 | 3 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO3 | 2 | 2 | 2 | 2 | 2 | 1 | 3 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| Overall CO | 2 | 2 | 2 | 2 | 2 | 1 | 3 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |

**1-low, 2-medium, 3-high, ‘-“- no correlation**

**PT3305 SOLID MECHANICS OF TECHNOLOGISTS L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To develop capacity to predict the effect of force and motion in the course of carrying out the design functions of engineering.
- To apply the mathematical knowledge to calculate the deformation behavior of beams.
- To understand the effect of torsion on shafts and springs.
- To analyze a complete two dimensional state of stress.

**UNIT I STATICS OF PARTICLES 9**

Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces – Vectorial representation of forces – Vector operations of forces - additions, subtraction, dot product, cross product – Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility .

**UNIT II EQUILIBRIUM OF RIGID BODIES 9**

Free body diagram – Types of supports –Action and reaction forces – stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Single equivalent force -Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions

**UNIT III DEFLECTION OF BEAMS 9**

Double integration method - Macaulay's methods - Area moment method - conjugate beam method for computation of slopes and deflections of determinant beams.

**UNIT IV TORSION 9**

Torsion of Circular and Hollow Shafts – Stresses and Deflection in Circular Solid and Hollow Shafts – strain energy due to torsion – Power transmitted to shaft – Shaft in series and parallel – Closed and Open Coiled helical springs – Springs in series and parallel.

**UNIT V THIN CYLINDERS AND THEORIES OF FAILURE 9**

Thin cylinders – Stresses in thin cylindrical shell due to internal pressure – circumferential and longitudinal stresses - Theories of failure - maximum Principal stress - maximum Principal strain - Shear stress - Total strain energy - Energy distortion theories.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

On successful completion of this course, the student will be able to

- Illustrate the vectorial and scalar representation of forces and moments
- Analyse the rigid body in equilibrium
- Apply the mathematical knowledge in determining the deformation behavior of beams
- Thoroughly understand the effect of torsion on shafts and springs.
- Analyze a complex two dimensional state of stress and to analyze the failure mode.

**TEXT BOOK**


1. Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2007
2. Jindal U.C., "Strength of Materials", Asian Books Pvt. Ltd., New Delhi, 2007


**REFFERENCE BOOK**


1. Egor. P.Popov "Engineering Mechanics of Solids" Prentice Hall of India, New Delhi, 2001
2. Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series, 2007.
3. Hibbeler, R.C., "Mechanics of Materials", Pearson Education, Low Price Edition, 2007
4. Ferdinand P. Been, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials", Tata McGraw Hill Publishing 'co. Ltd., New Delhi, 2005.

**MAPPING OF CO'S WITH PO'S**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | - | 1 | - | 2 | 1 | 1 | 2 |
| CO2 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | - | 1 | - | 2 | 1 | 1 | 2 |
| CO3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | - | 1 | - | 2 | 1 | 1 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | - | 1 | - | 2 | 1 | 1 | 2 |
| CO5 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | - | 1 | - | 2 | 1 | 1 | 2 |
| Overall CO | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | - | 1 | - | 2 | 1 | 1 | 2 |

**1-low, 2-medium, 3-high, '-"- no correlation**

**PT3311 CHEMICAL ENGINEERING LABORATORY L T P C**
**0 0 4 2**

**OBJECTIVE:**

- To practically train on various techniques for reducing and separating of particles, flow properties of fluids.

**LIST OF EXPERIMENTS:**

1. To determine the pipe friction using Flow through rough and smooth pipes.
2. To determine the efficiency of pump using Centrifugal pump.
3. To determine the coefficient of discharge of orifice meter.
4. To find the efficiency of Air compressor
5. To Calibrate the rotameter
6. To find the Pressure drop in packed bed
7. To study the concept of Fluidization by using fluidized bed
8. To determine the coefficient of discharge of Venturi meter
9. To find the Thermal conductivity of solids.
10. To find overall heat transfer coefficient of the Heat exchanger
11. To find the Stefan-Boltzman constant
12. To find the new surface area created by Jaw crusher
13. To find the critical speed of Ball Mill
14. To find the Screening efficiency.
15. To separate the component by Simple distillation
16. To separate the component by using steam distillation
17. To find the Particle size and Surface area of filler particles.

**(Any nine Experiments)** **TOTAL: 60 PERIODS**

**OUTCOMES:**

Upon completing of this course, the students will be able to:

- Apply the different technique for size reduction
- Attain skill in operating fluid pressure apparatus.

**REFERENCES:**

1. W.L .Mc Cabe, J.C. Smith, "Unit Operations of Chemical Engineering", McGraw-Hill,7th Edition, 2005. 2. W.L.Badger, J.T. Banchero. "Introduction to Chemical Engineering", McGraw-Hill, UK, 1st Edition, 2002.

**MAPPING OF CO'S WITH PO'S**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | - | 2 | 1 | 1 | 2 |
| CO2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | - | 2 | 1 | 1 | 2 |
| Overall CO | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | - | 2 | 1 | 1 | 2 |

**1-low, 2-medium, 3-high, '-"- no correlation**

**PT3312 POLYMER CHEMISTRY LABORATORY L T P C**
**0 0 4 2**

**COURSEOBJECTIVES:**

- To develop an understanding on various methods of polymerization and its structure property relationship.
- To equip with the fundamental knowledge of mechanism of polymerization and various process parameters affecting the polymerisation technique

**PRACTICALS**

List of Experiments:

1. Preparation of phenol-formaldehyde (Novolac) resin.
2. Preparation of phenol-formaldehyde (Resol) resin.
3. Preparation of urea-formaldehyde resin.
4. Preparation of bisphenol–A epoxy resin.
5. Preparation of unsaturated polyester resin.
6. Preparation of polyester using diethylene glycol & adipic acid.
7. Bulk polymerization of styrene.
8. Emulsion polymerization of styrene.
9. Solution polymerization of acrylonitrile.
10. Solution polymerization of vinyl acetate.
11. Suspension polymerization of methylmethacrylate.
12. Copolymerization of styrene and methylmethacrylate

**(Any nine Experiments) TOTAL: 60 PERIODS**

**OUTCOMES:**

Upon Completion of the Course the students will be able to

- Develop new polymers and chemically modify the existing polymers based on specific property requirements
- Apply suitable technique for synthesizing polymers for advance applications

**TEXTBOOKS:**


1. Sabu Thomas, Deepalekshmi Ponnamma, Ajesh K. Zachariah,"Polymer Processing and Characterization: 1 (Advances in Materials Science)",Apple Academic Press;1edition,January31,2013.
2. V. A. Bershtein, G. C. Berry, etal,"Polymer Analysis and Characterization (Advances in Polymer Science)",2013.
3. T.R.Crompton,"PracticalPolymerAnalysis",2012.
4. Joseph D. Menczel, R. Bruce Prime, "Thermal Analysis of Polymers", Fundamentals and Applications",Wiley; 1edition, April20,2009.
5. Characterization and Analysis of Polymers, by Wiley,2008.

**MAPPING OF CO'S WITH PO'S**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | - | 2 | 2 | 2 | 2 |
| CO2 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | - | 2 | 2 | 2 | 2 |
| Overall CO | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | - | 2 | 2 | 2 | 2 |

**1-low, 2-medium, 3-high, '-"- no correlation**

**GE3361 PROFESSIONAL DEVELOPMENT L T P C**
**0 0 2 1**

**OBJECTIVES:**

To be proficient in important Microsoft Office tools: MS WORD, EXCEL, POWERPOINT.

- To be proficient in using MS WORD to create quality technical documents, by using standard templates, widely acceptable styles and formats, variety of features to enhance the presentability and overall utility value of content.
- To be proficient in using MS EXCEL for all data manipulation tasks including the common statistical, logical, mathematical etc., operations, conversion, analytics, search and explore, visualize,interlink, and utilizing many more critical features offered
- To be able to create and share quality presentations by using the features of MS PowerPoint, including: organization of content, presentability, aesthetics, using media elements and enhance the overall quality of presentations.

**MS WORD: 10 Hours**

Create and format a document
Working with tables
Working with Bullets and Lists
Working with styles, shapes, smart art, charts
Inserting objects, charts and importing objects from other office tools
Creating and Using document templates
Inserting equations, symbols and special characters
Working with Table of contents and References, citations
Insert and review comments
Create bookmarks, hyperlinks, endnotes footnote
Viewing document in different modes
Working with document protection and security
Inspect document for accessibility

**MS EXCEL: 10 Hours**

Create worksheets, insert and format data
Work with different types of data: text, currency, date, numeric etc.
Split, validate, consolidate, Convert data
Sort and filter data
Perform calculations and use functions: (Statistical, Logical, Mathematical, date, Time etc.,)
Work with Lookup and reference formulae
Create and Work with different types of charts
Use pivot tables to summarize and analyse data
Perform data analysis using own formulae and functions

Combine data from multiple worksheets using own formulae and built-in functions to generate results
Export data and sheets to other file formats
Working with macros
Protecting data and Securing the workbook

**MS POWERPOINT: 10 Hours**

Select slide templates, layout and themes
Formatting slide content and using bullets and numbering
Insert and format images, smart art, tables, charts
Using Slide master, notes and handout master
Working with animation and transitions
Organize and Group slides
Import or create and use media objects: audio, video, animation
Perform slideshow recording and Record narration and create presentable videos

**TOTAL: 30 PERIODS**

**OUTCOMES:**

On successful completion the students will be able to

- Use MS Word to create quality documents, by structuring and organizing content for their day to day technical and academic requirements
- Use MS EXCEL to perform data operations and analytics, record, retrieve data as per requirements and visualize data for ease of understanding
- Use MS PowerPoint to create high quality academic presentations by including common tables, charts, graphs, interlinking other elements, and using media objects.

**PT3401 ADDITIVES AND COMPOUNDING L T P C**
**3 0 0 3**

**OBJECTIVES:**

To enable the students to

- Understand various draw backs of polymer materials and suitable remedies.
- understand various additives used in polymers
- understand the mechanism of degradation of polymers and chemistry of stabilizing additives
- understand various compounding methodologies for plastics materials
- Learn the house keeping and maintenance of compounding machinery.

**UNIT I FILLERS/ REINFORCEMENTS, STABILIZERS, PIGMENTS 9**

Fillers and Reinforcement–Antioxidants-Thermal Stabilisers, Ultraviolet stabilizer– Impact Modifiers/ toughening agents. Colourants-Fire retardants-Coupling agents-blowing-agents

**UNIT II ADDITIVES FOR PROCESSING 9**

Plasticizers- Antistatic agents-Anti blocking agents-Slip and anti slip agents-processing aids - Lubricants- mould releasing agents Additives for recycling.

**UNIT III FUNDAMENTALS OF COMPOUNDING 9**

Compounding-Selection of polymers and compounding-ingredients-general objectives- Merits and demerits of additives in polymer matrices. Mixing and mixing equipments. Compounding by batch mixer-High speed mixer-Two roll mill - Banbury Mixer - Ribbon blender - Planetary mixers.

**UNIT IV COMPOUNDING MECHANISMS 9**

Compounding Machineries specifications - temperature control system – operating characteristics and working details of continuous mixers - - Single Screw extruder - Twin Screw extruder-housekeeping and maintenance of compounding machines.

**UNIT V CASE STUDIES 9**

Case studies on preference of one plastics to other and co-relation of properties of conventional materials and blends and alloys - case studies on application of blends and alloys.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon Completion of the Course the students will be able to

- Understanding various types of additives for plastics and their merits and demerits.
- Analyse various compounding methods used in the manufacturing of compounded thermoplastics and thermosets.

**TEXT BOOKS:**

1. Al – Malaika; S. Golovoy; A and Wilkie (Eds), Chemistry and Technology of Polymer Additives, Black well Science Ltd, Oxford (1999).
2. Matthews; F.L. and Rawlings; R.D, Composite Materials, Engineering and Science Chairman and Hall, London (1994).
3. Plastics Testing Technology Hand Books by Vishu Shah, 1984.

**REFERENCES:**

1. Hand Book of Plastics Test Methods by Brown R.P, 1989.
2. Mascia; L., the Role of Additives in Plastics, Edward Arnold Publishers Ltd., U. K. (1974).
3. Murphy; John, Additives for Plastics Handbook, 2nd Edition, Elsevier Advanced Technology, Oxford, 2001.
4. R. Gachter and H. Muller, Plastics Additives Hand Book, Hanser Publishers, Munich, 1993.

**MAPPING OF CO'S WITH PO'S**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO2 | 3 | 3 | 3 | 1 | 1 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| Overall CO | 2.5 | 2.5 | 2.5 | 1 | 1 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |

**1-low, 2-medium, 3-high, '-"- no correlation**

**PT3402 FLUID MECHANICS AND POLYMER RHEOLOGY L T P C**
**3 0 0 3**

**OBJECTIVES:**

To enable the students to understand the basic concepts of rheology

- To analyze the flow behavior of polymer melts
- To understand the basics of fluid mechanism and to analyze behavior of Newtonian fluids.
- To familiarize with instruments such as orifice meter, Venturi meter and Pitot tube.

**UNIT I FLUID PROPERTIES 9**

Units and dimensions-Properties of fluids-mass density, specific weight, specific volume, specific gravity, viscosity, surface tension and capillarity-Terminologies of fluid flow-

Laminar and turbulent flow of Newtonian fluids-Power law-Reynolds number and its significance

**UNIT II FLUID FRICTION AND FLOW MESUREMENT 9**

Bernoulli‘s equation–kinetic energy correction factor; head loss; friction factor; major and Minor losses- Flow measurement: Introduction; Orifice meter; Venturi meter; concept of area meters: rotameter; Local velocity measurement: Pitot tube.

**UNIT III POLYMER RHEOLOGY 9**

Introduction and Basic concepts of Rheology, classification of fluids, Newtonian and non Newtonian fluids, shear stress, shear strain and shear rate, shear modulus, bulk modulus, Zero shear viscosity, Dependence of viscosity with temp, shear stress , Viscoelasticity - effect of rate of strain, temperature and time on mechanical behaviour of polymeric materials.

**UNIT IV RHEOLOGICAL MODELS 9**

Mechanical models - stress strain response of spring and dashpot - visco elastic models - Maxwell element - Voigt kelvin element - response to creep and stress relaxation -four parameter model - Boltzman principle - time temperature super position principle - WLF equation.

**UNIT V MEASUREMENT OF POLYMER MELT VISCOSITY 9**

Viscosity of polymer melts – dieswell and melt fracture - Weissenberg effect - Elongational viscosity. Measurements of rheological properties - capillary rheometers – cone and plate viscometer - Oscillating disc rheometer - Mooney viscometer

**TOTAL: 45 PERIODS**

**OUTCOMES**:

**On completion of the course, students**

- Will have thorough knowledge on the basic concepts of rheology.
- Will able to analyze the mechanical behavior of polymers under applied load.
- Will have the knowledge on experimental techniques for measuring the rheological properties.
- WilL understand the basics of fluid mechanics and to analyze the behavior of Newtonian fluids.
- Will have knowledge of the instruments such as orifice meter, venturi meter & pitot tube.

**TEXT BOOKS:**


1. Cogswell, Polymer melt rheology, Woodhead Publishing Ltd, 1994.
2. R.J. Crawford, Plastics Engineering, Butterworth - Heinemann, Oxford, 2002, 3rd edition
3. Dr. R. K. Bansal, “A Textbook of Fluid mechanics and Hydraulic Machines”, 9th edition, 2017


**REFERENCES:**


1. P.N.Cogswell, Polymer Melt Rheology, A guide for Industrial Practice, George Godwin,1981.
2. Richard C. Progelh of and James L. Throne, Polymer Engineering Principles, Hanser Publishers, New York, 1998.
3. John M. Dealy and Kurt F. Wissburn, Melt rheology and its role in plastics processing, Chapman, London, Oct 3rd, 2013.
4. R.S. Lenk, Polymer Rheology, Applied Science, London, 2012.
5. J.D. Ferry, Viscoelastic Properties of Polymers, john Wiley & Sons, New York, 1986.
6. Chang Dae Han. Rheology in Polymer Processing, Academic Press, New York, 1976

**MAPPING OF CO'S WITH PO'S**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO2 | 3 | 3 | 3 | 1 | 1 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO3 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO4 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO5 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| Overall CO | 2.2 | 2.2 | 2.2 | 1 | 1 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |

**1-low, 2-medium, 3-high, '-"- no correlation**

**PT3403 PLASTICS MATERIALS II L T P C**
**3 0 0 3**

**OBJECTIVES:**

**To enable the students to**

- learn about the general methods of preparation of individual class of plastic materials
- Understand the general properties, processing behavior of plastics materials.
- Gain knowledge in applications of different class of plastics materials.
- Make the student familiar about specialty polymers properties and end application.
- To understand the role of polymer blends & alloys in current scenario.

**UNIT I ENGINEERING PLASTICS & ITS APPLICATIONS – II 9**

Preparation-properties - and applications: Polyamides-Nylons 6, (6,6), (6,10), 11, 12, Polyesters–Polyethylene terephthalate, polybutylene terephthalate, Polycarbonate, Polyacetals.

**UNIT II HIGH PERFORMANCE PLASTICS - I 9**

Preparation -properties-and applications: Aromatic ether-Polypheneylene oxide (PPO), Aromatic thioether - Polyphenylenesulphide (PPS), Polysulfone, Aromatic polyamides

**UNIT III HIGH PERFORMANCE PLASTICS - II 9**

Preparation-properties-and applications: Polyimides (PI) Polyamideimide (PAI), Polyimidazoles, Fluoropolymers–Polyvinyl fluoride (PVF), Polyvinylidene fluoride (PVDF), Polytetrafluoroethylene (PTFE), Polychlorotrifluoroethylene (PCTFE).

**UNIT IV WATER SOLUBLE POLYMERS AND BIO DEGRADABLE POLYMERS 9**

Preparation- properties and applications of Biodegradable polymers-poly ξ–caprolactone - polylactic acid- Bacterial polyhydroxyalkonates.–polyvinylpyrrolidone–polyacrylic acid and its homolog's – polyacrylamide –polyethylene oxide – polyethylene amine-Polyvinyl alcohol

**UNIT IV ENGINEERING AND SPECIALITY THERMOSETS 9**

Preparation - properties - and applications of: Phenolic resin - Urea Formaldehyde - Melamine Formaldehyde – Unsaturated Polyesters-Epoxy resins- Polyurethane and Silicones.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completing this course, the students

- Will have the knowledge of manufacturing methods, properties of special purpose polymers applied in special application
- Will have knowledge of manufacturing methods and correlate the high performance polymer properties for special purpose
- Will Acquire skills in selection of conducting polymer to suitable application

- Will have the knowledge of manufacturing methods, properties and applications of ionic polymers
- Will have the knowledge of manufacturing methods, properties and applications of water soluble and bio degradable polymers

**TEXT BOOKS:**


1. Plastic Materials Ed 7 - By Brydson, J A,1999.
2. Hand Book of Plastics Materials & Technology - By Rubin, Irwin, J,1990.
3. Manas Chanda, Salil.K.Roy, “Plastics Technology Hand book”, 2nd edition, Marcel Dekker, New York, 1993.
4. Matrin.T.Goosey, “Plastics for Electronics”, Elsevier, Applied Science, 1985.
5. R.W. Dyson, “Specialty Polymers”, Chapman & Hall, 2nd edition, 1998.


**REFERENCES:**


1. Plastics Engineering Hand Book Ed. 5 & Society of the Plastic Industry Inc - By SPI,1994.
2. Plastics Materials and Processing - By Schwartz & Goodman,1982.
3. Plastics Materials (Properties & Application) - By Birley & Scott,1982.
4. Modern Plastics Hand Book - By Harper,2000..
5. Birley; Arthur W. and Scott; Martyn J., Plastics Materials: Properties and Applications, Leonard Hill, Blackie and Sons Ltd., 1982.
6. Biron; Michel, Thermoplastics and Thermoplastic Composites: Technical Information for Plastics Users, Elsevier, Amsterdam, 2007.
7. DuBois; P, Plastics in Agriculture, Applied Science Publishers Ltd., London 1978
8. H.F.Mark, (Ed), “Encyclopedia of polymer Science & Engineering”, John Wiley & Sons, New York, 1989.
9. Johannes Karl Fink, ‘Handbook of Engineering and SpecialityThermoplastics’, Volume 10, Water Soluble Polymers, John Wiley & Sons, New Jersy, 2011.
10. David Kaplan, “Biopolymers from renewable resources” ,Springer,1998.


**MAPPING OF CO’S WITH PO’S**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 3 | 2 |
| CO2 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 3 | 2 |
| CO3 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 3 | 2 |
| CO4 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 3 | 2 |
| CO5 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 3 | 2 |
| Overall CO | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 3 | 2 |

**1-low, 2-medium, 3-high, ‘-“- no correlation**

**PT3404 PLASTICS MOULD AND DIES TECHNOLOGY L T P C**
**3 0 0 3**

**OBJECTIVES:**

**To impart knowledge on**

- Various Molds types, Mold making and Material of mold selection.
- Elements of the mould and manufacturing processes.
- Application of additive manufacturing in mould development
- Advanced measuring instruments for inspection of mold

**UNIT I BASIC MOULD TYPES, TOOL MAKING PROCESSES AND MATERIALS 9**

Introduction to Moulds - Classification - Working Principle and Construction - Types and making

processes – Materials for mould making - Injection moulding machine, Compression mould, Continuous extrusion mould and Blow moulding – General mould types – Other tools for plastics, Cut off Equipments – Metal Cutting process – Metal displacement process – Casting Process– Step in Mould Finishing & References –Steel & Steel forging – Machinability – Heat treatment – Annealing Stainless Steel Steels for machined moulds- Tool steel castings

**UNIT II INJECTION MOLDS 9**

Introduction to Injection Moulding - Classification - Working Principle and Construction – Materials for Transfer mould – Product design considerations – Runner systems, Gating Transfer mould – injection moulds for thermoset materials – Transfer Pressure – Runnerless Injection-compression moulds – Encapsulation. Injection equipment – Projected area press capacity – Hot manifold system for thermoplastics – Hot edge gating – Venting – Cooling – Sprue Bushings and pullers – Cavities - Stander mold Base – Types of operation

**UNIT III BLOW MOLDING AND EXTRUTION MOLDS 9**

Introduction - theory of Blow mould - Working Principle and Construction – Plastic blow moulding processing – Extrusion Blow moulding materials design and construction – Extrution Blow moulding Fabrications – Design of Extrution Blow moulding – Injection Blow moulding Design and Construction – Bottle Finishing – Container Terminology - Manufacturing of mould elements.

**UNIT IV COMPRESSION MOULDS 9**

Introduction to Compression moulds - Working Principle and Construction – Design of hand moulds – Design of 12 cavity semiautomatic mould – Spring Box Mould – Loading Shoe and Stripper plate moulds – Positive Moulds – Semi-positive mould – Mould Assembly – Automatic Compression Moulds – Special Design Features – Side Ram Moulds.

**UNIT V MAINTENANCE OF MOULDS & DIES 9**

Introduction to Design of mould, Care and Maintenance - Working Principle and Construction – Principles and rule of design for mould – Engineering and design procedure – Dimension and mould drawings – Mould stamping – Causes of wear and damage – Preventive maintenance of moulds.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completing this course, the students would have knowledge on

- Molds Tools and mould manufacturing
- Types of molds
- Advanced measuring equipment for inspection of mold

**TEXT BOOKS:**


1. DuBois J. Harry: Plastics Mold Engineering Handbook (English, Paperback, Springer-Verlag New York Inc.4th Edition November 2013
2. .Klus S DuBois J. Harry, Plastics Mold Engineering Handbook (English, Paperback, , Hanser Publishers, NY, 3rd Edition 2013


**REFRENCES:**


1. Peter Jones, “The Mould Design Guide”, Smithers Rapra Technology Ltd., 2008
2. R.G.W.Pye, Injection Mold Design, East West Press Pvt. Ltd., New Delhi.,2000.
3. Hajra Chouldhary S.K and Hajra Choudhury. AK., "Elements of workshop Technology", volume II, Media promoters and Publishers Private Limited, Mumbai, 2010.
4. Peter Jones, “The Mould Design Guide”, Smithers Rapra Technology Ltd., 2008.
5. W.A.J Chapman, Workshop Technology, Vol I & II, ELBS.
6. Herbert Rees, Mold Engineering, Hanser Publishers, NY.,2002.
7. George Menges & Paul Mohren, How To Make Injection Molds, Hanser Publishers,2001.
8. Douglas M. Bryce, Plastic Injection Molding manufacturing process fundamentals, Society of Manufacturing Engineers, Dearborn, Michigan.,1996.

9. Jain R K ," Engineering Metrology" , 19th Edition , Khanna Publishers , 2005.
10. Gaylor, Shotbolt and Sharp, Metrology for Engineers, Publisher: O.R.Cassel, London,1993.

**MAPPING OF CO'S WITH PO'S**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 3 |
| CO2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 3 |
| CO3 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 3 |
| Overall CO | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 3 |

**1-low, 2-medium, 3-high, '-"- no correlation**

**PT3405 PLASTICS PROCESSING L T P C**
**3 0 0 3**

**OBJECTIVES:**

To enable the students

- To understand various processing techniques of plastic materials.
- To learn the fundamentals of compression molding and transfer molding of thermoset plastics.
- To learn the basic processing of thermoplastics by injection molding, extrusion and blow moulding.

**UNIT I COMPRESSION MOULDING 9**

Basic principles of compression and transfer moulding-Meaning of terms-Bulk factor and flow properties as applied to moulding materials-The methods adopted for estimating these properties and their limitations Process variables-Inter relation between flow properties-Curing time-Mould temperature and Pressure requirements-Preforms and preheating-Techniques of preheating-Machines used-Types of compression mould-Common moulding faults and their correction-Finishing of mouldings.

**UNIT II TRANSFER MOULDING 9**

Fundamental principles of transfer moulding-advantages over compression moulding- Equipment used-Press capacity-Integral moulds and auxiliary ram moulds-Moulding cycles-Tool costs-Moulding tolerances-Materials Theoretical calculation of pressures- Line pressures- Injection ram pressure-clamping-Heating requirements-Finishing of moulded parts—Moulding faults – causes and remedies.

**UNIT III INJECTION MOULDING 9**

Principles processing outline - Process variables - Mould cycle - Machinery used – Parts and functions –Specifications - Construction and maintenance - Start-up and shut down procedures - Cylinder nozzles - Press capacity projected area -Shot weight Basic theoretical concepts and their relationship to processing - Interaction of moulding process aspect effects in quoted variables - Introduction to trouble shooting.

**UNIT IV EXTRUSION 9**

Basic principles of extrusion – Types of extruders, general features of extruders viz. barrel, screw, types of screws, drive mechanism, specifications, heating & cooling systems, flow mechanism, die entry effects and exit instabilities. Melt fracture & Bam- booing. Factors affecting the output of an extruder, process variables in extrusion Extrusion processes and the downstream equipments for

the production of films, blown film, cast film/slot film, BO film, coextruded film. Tube/pipe-sizing take off equipment, extrusion coating, wire & cable covering –pre treatment of conductor, cooling, takeoff equipment constructional features of dies for the above processes and trouble shooting. Applications of extrusion and new developments.

**UNIT V BLOW MOULDING 9**

Basic principles and definitions- Processer – viz, Injection Blow moulding, extrusion blow moulding, Accumulation blow moulding, Merits & Demerits - Development of blow moulding industry Processing Parameters-Temperature-Pressure and cycle time Components – Materials requirements related to process and product performance- Materials used-Limitations in product design presented by process characteristics- Design guide lines for optimum product performance and appearance-Equipment used- Hand and power operated equipment. Screw and Plunger Systems-Cross head and die design-Blow moulding machine features and operation including hydraulic and electrical control systems-faults, causes and remedies. Parison programming, blow mould construction, cooling methods, mould venting, blow moulding of difficult articles like fuel tanks, odd shaped containers with handles, limitation in blow moulding, decoration of blow moulding products, hot stamping-multi colour printing-faults, causes and remedies.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

On completing this course, the students would

- Demonstrate knowledge of processing of plastic materials by injection moulding, extrusion, and blow moulding.
- Understand processing techniques like compression molding and transfer moulding of thermoset plastics.

**TEXT BOOKS:**


1. Allen; W. S. and Baker; P. N., Hand Book of Plastic Technology, Volume-1, Plastic Processing Operations [Injection, Compression, Transfer, Blow Molding], CBS Publishers and Distributors, New Delhi (2004).Injection Molding Theory & Practice By Rubin, Irvin.
2. Injection Molding Hand Book By Rusto,D.V &Rosato, D.V Plastic Engineering Hand Book & D–5 By Society of Plastic Industry Inc.,2000.
3. Plastics Material & Processing By Strong, A, Brent ,Blow Molding Hand Book By Rosato, D.V & Rosato, D.V ,Plastic Extrusion Technology By Hensen.
4. Extrusion of Plastics By Fisher
5. Plastics Extrusion Technology By Grief
6. Plastic Engineering Hand Book By S P I,1991.
7. Plastics Extrusion Technology By Henson,1997.


**REFERENCES:**


1.A Guide to Injection Molding of Plastics By Bolur, P.C.,
2. Development in Injection Molding By Whelan, A & Craft, J.L.
3. Technician's Hand Book & Plastics By Grandilli, P.A.,1990.
4. Plastics Materials & Processing By Schwartz & Goodman.,1982.
5. Injection Molding By Athalye, A.S.,1997.
6. Injection Molding Technology By V.D.I.
7. Innovation in Polymer Processing By Stevenson.,1996.
8. Extrusion The definitive Processing Guide and Hand Book By Giles, H.H & Others., 2004.
9. Compression Molding By Iyesew, A.I.
10. Polymer Extrusion By Rauwedaal, Chris., 2014.

**MAPPING OF CO'S WITH PO'S**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 3 | 3 |
| CO2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 3 | 3 |
| Overall CO | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | - | 1 | - | 2 | 2 | 3 | 3 |

**1-low, 2-medium, 3-high, '-"- no correlation**

**GE3451 ENVIRONMENTAL SCIENCE AND SUSTAINABILITY L T P C**
**2 0 0 2**

**OBJECTIVES:**

- To introduce the basic concepts of environment, ecosystems and biodiversity and emphasize on the biodiversity of India and its conservation.
- To impart knowledge on the causes, effects and control or prevention measures of environmental pollution and natural disasters.
- To facilitate the understanding of global and Indian scenario of renewable and nonrenewable resources, causes of their degradation and measures to preserve them.
- To familiarize the concept of sustainable development goals and appreciate the interdependence of economic and social aspects of sustainability, recognize and analyze climate changes, concept of carbon credit and the challenges of environmental management.
- To inculcate and embrace sustainability practices and develop a broader understanding on green materials, energy cycles and analyze the role of sustainable urbanization.

**UNIT I: ENVIRONMENT AND BIODIVERSITY 6**

Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ.

**UNIT II: ENVIRONMENTAL POLLUTION 6**

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts.

**UNIT III RENEWABLE SOURCES OF ENERGY 6**

Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

**UNIT IV SUSTAINABILITY AND MANAGEMENT 6**

Development , GDP ,Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols-Sustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study.

**UNIT V SUSTAINABILITY PRACTICES 6**

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non-conventional Sources, Energy Cycles-carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization-Socio-economical and technological change.

**TOTAL: 30 PERIODS**

**OUTCOMES:**

- To recognize and understand the functions of environment, ecosystems and biodiversity and their conservation.
- To identify the causes, effects of environmental pollution and natural disasters and contribute to the preventive measures in the society.
- To identify and apply the understanding of renewable and non-renewable resources and contribute to the sustainable measures to preserve them for future generations.
- To recognize the different goals of sustainable development and apply them for suitable technological advancement and societal development.
- To demonstrate the knowledge of sustainability practices and identify green materials, energy cycles and the role of sustainable urbanization.

**TEXT BOOKS:**


1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers , 2018.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3. Gilbert M. Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
7. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.


**REFERENCE BOOKS:**


1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38 .
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 2005.
5. ErachBharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient BlackswanPvt. Ltd. 2013.

**CO-PO & PSO MAPPING**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 2 | 1 | - | - | - | 2 | 3 | - | - | - | - | 2 | - | - | - |
| 2 | 3 | 2 | - | - | - | 3 | 3 | - | - | - | - | 2 | - | - | - |
| 3 | 3 | - | 1 | - | - | 2 | 2 | - | - | - | - | 2 | - | - | - |
| 4 | 3 | 2 | 1 | 1 | - | 2 | 2 | - | - | - | - | 2 | - | - | - |
| 5 | 3 | 2 | 1 | - | - | 2 | 2 | - | - | - | - | 1 | - | - | - |
| Avg. | 2.8 | 1.8 | 1 | 1 | - | 2.2 | 2.4 | - | - | - | - | 1.8 | - | - | - |

- 1-low, 2-medium, 3-high, '-"- no correlation

**NCC Credit Course Level 2***

**NX3451 (ARMY WING) NCC Credit Course Level - II** **L T P C**
**3 0 0 3**

**PERSONALITY DEVELOPMENT** **9**

PD 3 Group Discussion: Change your mindset, Time Management, Social Skills 6

PD 5 Public Speaking 3

**LEADERSHIP** **7**

L 2 Case Studies: APJ Abdul Kalam, Deepa Malik, Maharana Pratap, N Narayan Murty, Ratan Tata, Rabindra Nath Tagore, Role of NCC cadets in 1965 7

**DISASTER MANAGEMENT** **13**

DM 1 Disaster Management Capsule: Organisation, Types of Disasters, Essential Services, Assistance, Civil Defence Organisation 3

DM 2 Initiative Training, Organising Skills, Do's & Don't's, Natural Disasters, Man Made Disasters 9

DM 3 Fire Service & Fire Fighting 1

**ENVIRONMENTAL AWARENESS & CONSERVATION** **3**

EA 1 Environmental Awareness and Conservation 3

**GENERAL AWARENESS** **4**

GA 1 General Knowledge 4

**ARMED FORCES** **6**

AF 1 Armed Forces, Army, CAPF, Police 6

**ADVENTURE** **1**

AD 1 Introduction to Adventure Activities 1

**BORDER & COASTAL AREAS** **2**

BCA 1 History, Geography & Topography of Border/Coastal areas 2

**TOTAL: 45 PERIODS**

**NCC Credit Course Level 2***

| **NX3452** | **(NAVAL WING) NCC Credit Course Level - II** | **L T P C**<br>**3 0 0 3** |
|---|---|---|
| **PERSONALITY DEVELOPMENT** | | **9** |
| PD 3 | Group Discussion: Change your mindset, Time Management, Social Skills | 6 |
| PD 5 | Public Speaking | 3 |
| **LEADERSHIP** | | **7** |
| L 2 | Case Studies: APJ Abdul Kalam, Deepa Malik, Maharana Pratap, N Narayan Murty, Ratan Tata, Rabindra Nath Tagore, Role of NCC cadets in 1965 | 7 |
| **DISASTER MANAGEMENT** | | **13** |
| DM 1 | Disaster Management Capsule: Organisation, Types of Disasters, Essential Services, Assistance, Civil Defence Organisation | 3 |
| DM 2 | Initiative Training, Organising Skills, Do's & Don't's, Natural Disasters, Man Made Disasters | 9 |
| DM 3 | Fire Service & Fire Fighting | 1 |
| **ENVIRONMENTAL AWARENESS & CONSERVATION** | | **3** |
| EA 1 | Environmental Awareness and Conservation | 3 |
| **GENERAL AWARENESS** | | **4** |
| GA 1 | General Knowledge | 4 |
| **NAVAL ORIENTATION** | | **6** |
| AF 1 | Armed Forces and Navy Capsule | 3 |
| EEZ 1 | EEZ Maritime Security and ICG | 3 |
| **ADVENTURE** | | **1** |
| AD 1 | Introduction to Adventure Activities | 1 |
| **BORDER & COASTAL AREAS** | | **2** |
| BCA 1 | History, Geography & Topography of Border/Coastal areas | 2 |

**TOTAL: 45 PERIODS**

**NCC Credit Course Level 2***

| **NX3453** | **(AIR FORCE WING) NCC Credit Course Level - II** | **L T P C**<br>**3 0 0 3** |
|---|---|---|
| **PERSONALITY DEVELOPMENT** | | **9** |
| PD 3 | Group Discussion: Change your mindset, Time Management, Social Skills | 6 |
| PD 5 | Public Speaking | 3 |
| **LEADERSHIP** | | **7** |
| L 2 | Case Studies: APJ Abdul Kalam, Deepa Malik, Maharana Pratap, N Narayan Murty, Ratan Tata, Rabindra Nath Tagore, Role of NCC cadets in 1965 | 7 |
| **DISASTER MANAGEMENT** | | **13** |
| DM 1 | Disaster Management Capsule: Organisation, Types of Disasters, Essential Services, Assistance, Civil Defence Organisation | 3 |

| | | |
|---|---|---|
| DM 2 | Initiative Training, Organising Skills, Do's & Don't's, Natural Disasters, Man Made Disasters | 9 |
| DM 3 | Fire Service & Fire Fighting | 1 |
| **ENVIRONMENTAL AWARENESS & CONSERVATION** | | **3** |
| EA 1 | Environmental Awareness and Conservation | 3 |
| **GENERAL AWARENESS** | | **4** |
| GA 1 | General Knowledge | 4 |
| **GENERAL SERVICE KNOWLEDGE** | | **6** |
| GSK 1 | Armed Forces & IAF Capsule | 2 |
| GSK 2 | Modes of Entry in IAF, Civil Aviation | 2 |
| GSK 3 | Aircrafts - Types, Capabilities & Role | 2 |
| **ADVENTURE** | | **1** |
| AD 1 | Introduction to Adventure Activities | 1 |
| **BORDER & COASTAL AREAS** | | **2** |
| BCA 1 | History, Geography & Topography of Border/Coastal areas | 2 |

**TOTAL: 45 PERIODS**

**PT3411 POLYMER SCIENCE LABORAOTY L T P C**
**0 0 3 1.5**

**OBJECTIVES:**

- To prepare the students with Methodology for facing the Industrial and academic challenges in Identifying various polymers and controlling the quality of incoming raw materials and processing
- To make the students to understand the laboratory scale synthesis process of various types of thermoplastics and thermosets
- To enable the student to carry out production, research and development in the areas of polymer synthesis, polymer nanocomposites, coating formulation development, fiber reinforced composites, polymer processing
- To make them aware of Environmental concerns of Polymer Synthesis
- To make the students to understand and do calculations observations formulations involved team work and understanding practical problems related to the experiment.

**LIST OF EXPERIMENTS**

1. Preparation of phenol - formaldehyde (Novalac) resin.
2. Preparation of phenol - formaldehyde (Resol) resin.
3. Preparation of Urea formaldehyde resin.
4. Preparation of Bisphenol - An epoxy resin.
5. Bulk polymerization of styrene.
6. Emulsion Polymerization of styrene.
7. Solution Polymerization of acrylonitrile.
8. Bulk Polymerization of Methyl methacrylate.
9. Copolymerization of styrene and methyl methacrylate.
10. Ring opening polymerization of Caprolactone
11. Solution Polymerization of Vinyl acetate.

12. Depolymerization of waste thermoplastics such as polystyrene or polymethylmethacrylate
13. Determination of acid value in unsaturated polyester resin
14. Preparation of saturated polyester resin
15. Determination of acid value in saturated polyester resin
(Any Nine of the above)

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon Completion of the Course the students wouldl

- Have skills in preparation of polymers using various polymerization techniques.
- Develop the conversion of polymeric materials into product.
- Design and conduct experiments for synthesis of Resins and polymers and understand the practical problems related to the experiment
- Interpret data, process parameters within realistic constraints of the experiment.
- Communicate effectively in team and understand professional and ethical responsibility.

**MAPPING OF CO'S WITH PO'S**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 3 | 3 | 2 | 1 | 3 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO2 | 2 | 2 | 3 | 3 | 2 | 1 | 3 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO3 | 2 | 2 | 3 | 3 | 2 | 1 | 3 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO4 | 2 | 2 | 3 | 3 | 2 | 1 | 3 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO5 | 2 | 2 | 3 | 3 | 2 | 1 | 3 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| Overall CO | 2 | 2 | 3 | 3 | 2 | 1 | 3 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |

**1-low, 2-medium, 3-high, '-"- no correlation**

**PT3412 PLASTICS PROCESSING LABORAOTY L T P C**
**0 0 3 1.5**

**OBJECTIVES:**

- To practice the students in different types of moulding machines.

| **Sl. No** | **Name of M/c/ Equipment/ Mould** | **Description of Practical Exercise to be done** |
|---|---|---|
| 1 | Hand operated Injection Moulding Machine | (i) Study of Machine in Idle-Run Observation (IRO), Parts & functions, operating principle, Free sketch of Machine-parts eg. Nozzle, Torpedo, Hopper, Rack & Pinion Barrel etc., shot capacity definition<br>(ii) Operation practice to produce moulding on Different and injection moulds. Recording the observation and results in practical record books. |
| 2 | Injection Moulding Semi Automatic | (i) Study of Semi Automatic Injection Moulding M/cs of all types in IRO. Comparative study of Pneumatic type & Hydraulic type of M/cs, Operating Principle of M/cs. Line diagrams of M/cs with nomenclature of parts, M/cs specifications.<br>(ii) Operation of Pneumatic & Hydraulic type of Semi automatic Injection moulding M/cs, to produce |

| | | |
|---|---|---|
| | | components in different moulds. Cycle-time analysis, observations of Process- Parameters & Procedure to be recorded |
| 3 | Extrusion Processes on Extruders | (i) Study of Extruders in IRO, Free sketch of machines, their parts and parts-function, List of products manufactured by Extrusion-Process. Study of different types of extrusion process.<br>(ii) Operation-Practice by Trainee on setting up of Process parameter to produce Blown-Film on Film-plant, observations on extruder output, size of film produced and technical specifications of machines to be recorded |
| 4 | Compression moulding – Hand Operated | (i) Study of Hand compression M/c in IRO Free sketch of Parts & study of part-function, comparison of compression moulding M/c with Injection Moulding M/c. Compression moulding processes.<br>(ii) Operating Principle of Hand Compression Press, mould setting procedure & parameter setting, operation practice on different compression moulds, M/c specification observations and recording |
| 5 | Blow Moulding and Recording Hand Operated | (i) Study of Hand Blow Moulding M/cs, Free-sketch of M/c with parts & study of part-function, Specification of M/c, Study of Parison-die with sketch.<br>(ii) Die-centering practice by Trainees, operation of Hand Blow Machines, to produce components observations, cycle time analysis Procedure of operation and observations. |
| 6 | Scrap Grinding | (i) M/c Study in IRO, specification of M/c, study of parts & function, Line Diagram of M/c.<br>(ii) Operation-practice with different materials and output study in Kg/hour for different materials. |
| 7 | Injection Moulding M/c.- Automatic | Study of M/c Parts & function, Study of clamping systems in M/cs, Technical spec. of M/c, study of process sequence in Machine, Study & definitions of terms related to M/c operation e.g. M/c Day light, Locating – Ring Dimensions, ejector-stroke, Tie-Bar distance,<br>M/c Platen sizes & mould clamping arrangements. Definitions of all Processing Parameters & study of controls in M/cs. |
| 8 | Compression & Transfer Moulding- Semi Automatic | Technical specification of M/c, Mould clamping on M/c, Parameter setting, operation-practice on different compression & Transfer Moulds, Cycle-time analysis, observation & Procedure of start-up & shut down of M/c. |
| 9 | Blow-Moulding Semi Automatic | Technical specification of M/c, Mould clamping on M/c, operation Practice with different moulds, Familiarisation with control-switches/ valves on the M/c, cycle-time analysis & procedure of operation of M/c. |
| 10 | Introduction to Maintenance | Basic knowledge of Hydraulic & Pneumatic systems, Electrical system, Definition of terms- Hydraulic fluid, viscosity Directional Valves, Resistance, Current, Voltage, Power, Hydraulic Pumps -Types & function, electrical heaters, thermocouples and temp control parameters and timers, electrical Motors - Types & fn. |
| 11 | Introduction to | Study of Different Types of Moulds & its Parts and |

| | | |
|---|---|---|
| | Moulds, Tool Room M/ c & Drawing Practice | function, free hand drawing practice, exposure to tool room machines. |

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- Upon completing this practical course, the student will have hands on experience on different types of moulding machines

**MAPPING OF CO'S WITH PO'S**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | 2 | 1 | 3 | 1 | 2 | 2 | - | 2 | 2 | 2 | 2 |
| Overall CO | 2 | 2 | 2 | 2 | 2 | 1 | 3 | 1 | 2 | 2 | - | 2 | 2 | 2 | 2 |

**1-low, 2-medium, 3-high, '-"- no correlation**

**PT3512 INDUSTRIAL TRAINING / INTERNSHIP I* L T P C**
**0 0 0 2**

**OBJECTIVES:**

To enable the students to

- Get connected with industry/ laboratory/research institute
- Get practical knowledge on production process in the industry and develop skills to solve related problems
- Develop skills to carry out research in the research institutes/laboratories

The students individually undergo training in reputed firms/ research institutes / laboratories for the specified duration. After the completion of training, a detailed report should be submitted within ten days from the commencement of next semester. The students will be evaluated as per the Regulations.

**No.of. Weeks: 04**

**OUTCOMES:**

On completion of the course, the student will know about

CO1: Plant layout, machinery, organizational structure and production processes in the firm or research facilities in the laboratory/research institute

CO2: Analysis of industrial / research problems and their solutions

CO3: Documenting of material specifications, machine and process parameters, testing parameters and results

CO4: Preparing of Technical report and presentation

**PT3501 PLASTICS TESTING AND CHARACTERIZATION L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To develop the knowledge of National & International standards for testing methods.
- To create the knowledge about the different testing techniques and its basic concepts for evaluating the chemical, mechanical, electrical, optical, thermal, and permanence properties of plastic materials.

- To enable the students to identify and compare the properties of different plastics materials.
- To enable the students to learn about the property of the plastic material for several

**UNIT I INTRODUCTION TO STANDARDS AND IDENTIFICATION OF PLASTICS 9**

Importance of testing, Standard and specifications- National and International standards-BIS, ASTM, ISO,BS,DIN,JIS,UL etc- Laboratory accreditations – NABL, NABCB, APLAC, FDA, ROHS, UL & REACH.

Identification of plastics by simple methods e.g., visual inspection, density, effects of heat, combustion and solvents analysis, melting & Softening point, elemental analysis, confirmation test analytical techniques used for identification and quantification of additives and fillers.

**UNIT II TESTING OF MECHANICAL PROPERTIES 9**

Preconditioning and test atmosphere, Specimen preparation techniques – Moulding, Contour cutting, contour punching,. Techniques for testing of Short term mechanical properties of Plastics – Stress – Strain curve, toughness, brittle and ductile nature of materials, Tensile, Flexural, Compression, Shear, Impact strength, Tear, abrasion, Hardness and friction test.

**UNIT III TESTING OF THERMAL, ELECTRICAL AND OPTICAL PROPERTIES 9**

Techniques for testing of Thermal properties – Melting Point, Specific heat capacity, HDT, VSP, Flammability (Rate of burning, UL 94, LOI ), Ignition properties of plastics. Thermal conductivity, Coefficient of Thermal Expansion, Brittleness Temperature Electrical properties – Surface & Volume Resistivity, Arc Resistance, CTI, Dielectric Strength, Dielectric constant and Dissipation factor. Optical properties – Luminous transmittance, Haze, Specular Gloss, Refractive Index, colour measurement, optical microscopy

**UNIT IV TESTING OF ENDURANCE, PERMANENCE AND WEATHERING PROPERTIES 9**

Fatigue properties-burst strength- folding endurance, Compression set, Long term mechanical properties: -creep & Stress relaxation. Permanence Properties: Water absorption-soluble and insoluble matter-chemical resistance- environmental stress cracking resistance, gas permeability-water vapour permeability. Thermal endurance, thermal stability, thermal ageing, glass transition temperature, moulding shrinkage. Weathering properties: Weather and Climatic impact on properties of plastics-Natural (outdoor) and Accelerated weathering (UV-A, UV-B & UV-C), Colour fastness

**UNIT V ANALYTICAL TECHNIQUES 9**

Characterization Principles and analysis of polymers / plastics –Fourier Transformed Infrared Spectroscopy (FTIR),UV-Visible spectroscopy, Differential Scanning Calorimetry (DSC), Thermogravimetric Analyzer (TGA), Dynamic Mechanical Analyzer (DMA), X-Ray Diffraction (XRD), Electron Microscope (SEM & TEM), Chromatography (GPC, GC-MS, HPLC, CHNSO analyzer), Rheometer (Capillary, Rotational Rheometer)

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of this course,

- Students are able to identify the plastic materials by simple methods as well as by analytical characterization.
- Students will be able to test and understand the chemical, mechanical, electrical, optical, thermal, and permanence properties of plastics.
- Students will be able the principles of plastics testing and characterization.

**TEXT BOOKS:**

1. Allen; W.S and Baker; P.N, Hand Book of Plastics Technology, Volume 2, Identification

2. Testing & Recycling of Plastics, CBS Publishers and distributors, New Delhi 2004). 3. Brown; Roger P (Ed.), Hand Book of Polymer Testing, Marcel Dekker, Inc, New York (1999).

**REFERENCES:**


1. Brown; Paul F (Ed), Hand Book of Plastics Test Methods, Longman Scientific and Technical, Harlow (1988).
2. Shah, Vishnu, Hand Book of Plastics Testing Technology, John Wiley and Sons, SPE Monograph (1984).
3. Blythe; A. R., Electrical Properties of Polymers, Cambridge University Press, Cambridge (1979).
4. Hubert Lobo, Jose V. Bonilla, “Handbook of Plastics Analysis”, Taylor & Francis 2003.


| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO2 | 2 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO3 | 2 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| Overall CO | 2 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |

**PT3511 PLASTICS TESTING AND CHARACTERIZATION LABORAOTY L T P C**
**0 0 3 1.5**

**OBJECTIVES:**

- To create the knowledge about the different testing techniques and its basic concepts for evaluating the chemical, mechanical, electrical, optical, thermal, and permanence properties of plastic materials.
- To enable the students to identify and compare the properties of different plastics materials
- To understand about characterisation techniques and equipments

**LIST OF EXPERIMENTS**

1. Determination of tensile, flexural and compression properties of plastics materials using universal testing machine.
2. Determination of Rate of flow of plastics (Melt flow index)
3. Identify the given plastic material using FTIR spectrum
4. Composition analysis of plastics composites using DSC and TGA
5. Determine the hardness (Shore A & D, Barcol and Rockwell) of plastic material
6. Determine the abrasion resistance of Plastic materials
7. Determine the impact strength (Izod, Charpy) of Plastic materials and dart impact strength of plastic films
8. Determine the Density, Moisture content and water absorption for plastic materials.
9. Testing of electrical properties of plastics a) Arc resistance b) Surface and Volume resistance c) Comparative tracking index (CTI) d) Dielectric strength e) Dielectric constant and dissipation factor
10. Determine the filler content (Ash content) and $TiO_2$ content in plastics
11. Determination of Heat deflection temperature and Vicat softening point of plastics materials

12. Determine the moulding shrinkage of given plastic materials

(Any Nine of the above) **TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of this course, the students would be able to

- Determine important properties of plastic materials
- Prepare specimen by injection moulding and contour cutting
- Will be able to get knowledge about the different testing techniques and its basic concepts for evaluating the chemical, mechanical, electrical, optical, thermal, and permanence properties of plastic materials.
- Will learn about sophisticated characterisation equipments

**TEXT BOOKS:**

1. Vishu Shah, Hand Book of Plastics Testing Technology, John Wiley & Sons. Inc. New York, 1998.
2. R.P. Brown, Hand Book of Plastics Test Methods, George Godwin Ltd., London,1981

**REFERENCES:**

1. ASTM, ISO and BIS standards of relevant tests
2. J.S. Anand, K. Ramamurthy, K. Palanivelu & C. Brahatheeswaran, How to Identify Plastics by Simple Methods, 1997.

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 |
| **CO2** | 2 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 |
| **CO3** | 2 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 |
| **CO4** | 2 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 |
| **Overall CO** | 2 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 |

**PT3601 PLASTICS PRODUCT TESTING L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To impart knowledge of National & International standards for testing methods.
- To create the knowledge about the different testing techniques and its basic concepts for evaluating the chemical, mechanical, electrical, optical, thermal, and permanence of plastic materials.
- To enable the students to identify and compare the properties of different plastics materials.
- To enable the students to learn about the property of the plastic material for several applications.
- To learn about failure analysis and destructive testing in polymers

**UNIT I TESTING OF PLASTIC FILMS AND MULTILAYER LAMINATES 9**

Methods for identifying the construction of materials of films / laminates, chemical properties: Ash Content, Carbon Black content & dispersion, overall migration, colour migration and specific

migration for plastic films and multi-layered laminates / coextruded films. Mechanical Properties: Films – Types of packaging films and pouches - Dart & drop impact strength, burst strength.

**UNIT II TESTING OF MOULDED PRODUCTS 9**

Testing of potable water storage containers - roto-moulded water tanks - food grade containers / bottles - UPVC profiles – Milk crates – Toys – Automotive components –Rigid Packaging formats: Vibration analysis – Roofing & Floorings – Health care products: Polymer Implants, Sutures, Syringes, etc.,

**UNIT III TESTING OF PIPES, SHEATHS AND TEXTILES 9**

Testing of HDPE Pipe - UPVC Pipe Fittings - Irrigation Product: Lateral, Emitters, Quick Coupled Pipes, PVC Conduits. Geotextiles and membrane, Shade Nets – Woven sack – Types of woven sacks for various applications - Denier, Tenacity for yarns, Breaking strength & seam strength, UV resistance.

**UNIT IV TESTING OF COMPOSITES 9**

FRP: Thermoplastic and Thermosets, Tensile properties – Flexural Properties, Chemical Properties: Acid value, Amine Value, Carboxylic end group analysis, Gel time, Pot life, Resin viscosity, Fire retardant characteristics: Flammability, Spread of Flame, Toxicity Index, Smoke Density.

**UNIT V FAILURE ANALYSIS OF PLASTICS PRODUCTS 9**

Introduction, Types of failures: Design, Process and Material, Concepts of non-Destructive Testing – Testing protocols to analyse root cause of failures, sources of failures, Ageing characteristics in various environment, Shelf-Life assessment - Case studies.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of this course,

- Students will learn how the plastics products are tested to ensure its performance and quality.
- Will be able to get knowledge about the different testing techniques and its basic concepts for evaluating the chemical, mechanical, electrical, optical, thermal, and permanence properties of plastic materials.
- Will learn about sophisticated characterisation equipments
- Students can identify different plastics based on applications
- Students will be able to identify the root cause for failure of plastics products

**TEXT BOOKS:**


1. Allen; W.S and Baker; P.N, Hand Book of Plastics Technology, Volume 2, Identification,
2. Testing & Recycling of Plastics, CBS Publishers and distributors, New Delhi (2004).
3. 3. Brown; Roger P (Ed.), Hand Book of Polymer Testing, Marcel Dekker, Inc, New York (1999).


**REFERENCES:**


1. Brown; Paul F (Ed), Hand Book of Plastics Test Methods, Longman Scientific and Technical, Harlow (1988).
2. Shah, Vishnu, Hand Book of Plastics Testing Technology, John Wiley and Sons, SPE Monograph (1984).
3. Blythe; A. R., Electrical Properties of Polymers, Cambridge University Press, Cambridge (1979).


| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 1 | - | 2 | - | 2 | 2 | 1 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 1 | - | 2 | - | 2 | 2 | 1 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 1 | - | 2 | - | 2 | 2 | 1 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 1 | - | 2 | - | 2 | 2 | 1 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 1 | - | 2 | - | 2 | 2 | 1 | 2 |
| **Overall CO** | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 1 | - | 2 | - | 2 | 2 | 1 | 2 |

**NCC Credit Course Level 3***

**NX3651** **(ARMY WING) NCC Credit Course - III** **L T P C**
**3 0 0 3**

**PERSONALITY DEVELOPMENT** **9**
PD 3 Group Discussion: Team Work 2
PD 4 Career Counselling, SSB Procedure & Interview Skills 3
PD 5 Public Speaking 4

**BORDER & COASTAL AREAS** **4**
BCA 2 Security Setup and Border/Coastal management in the area 2
BCA 3 Security Challenges & Role of cadets in Border management 2

**ARMED FORCES** **3**
AF 2 Modes of Entry to Army, CAPF, Police 3

**COMMUNICATION** **3**
C 1 Introduction to Communication & Latest Trends 3

**INFANTRY** **3**
INF 1 Organisation of Infantry Battalion & its weapons 3

**MILITARY HISTORY** **23**
MH 1 Biographies of Renowned Generals 4
MH 2 War Heroes - PVC Awardees 4
MH 3 Study of Battles - Indo Pak War 1965, 1971 & Kargil 9
MH 4 War Movies 6

**TOTAL: 45 PERIODS**

**NCC Credit Course Level 3***

**NX3652** **(NAVAL WING) NCC Credit Course - III** **L T P C**
**3 0 0 3**

**PERSONALITY DEVELOPMENT** **9**
PD 3 Group Discussion: Team Work 2
PD 4 Career Counselling, SSB Procedure & Interview Skills 3
PD 5 Public Speaking 4

**BORDER & COASTAL AREAS** **4**
BCA 2 Security Setup and Border/Coastal management in the area 2
BCA 3 Security Challenges & Role of cadets in Border management 2

**NAVAL ORIENTATION** **6**
NO 3 Modes of Entry - IN, ICG, Merchant Navy 3
AF 2 Naval Expeditions & Campaigns 3

**NAVAL COMMUNICATION** **2**
NC 1 Introduction to Naval Communications 1

| | | |
|---|---|---|
| NC 2 | Semaphore | 1 |
| **NAVIGATION** | | **2** |
| N 1 | Navigation of Ship - Basic Requirements | 1 |
| N 2 | Chart Work | 1 |
| **SEAMANSHIP** | | **15** |
| MH 1 | Introduction to Anchor Work | 2 |
| MH 2 | Rigging Capsule | 6 |
| MH 3 | Boatwork - Parts of Boat | 2 |
| MH 4 | Boat Pulling Instructions | 2 |
| MH 5 | Whaler Sailing Instructions | 3 |
| **FIRE FIGHTING FLOODING & DAMAGE CONTROL** | | **4** |
| FFDC 1 | Fire Fighting | 2 |
| FFDC 2 | Damage Control | 2 |
| **SHIP MODELLING** | | **3** |
| SM | Ship Modelling Capsule | 3 |
| | | **TOTAL : 45 PERIODS** |

**NCC Credit Course Level 3***

| **NX3653** | **(AIR FORCE WING) NCC Credit Course Level - III** | **L T P C**<br>**3 0 0 3** |
|---|---|---|
| **PERSONALITY DEVELOPMENT** | | **9** |
| PD 3 | Group Discussion: Team Work | 2 |
| PD 4 | Career Counselling, SSB Procedure & Interview Skills | 3 |
| PD 5 | Public Speaking | 4 |
| **BORDER & COASTAL AREAS** | | **4** |
| BCA 2 | Security Setup and Border/Coastal management in the area | 2 |
| BCA 3 | Security Challenges & Role of cadets in Border management | 2 |
| **AIRMANSHIP** | | **1** |
| A 1 | Airmanship | 1 |
| **BASIC FLIGHT INSTRUMENTS** | | **3** |
| FI 1 | Basic Flight Instruments | 3 |
| **AERO MODELLING** | | **3** |
| AM 1 | Aero Modelling Capsule | 3 |
| **GENERAL SERVICE KNOWLEDGE** | | **2** |
| GSK 4 | Latest Trends & Acquisitions | 2 |
| **AIR CAMPAIGNS** | | **6** |
| AC 1 | Air Campaigns | 6 |
| **PRINCIPLES OF FLIGHT** | | **6** |
| PF 1 | Principles of Flight | 3 |
| PF 2 | Forces acting on Aircraft | 3 |
| **NAVIGATION** | | **5** |
| NM 1 | Navigation | 2 |
| NM 2 | Introduction to Met and Atmosphere | 3 |

| | | |
|---|---|---|
| **AERO ENGINES** | | **6** |
| E 1 | Introduction and types of Aero Engine | 3 |
| E 2 | Aircraft Controls | 3 |

**TOTAL : 45 PERIODS**

**PT3611 PLASTICS PRODUCT TESTING LABORATORY L T P C**
**0 0 3 1.5**

**OBJECTIVES:**

- To understand the mechanical and electrical properties of plastics
- To familiarize with various testing standards
- To identify different plastic materials for different applications

1. Testing of HDPE Pipes
2. Testing of UPVC Pipes
3. Testing of Water Storage Tanks
4. Testing of Films/Sheets
5. Testing of HDPE/PP Woven Sacks/Tapes
6. Testing of Baby Feed Bottles
7. Testing of Milk Packing Pouches
8. Testing of UPVC Pipe Fittings
9. Testing of Irrigation Product-Lateral
10. Testing of Irrigation Product-Emitters
11. Testing of Irrigation Product-Quick Coupled Pipes
12. Testing of FRP Sheets
13. Testing of PVC Conduit
14. Testing of electrical enclosures
15. Testing of UPVC profiles

(Any Nine of the above) **TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- Carry out testing independently
- Understand the operating procedure of various testing machines
- Identify plastics for various applications

**TEXT BOOKS:**

- 1. Vishu Shah, Hand Book of Plastics Testing Technology, John Wiley & Sons. Inc.New York, 1998.
- 2. R.P. Brown, Hand Book of Plastics Test Methods, George Godwin Ltd., London,1981

**REFERENCES:**

- 1. ASTM test standards for plastics Vol.8.01 to 8.04, 9.01 & 9.02, 2002.
- 2. ISO test standards, 1998.
- 3. J.S. Anand, K. Ramamurthy, K. Palanivelu& C. Brahatheeswaran, How to Identify
- Plastics by Simple Methods, 1997.

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | - | 2 | 3 | 2 | 2 |
| **CO2** | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | - | 2 | 3 | 2 | 2 |
| **CO3** | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | - | 2 | 3 | 2 | 2 |
| **Overall CO** | 3 | 2 | 1.33 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | - | 2 | 3 | 2 | 2 |

**PT3612 SEMINAR AND COMPREHENSION L T P C**
**0 0 4 2**

In the VI Semester, a comprehension test will be conducted with at least one written test in the middle of the Semester with Objective type of questions and a terminal viva-voce test to evaluate the comprehension of the students in all the subjects covered in all previous semester subjects for one credit. Also, the students will have to present a seminar every alternate week on the latest technologies which will be evaluated for another one credit.

**TOTAL: 60 PERIODS**

**PT3712 INDUSTRIAL TRAINING / INTERNSHIP II[##] L T P C**
**0 0 0 2**

**OBJECTIVES:**

To enable the students to

- Get connected with industry/ laboratory/research institute
- Get practical knowledge on production process in the industry and develop skills to solve related problems
- Develop skills to carry out research in the research institutes/laboratories

The students individually undergo training in reputed firms/ research institutes / laboratories for the specified duration. After the completion of training, a detailed report should be submitted within ten days from the commencement of next semester. The students will be evaluated as per the Regulations.

**No.of. Weeks: 04**

**OUTCOMES:**

On completion of the course, the student will know about

CO1: Plant layout, machinery, organizational structure and production processes in the firm or research facilities in the laboratory/research institute

CO2: Analysis of industrial / research problems and their solutions

CO3: Documenting of material specifications, machine and process parameters, testing parameters and results

CO4: Preparing of Technical report and presentation

**PT3701 PLASTICS PRODUCT DESIGN L T P C**
**3 0 0 3**

**OBJECTIVES:**

To enable the students

- To understand the concepts and features of Plastic Product design.

- To learn the basic concepts of designing with plastics for various loading applications, structural elements and joints.
- To understand the concepts of composite product design.
- To understand the concepts of assembly features
- To learn about holes & threads mould

**UNIT I PRODUCT DESIGN REQUIREMENT 9**

Introduction to Product Design – Principles & Methodical approach for Product Design – Design Process – Material selection – Process selection – Safety Factors in Product Design–Product Design Appraisal- Geometric Dimensioning and Tolerances on Product-Product Design criteria – Structural, Environmental, Assembly, Aesthetics & Decoration- Design for Manufacture &Assembly (DFMA)- Tooling Aspects on Product Design – Cost Analysis for Product Design

**UNIT II PRODUCT DESIGN FEATURES 9**

Wall thickness – variations in wall thickness – suggested wall thickness for various plastics materials –Taper & Draft – Design of radii, fillets, ribs and bosses- Shrinkage - Fits & Tolerances- External & Internal Undercuts

**UNIT III HOLES & THREADS 9**

Moulded Holes & its types - Drilled and tapped holes- Hinges – Types - Design of Integral hinges. Moulded threads – thread types- Inserts – materials – selection of metal for inserts –location ofinserts in the part – moulded inserts – pressed in inserts.

**UNIT IV ASSEMBLY FEATURES 9**

Part Consolidation-Mechanical Fasteners- Snap Fits Joints- Snap Fit Theory, Annular and Torsional Snap fits, Assembly Procedures and Issues with Snap Fits- Welding –Ultrasonic Welding, Vibration and Hot-Plate Welding, Spin Welding- Bonding - Solvent and Adhesive Bonding-Retention Features-Alignment Features- Orientation-Expansion Differences- Tolerances– Introduction to In-mould Assembly.

**UNIT V DESIGN FOR COMPOSITES 9**

Design Criteria for Composites- Cost, Size, Mechanical Properties, Repeatability and Precision, Damage Tolerance and Durability, Environmental Constraints - Design allowables- Need for Design allowables- development of design allowables- Important factors that affect the selection of allowables - Specific techniques used in the statistical development of allowable values.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- The students will understand the basics of plastics product design.
- The students will understand the basics of plastics mould design.
- They also acquire knowledge about various moulds for different processing techniques.
- The students can apply the basic design aspects related to Injection Mould, Compression Mould, Transfer Mould, Blow Mould.
- Will be able to apply the basic design aspects related to extrusion dies.

**TEXT BOOKS:**

1. Robert A. Malloy, “Plastic Part Design for Injection Moulding”, Hanser Publishers, Munich Vienna, New York, 1994.
2. R. D. Beck “Plastics Product Design”, Van Nostrand Reinhold, New York,1980

**REFERENCES:**

1. Belofsky, H, “Plastics Product Design and Processing Engineering, Hanser Publishers, Munich Vienna New York, 1994.
2. Sidney levy J. Harry Dubois, “Plastics Product Design Engineering Hand Book”, Second Edition, Chapman and Hall Ltd, 1984

3. Paul A. Tres, “Designing Plastic Parts for Assembly”, 2nd Revised Edition, Hanser Publishers, Munich Vienna New York, 1994
4. Alfredo Campo E. “The Complete Part Design Handbook for Injection Molding of Thermoplastics”, Hanser Publishers, Munich, 2006
5. Daniel B. Miracle and Steven L. Donaldson “Composites” Volume 21, ASM Handbook,ASM International, 2001.
6. P.K. Mallick, “Fiber-Reinforced Composites: Materials, Manufacturing, and Design”, Third Edition, CRC Press 2007

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 1 | - | 1 | - | 2 | 3 | 2 | 3 |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 1 | - | 1 | - | 2 | 3 | 2 | 3 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 1 | - | 1 | - | 2 | 3 | 2 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 1 | - | 1 | - | 2 | 3 | 2 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 1 | - | 1 | - | 2 | 3 | 2 | 3 |
| **Overall CO** | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 1 | - | 1 | - | 2 | 3 | 2 | 3 |

**PT3702 PLASTICS RECYCLING AND WASTE MANAGEMENT L T P C**
**3 0 0 3**

**OBJECTIVES:**

To enable the students

- To know various sources of plastics waste generation
- To know segregation methods for recycling the plastics
- To know recycling codes of commodity and engineering plastics.
- To learn about primary recycling techniques with examples/case studies.
- To understand the recycling of various commodity and engineering plastics.

**UNIT I INTRODUCTION TO PLASTICS WASTE MANAGEMENT 9**

Plastics production and consumption- Plastic wastes generation source and types – Plastic waste composition, quantities - Plastics identification methods physical, chemical and instrumental – sorting and separation technologies - disposal alternatives – Recycling methods – Primary, Secondary and tertiary recycling of plastics-Plastic road. Economics of plastics recycling, EPR, Recycling rules & regulations. Industrial waste, Post consumer waste.

**UNIT II PROCESSING OF CO-MINGLED PLASTIC WASTE 9**

Size reduction of recycled plastics – cutting / shredding, densification, pulverization and chemical size reduction processes- municipal solid waste and composition – recycling of plastics from urban solid wastes - household waste – industrial sector –density and mechanical properties of recyclable plastics–Processing of commingled / mixed plastic waste – super wood, plastic lumber

**UNIT III RECYCLING OF POLYOLIFINS, PET & PVC 9**

Recycling of polyolefins–polyethylene films – Polypropylene battery recyling- Recycling of HDPE fuel tanks - PET recycling methods – PET film recycling - Applications of polyolefin and PET recyclate – PVC recycling

**UNIT IV RECYCLING OF ENGINEERING THERMOPLASTICS 9**

Engineering thermoplastics and their major areas where engineering polymers are recycled – major recyclers of engineering plastics – GE/ Bayer/ MRC Polymers – PC, PBT, Nylon, PPO, ABS and polyacetals and their blends

**UNIT V RECYCLING OF THERMOSET COMPOSITES 9**

Recycling of Polymer thermoset composites – regrind processes - SMC scrap – pyrolysis andenergy recovery –Types of rubber products – rubber grinding methods – tyre grinding – rubbercrumb applications – Reclaiming and de-vulcanization processes tyre derived fuel and energy recovery – Pyrolysis of scrap tyres-Act on plastic waste management

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- Will understand the impact of plastic waste on environment
- Will able to recycle of both commercial and engineering plastics.
- Will thorough with policies related to environmental issues of plastics waste.
- Will know legislations related to environmental issues of plastic waste.

**TEXT BOOKS:**

1. Polymer recycling, "Science, Technology and Applications, John Scheirs, John Wiley & Sons, England 1988
2. "Recycling of Plastic Materials (Ed)", Francesco Paolo La Mantia, Chem Tec Publishing.
3. "Plastics Waste Management (Ed)", Nabil Mustafa, Marcel Dekker, New York,1995.

**REFERENCES:**

1. Degradable polymers, Recycling and Plastic Waste Management (Eds) Ann Christine
2. Albertson and Samuel J. Huang, Marcel Dekker, New York.
3. John Schiles, Polymer Recycling.
4. Recycling & Plastics Waste Management, Edited by Dr.J.S.Anand, CIPET, 1 997.

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| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | - | 1 | 2 | 2 | 3 | 3 | 3 |
| **CO2** | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | - | 1 | 2 | 2 | 3 | 3 | 3 |
| **CO3** | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | - | 1 | 2 | 2 | 3 | 3 | 3 |
| **CO4** | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | - | 1 | 2 | 2 | 3 | 3 | 3 |
| **Overall CO** | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | - | 1 | 2 | 2 | 3 | 3 | 3 |

**GE3791 HUMAN VALUES AND ETHICS L T P C**
**2 0 0 2**

**COURSE DESCRIPTION**

This course aims to provide a broad understanding about the modern values and ethical principles that have evolved and are enshrined in the Constitution of India with regard to the democratic, secular and scientific aspects. The course is designed for undergraduate students so that they could study, understand and apply these values in their day to day life.

**COURSE OBJECTIVES:**

- To create awareness about values and ethics enshrined in the Constitution of India
- To sensitize students about the democratic values to be upheld in the modern society.
- To inculcate respect for all people irrespective of their religion or other affiliations.
- To instill the scientific temper in the students' minds and develop their critical thinking.
- To promote sense of responsibility and understanding of the duties of citizen.

**UNIT I DEMOCRATIC VALUES 6**

Understanding Democratic values: Equality, Liberty, Fraternity, Freedom, Justice, Pluralism, Tolerance, Respect for All, Freedom of Expression, Citizen Participation in Governance – World Democracies: French Revolution, American Independence, Indian Freedom Movement.
Reading Text: Excerpts from John Stuart Mills' *On Liberty*

**UNIT II SECULAR VALUES 6**

Understanding Secular values – Interpretation of secularism in Indian context - Disassociation of state from religion – Acceptance of all faiths – Encouraging non-discriminatory practices.

Reading Text: Excerpt from *Secularism in India: Concept and Practice* by Ram Puniyani

**UNIT III SCIENTIFIC VALUES 6**

Scientific thinking and method: Inductive and Deductive thinking, Proposing and testing Hypothesis, Validating facts using evidence based approach – Skepticism and Empiricism – Rationalism and Scientific Temper.

Reading Text: Excerpt from *The Scientific Temper* by Antony Michaelis R

**UNIT IV SOCIAL ETHICS 6**

Application of ethical reasoning to social problems – Gender bias and issues – Gender violence – Social discrimination – Constitutional protection and policies – Inclusive practices.

Reading Text: Excerpt from *21 Lessons for the 21st Century* by Yuval Noah Harari

**UNIT V SCIENTIFIC ETHICS 6**

Transparency and Fairness in scientific pursuits – Scientific inventions for the betterment of society - Unfair application of scientific inventions – Role and Responsibility of Scientist in the modern society.

Reading Text: Excerpt from *American Prometheus: The Triumph and Tragedy of J.Robert Oppenheimer* by Kai Bird and Martin J. Sherwin.

**TOTAL: 30 PERIODS**

**REFERENCES:**


1. The Nonreligious: Understanding Secular People and Societies, Luke W. Galen Oxford University Press, 2016.
2. Secularism: A Dictionary of Atheism, Bullivant, Stephen; Lee, Lois, Oxford University Press, 2016.
3. The Oxford Handbook of Secularism, John R. Shook, Oxford University Press, 2017.
4. The Civic Culture: Political Attitudes and Democracy in Five Nations by Gabriel A. Almond and Sidney Verba, Princeton University Press,
5. Research Methodology for Natural Sciences by Soumitro Banerjee, IISc Press, January 2022


**COURSE OUTCOMES**

Students will be able to

CO1 : Identify the importance of democratic, secular and scientific values in harmonious functioning of social life
CO2 : Practice democratic and scientific values in both their personal and professional life.
CO3 : Find rational solutions to social problems.
CO4 : Behave in an ethical manner in society
CO5 : Practice critical thinking and the pursuit of truth.

| PT3711 | CAD/CAM/CAE LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**OBJECTIVE:**

To practice the students in Computer Aided Design, Manufacturing and Engineering software for mould design

**LIST OF EXPERIMENTS:**

**I. Mold Design using CAD Software:**

(1) Design calculations for No. of cavities, Selection of injection moulding machine, shot capacity, plasticizing rate, Clamping force for Injection mould

(2) 2D modeling for Two plate Injection Mould using CAD Software
(3) 2D modeling of Three Plate Injection Mould using CAD Software
(4) Design calculations for No. of cavities, Flash thickness allowances, Loading chamber, Bulk factor, Pressure pad, Heaters for Compressive Mould
(5) 2D modeling for Compression Mould using CAD Software
(6) Design calculations for Clamping force, pinch-off, Head die design, Parison dimensions for Blow Mould
(7)2 D Modeling for Blow Mould using CAD Software

**II Mould machining using CAM software**:

(1) CAM Programming for CNC Machining of Core and Cavity
(2) CAM Programming for CNC Tunning of Gide Pillar and Guide Bush.

**III Mould Flow Analysis using CAE Software:**

(1) Modelling and Mesh Creation using CAE Software
(2) Creation of Feed system and cooling system using CAE Software
(3) Gate Location Analysis using CAE software
(4) Fill Analysis using CAE software
(5) Flow Analysis using CAE software
(6) Cooling Analysis using CAE Software

**OUTCOME:**

At the end of this course, the students will be able to

- Design the moulds using CAD software
- Develop mould using CAM programming
- Analyze the flow and fill characteristics using CAE software

**TOTAL:60 PERIODS**

**REFERENCES**


1. 1. R.G.W.Pye, Injection Mould Design, SPE Publication.
2. P.S.Cracknell and R.W.Dyson, Hand Book of thermoplastics injection mould design, Chapman & Hall, 1993.
3. Herbert Rees, Mould Engineering, Hanser publishers, Munich, Vienna N.Y. 1994.
4. Technical Directory on Design and Tooling for plastics, CIPET, Guindy, Chennai.
5. Design calculations for Compression moulds, Machinery publications, Yellow series, U.K.
6. Mould Flow Manual & Part - Adviser Manual - MOULD FLOW.
7. Laszco Sors and Imre Blazs, Design of Plastic Moulds and Dies, Elsevier, Amsterdam - Oxford - Tokyo - NY, 1989.
8. Jay Shoemaker “Moldflow Design Guide: A Resource for Plastics Engineers”, Volume 10, Hanser, 2006


| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 3. | 1 | 2 | 1 | 2 | 2 | - | 3 | 3 | 3 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 3. | 1 | 2 | 1 | 2 | 2 | - | 3 | 3 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 3. | 1 | 2 | 1 | 2 | 2 | - | 3 | 3 | 3 | 2 |
| **Overall CO** | 3 | 3 | 3 | 3 | 3. | 1 | 2 | 1 | 2 | 2 | - | 3 | 3 | 3 | 2 |

**PT3811 PROJECT WORK / INTERNSHIP[#] L T P C**
**0 0 20 10**

**OBJECTIVES:**
To train the students in

- Identifying problem and developing the structured methodology to solve the identified problem in the industry or research problem at research Institution or college.
- Conducting experiments, analyze and discuss the test results, and make conclusions.
- Preparing project reports and presentation

The students shall individually / or as group work on a specific topic approved by the Department. The student can select any topic which is relevant to his/her specialization of the programme. The student should continue the work on the selected topic as per the formulated methodology. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work, results and discussion, conclusion and references should be prepared as per the format prescribed by the University and submitted to the Head of the department. The students will be evaluated based on the report and viva-voce examination by a panel of examiners as per the Regulations.

**TOTAL: 300 PERIODS**

**OUTCOMES:**
At the end of the project, the student will be able to
CO1: Formulate and analyze problem / create a new product/ process.
CO2: Design and conduct experiments to find solution
CO3: Analyze the results and provide solution for the identified problem, prepare project report and make presentation

**PT3001 COMPOSITE MATERIALS L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To enable the students to understand the basic materials in FRP system.
- To understand the raw materials for matrix resins and reinforcements.
- To acquire knowledge about various processing methods of composites
- To understand the post processing operations, various applications of composites
- To understand the various testing of FRP materials

**UNIT I REINFORCEMENTS FOR COMPOSITES 9**
Composites- classifications - metal matrix composites, ceramic matrix composites, Polymer Composites- general properties and applications- Reinforcements: Properties and applications of - various types of glass fiber, carbon fibers, aramid fibers, boron fibers, natural fibers.

**UNIT II GENERAL PURPOSE RESINS 9**
Methods of manufacturing- properties, curing characteristics and applications of unsaturated polyesters - vinyl ester -phenol formaldehyde resin-urea formaldehyde resin-melamine formaldehyde resin.

**UNIT III SPECIAL PURPOSE THERMOSETS 9**
Methods of manufacturing, properties, curing characteristic and applications of epoxy resins, Polyimide, Thermoset polyurethanes and Cyanate esters resins.

**UNIT IV PROCESSING OF COMPOSITES 9**

Composites Processing techniques - Hand Lay-Up, Spray- Up, Bag Molding, Resin Transfer Molding (RTM), Filament Winding, Pultrusion, Prepregs, SMC, DMC.

**UNIT V LAMINATES & TESTING OF COMPOSITES 9**

Mechanics of composites-Fracture and damage mechanics - laminates –delamination - Measurement of physical and mechanical properties: density-fibre volume fraction-void content, test for tensile-compression- flexural in fiber direction –Non- Destructive Evaluation Methods for Composites – Visual Inspection, Ultrasonic Methods, X-Ray Imaging.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completing this course, the students

- Will familiarize about the resins used in FRP system
- Will attain the knowledge of reinforcement mechanism
- Will able to understand the processing methods of composites
- Will attain the knowledge post processing operations of composites
- Will develop the knowledge in testing of composites

**TEXT BOOKS:**


1. J. A. Brydson, "Plastics materials", Butterworth- Heinemann - Oxford, 6th Ed., 1995.
2. S. T. Peters, “Handbook of Composites”, Chapmun& hall, 2nd Edition 1998.


**REFERENCES:**


1. G Lubin, “Hand Book of Composites”, 2nd Ed, Van Nostrand Reinhold, New York, 1982.
2. F.L. Matthews and R.D. Rawlings, 'Composite materials: engineering and science', Chapman and Hall, 1994.
3. P.K. Mallick, 'Composites Engineering Handbook', Marcel Dekker Inc.NY., 1997.
4. D. Hull and T. W. Clyne, "An introduction to Composite Materials 2nd Ed", Cambridge, 1996
5. B.T. Astrom, “Manufacturing of Composites”, Chapman & Hall, 1997.


| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | - | 1 | - | 2 | 2 | 2 | 3 |
| CO2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | - | 1 | - | 2 | 2 | 2 | 3 |
| CO3 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | - | 1 | - | 2 | 2 | 2 | 3 |
| CO4 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | - | 1 | - | 2 | 2 | 2 | 3 |
| CO5 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | - | 1 | - | 2 | 2 | 2 | 3 |
| Overall CO | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | - | 1 | - | 2 | 2 | 2 | 3 |

**PT3002 PLASTICS IN ELECTRONICS L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To learn about basic conduction mechanism, the concept of doping and dedoping
- To understand different insulating polymers for electronic applications
- To enable the students to understand the basic concepts on conducting polymers
- To understand common applications of polymers in electronic field and the science behind them
- To acquire knowledge about the fabrication of electronic device

**UNIT I FUNDAMENTALS OF ORGANIC ELECTRONICS 9**

Introduction to Plastic electronics, Concept of organic semiconductors; Electrical conductivity, Electronic structure of organic molecules: Atomic and molecular orbitals, Orbital hybridization, HOMO and LUMO levels, Charge carrier transport in polymeric and organic semiconductors; Optical properties of organic semiconductors;

**UNIT II PLASTICS FOR ELECTRONICS ENCLOSURES AND ITS PROPERTIES 9**

Electrically insulating polymers: Acrylonitrile Butadiene Styrene (ABS), Acrylonitrile Styrene Acrylate, Polycarbonate (ASA+PC Blend), Polyamide (PA), Polybutylene Terephthalate (PBT), Polycarbonate (PC), Polycarbonate + Acrylonitrile Butadiene Styrene (PC+ABS Blend), Epoxy, Silicone encapsulation & coating, Polycarbonate + Acrylonitrile Butadiene Styrene (PC+ABS Blend), Polymethyl Methacrylate, Acrylic, Plexiglas (PMMA), Polyphenylene Ether+Polystyrene (PPE+PS), Styrene Ethylene Butadiene Styrene (SEBS). Fluropolymers: Perfluoroelastomers (FFKM) and Polytetrafluoroethylene (PTFE), Phenolic Resins

**UNIT III INHERENTLY CONDUCTING POLYMERS AND ITS PROPERTIES 9**

Introduction to Inherently Conducting Polymers, Classification of conducting polymer, Concept of doping, n-Type, p-Type, Electrochemistry of electronically conducting polymers-source of electronic conduction in polymers, polaron, bipolaron, conduction mechanism. Poly(*p*-phenylene vinylene), Polypyrroles, Polyindoles, Polyanilines (PANI), Polythiophenes, Poly(3,4-ethylenedioxythiophene) (PEDOT), and Poly(*p*-phenylene sulfide) Adhesives, coatings, potting compounds, and sealants

**UNIT IV PLASTIC ELECTRONIC DEVICES 9**

Introduction to Flexible & Stretchable electronics, Photonic devices: Organic light emitting diodes, Displays, Lasers & photo-diodes, Sensors: Wearable sensors, Biosensors, Piezoelectric sensors, Energy Harvesting Devices: Polymer based photovoltaics, blue energy devices, Energy Storage Devices: Fuel cells, Polymer based rechargeable batteries, & supercapacitors, Electronic devices and integrated circuits: Silicon hybrid thin film transistor, FETs, nano-FETs, electro-chromic devices, high current switches, and flexible printed circuit boards, Superconductors.

**UNIT V FABRICATION TECHNOLOGIES OF PLASTICS ELECTRONIC DEVICES 9**

Solution Processable: Langmuir–Blodgett films, Spin Coating, Electro-spinning, Patterning, Screen printing, Additive Manufacturing Technology: Inkjet Printing, Electrohydrodynamic Printing, Light-Based 3D Printing - Direct Laser Writing Technology, Steriolithography (SLA), Two photon polymerization.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completing this course, the students

- Will understand basic conduction mechanism, the concept of doping and dedoping
- Will learn different types of insulating polymers for electronic applications
- Will understand the basic concepts on conducting polymers
- Be familiar with common applications of polymers in electronic field and the science behind them
- Will acquire knowledge about the fabrication of electronic device

**REFERENCES:**


1. Conducting Polymers, Fundamentals and Applications, Prasanna Chandrasekhar, Springer New York, NY (1999)
2. Conducting Polymers: Chemistries, Properties and Biomedical Applications Ram K. Gupta, Taylor & Francis (2022)
3. Hand book of Conducting Polymers: Terje A. Skotheim (Vol.l), Dekker (668.42)

4. Green Materials for Electronics, Mihai Irimia-Vladu, Eric D. Glowacki, Niyazi S. Sariciftci, Siegfried Bauer, Wiley (2017)

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 3 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO2 | 3 | 2 | 2 | 3 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO3 | 3 | 2 | 2 | 3 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO4 | 3 | 2 | 2 | 3 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO5 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| Overall CO | 3 | 2 | 2 | 3 | 1.4 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |

**PT3003 BIODEGRADABLE POLYMERS L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To enable the students to understand the method to develop biodegradable polymers
- To get knowledge on need of biodegradable polymer.
- To enrich various testing methods used for analyzing the biodegradability
-

**UNIT I CHEMISTRY AND BIOCHEMISTRY OF POLYMER DEGRADATION 9**

Introduction, enzymes - enzyme nomenclature - enzyme specificity - physical factors affecting the activity of enzymes - enzyme mechanism, Chemical degradation initiates biodegradation, Hydrolysis of synthetic biodegradable polymers.

**UNIT II PARTICULATE STARCH BASED PRODUCTS 9**

Development of Technology, Current objectives, relative starch technology, Manufacture of master batch, Conversion technology - processing precautions - moisture and temperature – rheological considerations, cyclic conversion process, physical properties of products - sample preparation - physical testing methods

**UNIT III BIOPOLYESTERS 9**

Introduction, History, biosynthesis, Isolation - solvent extraction - sodium hypo chloride digestion, enzymatic digestion, Properties - crystal structure - nascent morphology, degradation-Intracellular biodegradation - extra cellular biodegradation - thermal degradation - hydrolytic degradation - environmental degradation

**UNIT IV RECYCLING TECHNOLOGY FOR BIODEGRADABLE PLASTICS 9**

Introduction, conventional recycling - recycling problems, degradable complicate recycling - polyethylene/starch film, reprocessing polyethylene/cornstarch film scrap - learning to reprocess PE/S - Calcium oxide moisture scavenger -temperature control - accounting for pro-oxidant - handling PE/S repro - economics of in-plant recycling, Using PE/S repro – comparative study of PE/S repro on film properties, recycling other degradables.

**UNIT V TEST METHODS & STANDARDS FOR BIODEGRADABLE PLASTICS 9**

Introduction, defining biodegradability, criteria used in the evaluation of biodegradable polymers, choosing the most appropriate methodology, description of current test methods -screening test for ready biodegradability, tests for inherent biodegradability, tests for simulation studies, - Petridis screen -environmental chamber method - soil burial tests

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completing this course, the students

- Will develop biodegradable polymer by various methods.
- Will understand mechanism of degradation of rubber compounds.
- Will assess bio-degradability of polymers.
- Will do recycle of biodegradable polymer.
- Will understand standards for biodegradable polymer.

**TEXT BOOKS:**

1. G.J.L Griffin Blackie (ed.), Chemistry & Technology of Biodegradable Polymers Academic& Professional London 1994.
2. Yoshiharu Doi, Kazuhiko Fukuda (ed.) Biodegradable Plastics & Polymers Elsevier 1994.

**REFERENCES:**

1. Abraham J.Donb& Others (ed.) Handbook of Biodegradable polymers, Harvard Academic Publishers Australia 1997.

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | - | 1 | - | 2 | 2 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 2 | 1 | 2 | 2 | 2 | - | 1 | - | 2 | 2 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | - | 1 | - | 2 | 2 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | - | 1 | - | 2 | 2 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 2 | 3 | 1 | 1 | 2 | - | 1 | - | 2 | 2 | 3 | 3 |
| Overall CO | 3 | 3 | 3 | 2 | 2 | 2.4 | 2.4 | 2 | - | 1 | - | 2 | 2 | 3 | 3 |

**PT3004 POLYMERS IN BIOMEDICAL ENGINEERING L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To understand various natural and synthetic polymers used for biomedical applications and
- their compatibility with biological system
- To learn about the plastics that is used as implants in cardiovascular, ophthalmology, and other artificial organs.

**UNIT I BIOMATERIALS 9**

Biomaterials, Biocompatibility, Stabilization, Inflammation and Wound Healing, Blood Clotting System, skin System, Biological response to Implants, Implant Design and Applications.

**UNIT II BIOMEDICAL POLYMERS 9**

Criteria for the Selection of Biomedical Polymers Physicochemical Aspects of the Blood Compatibility of Polymeric Surface. Biomedical Polymers from biological source, Poly hydroxyl Alkanoic Acids, Microbial polysaccharides, Silk, Collagen. , Microbial Cellulose, Hyaluronic Acid, Synthetic Polymers such as PMMA, Silicone Rubber, Polyethylene, Natural Rubber, Hydrogels.

**UNIT III BIOMEDICAL APPLICATIONS OF POLYMERS 9**

Permanent Implants For Function-Orthopedics, Cardio Vascular, Respiratory Patches and Tubes, Digestive System, Genitourinary System, Nervous System, Orbital (Corneal And Lens Prosthesis)–Permanent Implant For Cosmoses, Other Applications of Engineered Material In Clinical Practices, Silicone Implants. Polymer Membranes, Polymer Skin, Polymeric Blood.

**UNIT IV POLYMERIC LENSES 9**

Contact Lenses, Hard Lenses, Gas Permeable Lenses, Flexible Lenses, Soft Lenses, Hydrogels, Equilibrium Swelling, Absorption And Desorption, Oxygen Permeability, Types of Soft Lenses, Manufacture, Cleaning And Disinfection.

**UNIT V DENTAL POLYMERS 9**

Dental applications, denture bases, crown and bridge resins, plastic teeth, mouth protectors, maxillofacial prosthetic materials, restorative material, polyelectrolyte based restoratives, sealants, adhesives, dental impression and duplicating materials, agar, algmater elastomers.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- Able to describe the criteria for selection of bio medical polymers
- Able to explain the biomedical applications of polymers
- Able be familiarized with the polymers used in dental applications
- Able to attain the skill on polymeric lenses used in medical applications

**TEXT BOOKS:**

1. J B Park, Bio-materials, An Introduction –, CRC Press, 2003.
2. H.F. Mark (Ed), Encyclopedia of polymer science and engineering, John Wiley and Sons New York, 1989.

**REFERENCES:**

1. Robert C Portnoy, Medical Plastics - Degradation Resistance and Failure Analysis, Elsevier – 1st edition (1998)
2. Chiellini; Emo, Sunamoto; Junzo, Migliaesi; Claudio, Ottebrite; Raphael and Cohn; Daniel (Eds.), Biomedical Polymers and Polymer Therapeutics, Kluwer Academic/Plenum Publishers, New York (2001).
3. Galaev; Igor and Mattiasson; Bo (Eds.), Smart Polymers; Applications In Biotechnology and Biomedicine, CRC Press, Boca Raton (2008).

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 2 | - | 1 | - | 2 | 2 | 3 | 3 |
| CO2 | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 2 | - | 1 | - | 2 | 2 | 3 | 3 |
| CO3 | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 2 | - | 1 | - | 2 | 2 | 3 | 3 |
| CO4 | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 2 | - | 1 | - | 2 | 2 | 3 | 3 |
| Overall CO | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 2 | - | 1 | - | 2 | 2 | 3 | 3 |

**PT3005 ADHESIVES, PAINTS AND COATINGS L T P C**

**3 0 0 3**

**OBJECTIVES:**

To enable the students to understand the following:

- Understand theories of adhesion and types of specialty adhesives and their application
- Understand the concepts of adherend surface treatments and hardening of adhesives
- Compare joint design on adhesive bond and testing of adhesives
- Surface coatings - constituents and classifications
- Evaluation of application and properties of surface coatings

**UNIT I CONCEPTS AND TERMINOLOGY 9**

Definition of Adhesives and adhesive bonding , functions of adhesives, advantages and disadvantages of adhesive bonding, requirements for a good bond, criteria for selection of adhesives- Theories of adhesion-mechanical theory, adsorption theory, electrostatic theory, diffusion theory, weak-boundary layer theory.

**UNIT II ADHESIVES TYPES 9**

Types of adhesives, Adhesives from natural source, structural adhesives, Urethane structured adhesives, Modified acrylic structural adhesives, phenolic adhesives, anaerobic adhesives, cyanoacrylate adhesives, hot melt adhesives, pressure sensitive adhesives, RTV Silicone adhesives ,Epoxides, conductive adhesives-Low energy and high energy surface- surface preparation of adherends-metals, plastics and rubbers-Mechanical abrasion, solvent cleaning, chemical treatment, primers ,plasma treatment, corona treatment.

**UNIT III JOINT DESIGN 9**

Hardening by solvent or dispersing medium removal, Hardening by cooling, Hardening by chemical reaction, non hardening adhesives-Joint design, stresses, types of joints, selection of joint detail, joint design criteria-Adhesive bonding process methods for adhesives application and bonding equipment, Standard test methods of adhesives-Destructive and non destructive testing, adhesive specifications and quality control.

**UNIT IV INTRODUCTION TO SURFACE COATINGS 9**

Introduction to surface coatings-Components of paints. Pigments, pigment properties, different types, extenders, solvents, oils, driers, diluents, lacquers, varnishes, paint preparation, formulation, factors affecting pigment dispersion, preparation of pigment dispersion. Different types of paints- classification based on polymeric resin, emulsion, oil and alkyd paints, acrylic paints, epoxy coatings, polyurethane, silicones, formaldehyde based resins, chlorinated rubbers, hydrocarbon resins, fluropolymers, vinyl resins. Classification based on application- appliance furnishes, automotive finishes, coil coatings, can coatings, marine coatings, aircraft coatings.

**UNIT V SURFACE COATING METHODS 9**

Surface preparation and paint application-brushing, dip coating, roller coating, spray coating, electro deposition and chemiphoretic deposition. Paint properties and their evaluation -mechanism of film formation, factors affecting coating properties, methods used for film preparation – barrier properties, mechanical properties, optical properties, ageing properties, rheological properties of coatings

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completing this course, the students

- Will attain the knowledge in mechanism of adhesion
- Will demonstrate the adhesive types and application
- Understanding of joint designs and testing of adhesives
- Will familiarize about the compounding of paints
- Will understand application techniques and properties of surface coatings

**TEXT BOOKS:**


1. Gerald L. Schreberger, “Adhesive in Manufacturing”, Marcel Dekker Inc., New York, 1983
2. W.C. Wake, “Adhesion and the Formulation of Adhesives”, Applied Science Publishers, London, 1976.
3. Premamoy Ghosh, Adhesives and Coatings Technology, (2008)
4. Formulating Adhesives and sealants, B. Muller, Walter lath, (2010).


**REFERENCES:**


1. Swaraj Paul, “Surface Coatings”, John Wiley & Sons, NY, 1985.

2. George Mathews, “Polymer Mixing Technology”, Applied Science Publishers. Shields, “Hand Book of Adhesives”, Butterworths,1984

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | - | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 3 | 3 |
| CO2 | 2 | 2 | 2 | 2 | - | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 3 | 3 |
| CO3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 3 | 3 |
| CO4 | 2 | 2 | 2 | 2 | - | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 3 | 3 |
| CO5 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 3 | 3 |
| Overall CO | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 3 | 3 |

**PT3006 POLYMERS IN TRANSPORTATION L T P C**
**3 0 0 3**

**OBJECTIVES**

- To understand different polymers used in the field of transportation
- To understand processing techniques for manufacturing plastic components
- To acquire knowledge about properties and application of polymers in the field of transportation
- To understand specialty Surface coatings for automotive and its necessity
- Evaluation of properties of surface coatings

**UNIT I INTRODUCTION 9**

Transportation Industries:- Automotive, aerospace and marine-Use of thermoplastic and thermoset polymers, foamed polymers, elastomers, composites for transportation application-Composite-fibers, matrix, interface-Advantages and disadvantages of composites.

**UNIT II PROPERTIES OF POLYMERS FOR TRANSPORT APPLICATIONS 9**

Properties of polymers for transport applications- Thermal , chemical, mechanical, weathering resistance, sound insulation, durability, fire retardancy.- Application of polymers in automotive, aerospace and marine industries-polymer concrete-test methods-shrinkage, tensile elongation, water absorption, abrasion, chloride ion penetration.

**UNIT III AUTOMOTIVE COMPONENT PROCESSES 9**

Automotive component processes-Injection moulding, Co injection moulding-Gas assisted Injection moulding-Reaction Injection molding (RIM) Extrusion moulding, automotive plastics testing include functionality testing, perceptivity testing, weathering and environmental testing, physical testing, chemical resistance and chemical testing for automotive interiors and exteriors

**UNIT IV ENERGY CONSUMPTION IN TRANSPORTATION 9**

Energy consumption in transportation-Coatings technology for fuel efficiency-coatings used for transportation applications -coating techniques-DLC coating-application to engine components-Effect of Lubricant on Friction and Wear Properties of DLC Coatings-coatings for fuel injection systems, Coatings in Turbochargers-coatings for automotive manufacturing

**UNIT V SURFACE TREATMENTS FOR AUTOMOTIVE APPLICATIONS 9**

Surface treatments for automotive applications-Plasma assisted surface treatments, Heat treatments-PVD treatments-Magnetic sputtering, Thermal spraying-Decorative PVD coatings on

automotive plastics-Vacuum metallization of plastics, inline metallizer-transport system-Factory integration

**TOTAL: 45 PERIODS**

**OUTCOMES**

- Will familiarize about different polymers in transportation field
- Will demonstrate various processing techniques
- Will learn about different properties and applications of polymer in transportation field
- Will understand about different coating techniques
- Will learn different surface treatments of adherends and integration of vehicle components

**TEXTBOOKS**

- Long-Term Performance of Polymer Concrete for Bridge Decks - A Synthesis of Highway Practice, Fowler, David W., Whitney David W.
- Coating technology for vehicle appliations, Springer International Publishing, Sung Chul Cha, Ali Erdemir (eds.)
- Osswald, Tim A, Lih-Sheng Turng and Gramann, Paul, Injection Molding Hand Book, 2nd Ed., Hanser Publisher, Munich 2008Rubin, Irvin I., Injection Molding Theory & Practice, Johnwiley & sons Inc.,US, 1972
- Levy, Sydney and Carley, James F., Plastics Extrusion Technology Hand Book, 2nd Ed., Industrial Press Inc., Newyork 1989.
- Gerald L. Schreberger, "Adhesive in Manufacturing", Marcel Dekker Inc., New York, 1983
- Premamoy Ghosh, Adhesives and Coatings Technology, (2008)
- Formulating Adhesives and sealants, B. Muller, Walter lath, (2010).

**REFERENCES**

- James F. Stenvension, Innovation in Polymer Processing Moulding, HanserPublishers, New York, 1996.
- Friedhelm Henson, Plastics Extrusion Technology, Hanser Publishers, New York,1988
- Swaraj Paul, "Surface Coatings", John Wiley & Sons, NY, 1985

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | - | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO2 | 3 | 3 | 3 | 3 | - | 3 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO4 | 2 | 2 | 2 | 2 | - | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO5 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| Overall CO | 2.2 | 2.2 | 2.2 | 2.2 | 2 | 2.2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |

**PT3007 BIOPOLYMERS AND GREEN COMPOSITE L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To gain knowledge of synthetic biopolymers
- To acquire knowledge on structure and properties of biopolymers
- To understand the basic applications of various biopolymers and green composites

**UNIT I GREEN CHEMISTRY OF POLYMERS 9**

Raw materials for polymers – Sustainability of Petroleum resources – Need for Alternate Sources for Polymers -Polymer Recycling and Environmental Issues – Bio derived Polymers – Biodegradation and its Evaluation techniques – Standards for biodegradation – Need for

biodegradation of packaging materials – Introduction to Life Cycle Assessment – Monomers from biosources.

**UNIT II BIOPOLYMERS 9**

Types of Biopolymers: Natural, Synthetic and Microbial biopolymers – Polysaccharides, Protein and Polynucleotides based biopolymers: Plant and animal-based Proteins – Solution casting of proteins–Processing of proteins as plastics – preparation and properties of hemicellulose – Cellulose based Composites -Surface and Chemical modifications of Cellulose fibers. Biodegradable polymers: Poly lactic acid, Polycaprolactone, etc.), hydrogels, smart hydrogels and their applications.

**UNIT III PROPERTIES AND APPLICATION OF BIOPOLYMERS 9**

Testing and Characterization of Biopolymers: Mechanical strength, Biodegradability, Biocompatibility. Applications: Agriculture - Mulching Films, Shade nets, etc., Packaging: Wrap films, shrink wraps, etc. Biomedical: Biosensors, Tissue Engineering, Controlled Drug Delivery, Organ transplants, etc.

**UNIT IV GREEN COMPOSITES 9**

Introduction to Green Composites – Reinforcements: Natural Fibers and Agricultural residues– Types, Physical & Chemical surface Modifications, Nanofibrils, Green Hydrogels. Processing and Fabrication methods of green composites with Thermoplastic and biodegradable polymer matrices.

**UNIT V PROPERTIES AND APPLICATIONS OF GREEN COMPOSITES 9**

Testing of Green Composites: Mechanical Properties – Tensile properties, fatigue resistance, Impact properties, Ballistic Characteristics, Thermal Properties: Heat Resistant, Fire retardancy, Flammability. Rheological properties. Applications: Automotives, Aerospace, Defence, Electrical and Electronics, Agriculture and Health care.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- The students will acquire in depth knowledge in biopolymers.
- Gain expertise in natural polymers, polymer prepared by microorganisms and polymers prepared form renewable sources.
- Gain knowledge on the synthesis of biopolymers the characterization methods
- Will get exposure to various kinds of natural fibers, green composites and its application in various sectors.

**TEXT BOOKS:**


1. Byrom D., (1991) Biomaterials: Novel Materials from Biological Sources, First Edition, Macmillan Publishers Ltd.
2. Bastioli C., (1987) Hand Book of Biodegradable polymers, Rapra Technology.
3. Niaounakis M., (2015) Biopolymers: Processing and Products, First Edition, Elsevier Inc.


**REFERENCES:**


1. David Plackett, “Biopolymers – New Materials for Sustainable films and Coatings”, John Wiley and Sons Ltd, 2011
2. David Kaplan, “Biopolymers from Renewable resources”, Springer, 1998
3. Carmen Scholz, Richard A Gross, “Polymers from Renewable Resources Biopolymers and Biocatalysis”, American Chemical Society, 2001.

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | - | 2 | 3 | 2 | - | 1 | - | 2 | 2 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 3 | - | 3 | 3 | 2 | - | 1 | - | 2 | 2 | 3 | 3 |
| CO3 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | - | 1 | - | 2 | 2 | 3 | 3 |
| CO4 | 2 | 2 | 2 | 2 | - | 2 | 3 | 2 | - | 1 | - | 2 | 2 | 3 | 3 |
| Overall CO | 2.25 | 2.25 | 2.25 | 2.25 | 2 | 2.25 | 3 | 2 | - | 1 | - | 2 | 2 | 3 | 3 |

**PT3008 POLYMER BLENDS AND ALLOYS L T P C**
**3 0 0 3**

**OBJECTIVE:**

- To enable the students to understand the miscibility of polymers, characteristics of blends and mechanism of toughening

**UNIT I CLASSIFICATION OF POLYMER BLENDS AND ALLOYS 9**

Definition of polymer blends and alloys - Classification - Criteria for selection of polymer – Thermodynamics of miscibility – Phase morphology – Phase separation behavior – Determination of morphology of polymer blend – Mechanical compatibility - Electron Microscopy.

**UNIT II PREPARATION OF POLYMER BLENDS AND ALLOYS 9**

Principles and methods involved in preparation of Polymer blends and alloys - Introduction to polymer rheology in blend – Interpenetrating polymer network: Synthesis, Morphology, Properties and application of polymer blend - Enhancement of polymer miscibility – utilization of miscible polymers.

**UNIT III SPECIALITY POLYMER BLENDS 9**

Liquid Crystalline Polymer, Blends-Ternary Polymer – Elastomer, Blends-Polymer blends containing block copolymers-– Biodegradable polymer blends- blends involving recycled polymers and challenges with mixed recycled polymers.

**UNIT IV TOUGHENED THERMOPLASTICS AND THERMOSETS 9**

Toughened polymers- Specific examples for toughened thermoplastics and thermosets – specific interaction - hydrogen bonding interaction, dipole-dipole interaction, ion–dipole & ion-ion interaction and additional specific interaction.

**UNIT V APPLICATION OF BLENDS AND ALLOYS 9**

Application of Blends in Emerging technology - Photovoltaic, Light Emitting Diode, Electro chromic, Electric conductivity polymer and blends, Lithium battery & Fuel cells Applications

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completing this course, the students

- Able to express the basic concepts of polymer blend
- Able to infer the thermodynamic of polymer -polymer miscibility
- Able to classify the types of polymer blends
- Able to interpret the characterized polymer blends
- Able to discover the application of polymer blends

**TEXT BOOKS:**

1. Lloyd M. Robeson - Polymer Blends: A Comprehensive Review, Hanser Publishers, 2007
2. D R Paul and S Newman, “Polymer Blends Vol. I & II”, Academic Press Inc, 1978.

**REFERENCES:**

1. Olabisis, I W Rubison and M T Shaw Polymer - Polymer Miscibility Academic Press – New York 1979.
2. Utracki, “Polymer Blends and Alloys”, Hanser Publisher.
3. G. Lubin, “Hand Book of Composites”, 2nd Ed., Van Nostrand Reinhold, NY, 1982.
4. S.M.Lee, “Dictionary of Composites Materials Technology”, Technomic Lancaster, Pa, 1989.

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 2 | - | 2 | 2 | 2 | - | 1 | - | 2 | 2 | 2 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | - | 2 | 2 | 2 | - | 1 | - | 2 | 2 | 2 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | - | 2 | 2 | 2 | - | 1 | - | 2 | 2 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | - | 2 | 2 | 2 | - | 1 | - | 2 | 2 | 2 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | - | 2 | 2 | 2 | - | 1 | - | 2 | 2 | 2 | 2 |
| **Overall CO** | 2.8 | 2.8 | 2.8 | 2.8 | - | 2 | 2 | 2 | - | 1 | - | 2 | 2 | 2 | 2 |

**PT3009 ADVANCED MOULD MANUFACTURING L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To impart knowledge on various Cutting Tools and CNC Machines
- To develop the knowledge on elements of the mould and manufacturing processes with
- CAD/CAM/CAE
- To learn the application of additive manufacturing in mould development
- To acquire skills in advanced measuring instruments for inspection of mold

**UNIT I CNC MACHINING CENTERS 9**

Introduction to CNC Machining Center- Classification - Working Principle and Construction - coordinate system -Dimensioning method -Cutter radius and length compensation – Interpolations- Preparatory and miscellaneous functions– Cutting Tools - Types, Materials and Selection –Cutting parameters - Tool holding devices – Work holding devices – work piece alignment & datum setting – Part programming - types, cycles – CAM Programming – Execution of NC file-Manufacturing of mould elements with CAD/CAM

**UNIT II CNC TURNING CENTERS 9**

Introduction to CNC Turning Center- Classification - Working Principle and Construction - coordinate system -Dimensioning method -Tool Nose radius and length compensation – Interpolations - Preparatory and miscellaneous functions– Cutting Tools - Types, Materials and Selection – Cutting parameters - Tool holding devices – Work holding devices – work piece alignment & datum setting – Part programming- types, cycles – CAM Programming – Execution of NC file- Manufacturing of mould elements with CAD/CAM

**UNIT III CNC DIE SINKING EDM AND WIRE EDM 9**

CNC DIE SINKING EDM: Introduction - theory of metal removal- Working Principle and Construction – Process parameters– Electrode materials and selection- Electrode Design- Dielectric fluid – Functions, requirements and properties - Factors affecting Metal Removal Rate –

Applications, advantages and disadvantages– Programming and Manufacturing of mouldelements.CNC Wire EDM: Introduction - Working Principle and Construction – Process parameters–specification and selection of Tool (Wire) -– Dielectric fluid – Functions, requirements and properties - Factors affecting cutting process– Applications, advantages and disadvantages comparison of EDM and wire EDM– Programming and Manufacturing of mould elements.

**UNIT IV RAPID TOOLING 9**

Introduction to Additive manufacturing - Difference between rapid tooling & conventional tooling - Development of mould elements with RP- conformal cooling of mold elements – silicon moulds for Vacuum Casting - Epoxy Tooling System.

**UNIT V ADVANCED METROLOGY 9**

Co-ordinate measuring machine – Constructional features – Types – Applications of CMM – CNCCMM applications – Computer Aided Inspection – Machine Vision - Form Measurement – Straightness, Flatness and roundness – Nano metrology – Introduction – Principles – Nanometer metrology systems – Methods of measuring length and surfaces to nano scale result with interferometers and other devices.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completing this course, the students

- will have the knowledge in CNC Machine Tools for mould manufacturing
- will acquire skills in 3 D printing and Rapid tooling
- will acquire skills in advanced measuring equipment for inspection of mold
- will acquire skills in rapid tooling
- will acquire skills in CNCCMM and computer aided inspection.

**TEXT BOOKS:**


1. KlusStokhert, Mold making handbook for Plastic Engineers, Hanser Publishers, NY, 3rdEdition 2013
2. HMT Production Technology, Tata McGraw Hill, 2001


**REFERENCES:**


1. R.G.W.Pye, Injection Mold Design, East West Press Pvt. Ltd., New Delhi.,2000.
2. Hajra Chouldhary S.K and Hajra Choudhury. AK., "Elements of workshop Technology", volume II, Media promoters and Publishers Private Limited, Mumbai, 2010.
3. W.A.J Chapman, Workshop Technology, Vol I & II, ELBS.
4. Peter Jones, “The Mould Design Guide”, Smithers Rapra Technology Ltd., 2008
5. Herbert Rees, Mold Engineering, Hanser Publishers, NY.,2002.
6. George Menges & Paul Mohren, How To Make Injection Molds, Hanser Publishers,2001.
7. Douglas M. Bryce, Plastic Injection Molding manufacturing process fundamentals, Societyof Manufacturing Engineers, Dearborn, Michigan.,1996.
8. Jain R K ,” Engineering Metrology” , 19th Edition , Khanna Publishers , 2005
9. Gaylor, Shotbolt and Sharp, Metrology for Engineers, Publisher: O.R.Cassel, London,1993.
10. White house, D. J, Handbook of Surface & Nanometrology, Publisher: The institute of Physics., 2010.
11. Graham T. Smith, Industrial Metrology, Publisher: Springer-Verlag London Ltd.,2002


| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 1 | 2 |
| **CO2** | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 1 | 2 |
| **CO3** | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 1 | 2 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO4** | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 1 | 2 |
| **CO5** | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 1 | 2 |
| **Overall CO** | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 1 | 2 |

**PT3010 ADDITIVE MANUFACTURING L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To educate students with fundamental and advanced knowledge in the field of Additive manufacturing technology for plastics product
- To learn the fundamentals process of additive manufacturing process.
- To gain knowledge on solid & liquid based additive manufacturing
- To gain knowledge on powder based additive manufacturing
- To understand the post processing and applications of additives.

**UNIT I INTRODUCTION 9**

Introduction to Additive Manufacturing (AM)- AM evolution- Distinction between AM & CNC machining- Advantages of AM- AM process chain- Conceptualization- CAD- conversion to STL Transfer to AM- STL file manipulation- Machine setup- build -removal and clean up-post processing- Classification of AM processes – Advantages and limitations of AM.

**UNIT II DESIGN FOR AM 9**

Motivation- DFMA concepts and objectives- AM unique capabilities- Exploring design freedoms- Design tools for AM- Part Orientation- Removal of Support- Hollowing out part- Inclusion of Undercuts and Other Manufacturing Constraining Features- Interlocking Feature- Reduction of Part Count in an Assembly- Identification of markings / numbers etc.

**UNIT III SOLID & LIQUID BASED AM 9**

Liquid Based AM: Stereo lithography Apparatus (SLA) - Solid Ground Curing (SGC) - Principle, pre-build process, part-building and post-build processes, resins, Advantages, limitations and applications Solid Based AM: Fused deposition Modeling (FDM) - Laminated Object Manufacturing (LOM) -Principles, details of processes, materials, advantages, limitations and applications.

**UNIT IV POWDER BASED AM 9**

Selective Laser Sintering (SLS) - Laser Engineered Net Shaping (LENS) - Principles, details of processes, materials, advantages, limitations and applications. Other Additive Manufacturing Systems: Principles of Shape Deposition Manufacturing (SDM), Ballastic Particle Manufacturing (BPM), Selective Laser Melting, Electron Beam Melting.

**UNIT V POST PROCESSING & APPLICATIONS OF AM 9**

Post processing of AM parts: Support material removal - Surface texture improvement-Accuracy improvement - Aesthetic improvement - Preparation for use as a pattern- Property enhancement using non-thermal and thermal techniques. Applications of AM: Functional models- Pattern for investment and vacuum casting – Medical models - art models - Engineering analysis models- Rapid tooling ( Direct and Indirect method-New materials development- Bi-metallic parts- Re-manufacturing- Application examples for Aerospace, defense, automobile, Bio-medical and general engineering industries;

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completing this course, the students

- Will learn about a variety of Additive Manufacturing (AM) technologies, their potential to support design and manufacturing
- Will learn the important research challenges associated with AM and its data processing tools
- Will learn about solid and liquid based additives
- Will learn about powder based additives
- Will gain knowledge on applications and post processing treatment of additives.

**REFERENCES:**


1. Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications",second edition, World Scientific Publishers, 2010
2. Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
3. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010
4. Andreas Gebhardt, Understanding Additive Manufacturing: Rapid Prototypying, Rapid Tooling, Rapid Manufacturing.,2012.


| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 1 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 1 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 1 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 1 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 1 | 2 |
| **Overall CO** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 1 | 2 |

**PT3011 FIBRE TECHNOLOGY L T P C**
**3 0 0 3**

**OBJECTIVES:**

To enable the students

- To learn about the production technologies of synthetic fibres such as melt spinning, wet spinning, dry spinning, texturing and stretching methods; colouration techniques of fibres.
- To enable the students to understand the need of various fibre production methods
- To acquire knowledge about various fibre drawing processes
- To enable the students to learn the basic knowledge of modified synthetic fibres.
- To learn about modification and testing of fibre

**UNIT I CRITERIA FOR FIBRE FORMING POLYMERS 9**

Development of synthetic - commercial synthetic fibres, Raw materials manufacture. DMT, TPA, MEG, caprolactum, adipicacid, hexamethylene diamine, acrylonitrile, polymerisation-types of polymers - criteria for fibre forming polymers - production of polyethylene terephthalate polymer - polyamides - production of nylon 66 polymer -nylon 6 polymer.

**UNIT II FIBRE PRODUCTION METHODS –i 9**

Production of acrylic fibres - polypropylene - production of other fibres - PVC fibres-PVA fibres - Aramid fibres - Melt spinning - Polymer feed -melt spinning equipment - high speed spinning - spin draw processes - crystallization method - melt spinning of PET & PP stable fibres - wet and dry spinning comparison. Spin finishes -functions of spin finish - methods of application of spin finish - spin finish for polyester staple fibres - spin finish for texturing process - effect of spin finish on dyeing.

**UNIT III FIBRE PRODUCTION METHODS-II 9**

Stretching or drawing - conditions of drawing - machines for draw warping - texturing -false twist process - draw texturing- staple fibre production, melt spinning - drawing, heat setting - crimping in fibre line-production of melt spin staple fibre-polyester tops for wool blending-Mass coloration and tow dyeing of polyester, nylon, acrylic -polypropylene - dyeing in loose fibre and yarn forms of polyester, nylon, acrylic, PP, other synthetic fibres - loose fibre dyeing.

**UNIT IV MODIFIED SYNTHETIC FIBRES 9**

Modified synthetic fibres - modified polyester, Nylon, PP, acrylics - Hydrophilic -Hollow–Low pilling - flame retardant- bicomponent fibres - Dye ability of synthetic fibres

**UNIT V TESTING OF YARN AND FIBRES 9**

Quality control - testing raw material - testing polymers - testing yarns & fibres - waste utilisation of polyester - nylon 6 - 66 - acrylics-PP-Energy conservation - pollution control.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completing this course, the students

- Will have knowledge of polymer used in fiber formation.
- Will demonstrate the processing techniques for fiber formation.
- Will able to prepare a fiber forming polymers
- Will able fiber stretching polymers
- Will attain the knowledge of testing of fiber.

**TEXT BOOK:**

1. A.A. Vaidya, Production of synthetic fibres, Prentice Hall of India Pvt. Ltd., New Delhi, 1988.

**REFERENCES:**

1. Fourne, Franz, “Synthetic Fibres, Machines and Equipment, Manufacture, Properties”,Hanser Publishes, 1999.
2. Corbman Bernard P., “Textiles: fibre to fabric”, Sixth Edition, McGraw Hill, 1983.

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 1 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 1 | 2 |
| **CO3** | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 1 | 2 |
| **CO4** | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 1 | 2 |
| **CO5** | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 1 | 2 |
| **Overall CO** | 2.2 | 2.2 | 2.2 | 2.2 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 1 | 2 |

**PT3012 PLASTICS PACKAGING TECHNOLOGY L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To study about the functions of packaging.

- To enable the students to understand the concepts testing of packaging material.
- To know about the different packaging materials like cans, bottles, flexible films etc.
- To study about the various methods of packaging to improve the shelf life of the products.
- To learn about the testing of packaging.

**UNIT I SELECTION CRITERIA FOR PACKAGING MATERIALS 9**

Introduction to plastics packaging: functions of packaging, advantages of plastic packaging, special requirements of food and medical packaging,. Packaging as a system: Elements, approach, package, design, relation criteria for packaging materials, packaging equipment checklist, case histories Major packaging plastics Introduction - PE, PP, PS, PVC, polyesters,PVA, EVA, PA, PC, ionomers & fluoro polymers.

**UNIT II CONVERSION PROCESS FOR PACKAGING MATERIALS 9**

Conversion process - Compression & transfer for moulding, Injection moulding, Blow moulding, Extrusion, roto moulding, thermoforming, Lamination, metalizing, decoration process, Shrink wrapping, Pallet & stretch wrapping

**UNIT III PROCESSES FOR FLEXIBLE PACKAGING 9**

Extrusion, film and flexible packaging - extrusion, cast film & sheet, Blown film, Multi layer film &sheet coatings, co-extrusions, pouching, sealing, evaluation of seals in flexible packages, advantages of flexible packaging - flexible packaging products.

**UNIT IV PROCESSES FOR RIGID PACKAGING 9**

Thermoformed, moulded and rigid packages, Thermoforming packages: Position & thermoforming& wrap forming, solid phase pressure forming, scrabbles, twin sheet & melt - to-mold thermoforming, skin packaging, Polystyrene & other foams systems cushioning, plastic pallets, drums , shipping containers.

**UNIT V TESTING OF PLASTIC PACKAGING 9**

Testing of plastic packages, Barrier, Migration & compatibility, Sterilization systems and healthcare products. Packaging hazards and their controls. Waste management act 2016.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completing this course, the students

- Will learn about the functions of packaging
- will apply and examine the knowledge of properties of polymers for selection of packaging materials
- will select between different techniques of packaging
- Will study about the various methods of packaging to improve the shelf life of the products
- Will familiarize in testing of plastic packaging

**TEXT BOOKS:**

1. Susan E.M. Seleke, “Understanding Plastic Packaging Technology”, Hanser publications - 1997
2. A.S. Altalye, “Plastics in Packaging”, Tata McGraw-Hill publishing Co. Ltd., New Delhi,1992.

**REFERENCES:**

1. Walter Soroka, ‘Fundamentals of Packing Technology’ Institute of Plastics Packaging, 1999.
2. Neil Farmer (Ed.) Trends in Packaging of Food, Beverages and Other Fast-Moving Consumer Goods, Wood Head Publishing India Pvt. Ltd. 2013.

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 1 | 2 | 3 | 2 | - | 1 | - | 2 | 2 | 3 | 2 |
| CO2 | 3 | 2 | 2 | 2 | 1 | 2 | 3 | 2 | - | 1 | - | 2 | 2 | 3 | 2 |
| CO3 | 3 | 2 | 2 | 2 | 1 | 2 | 3 | 2 | - | 1 | - | 2 | 2 | 3 | 2 |
| CO4 | 3 | 2 | 2 | 2 | 1 | 2 | 3 | 2 | - | 1 | - | 2 | 2 | 3 | 2 |
| CO5 | 3 | 2 | 2 | 2 | 1 | 2 | 3 | 2 | - | 1 | - | 2 | 2 | 3 | 2 |
| Overall CO | 3 | 2 | 2 | 2 | 1 | 2 | 3 | 2 | - | 1 | - | 2 | 2 | 3 | 2 |

**PT3013 RUBBER TECHNOLOGY L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To provide the students with basic knowledge on the natural rubber and various synthetic rubbers and their processing.
- To enable the students to understand the need of various additives and compounding of rubbers and vulcanization.
- To enable the students to learn the basic processing of rubber products like hose conveyor belts etc.
- To understand about Thermoplastic Elastomers, its manufacturing and applications
- To acquire knowledge about Rubber testing

**UNIT I NATURAL AND SYNTHETIC RUBBERS 9**

Tapping latex, Processing of Latex - Dry rubber production (Smoked sheet, air dried sheet, Creep etc.) - Grading of rubbers - Modified natural rubber, Reclaimed rubber - process of reclamation - applications. Manufacturing, structure, properties, compounding, curing and applications - Polyisoprene, Polybutadiene, SBR, EPDM, Butyl rubber, Neoprene, Nitrile rubber, Silicone rubber, Fluoroelastomer, Polysulphide rubber, polyurethane rubber, Acrylic rubber.

**UNIT II COMPOUNDING DESIGN AND VULCANIZATION 9**

Sulphur vulcanization and non-sulphur vulcanization, vulcanization systems - accelerators, activators, promoters, antioxidants, antiozonants, processing aids, fillers and effect of fillers, Blowing agents etc.

**UNIT III THERMOPLASTIC ELASTOMERS 9**

Basic structure, Manufacture, Morphology, Commercial grades and Applications – Thermoplastic styrene block copolymers, Polyester thermoplastic elastomers, polyamide thermoplastic elastomer, Polyurethane thermoplastic elastomers.

**UNIT IV RUBBER PRODUCT MANUFACTURING 9**

Manufacturing of Belting, Hoses, Footwear, Rubber metal bonded items, sports goods, cellular rubber, tyres etc.

**UNIT V RUBBER TESTING 9**

Principles of Testing- Standards and specification -Line Call – out- Nomenclature- ISO and DIN, ASTM and BIS standards- Scorch and cure parameters – Techniques and instruments -Types of cure meters – Principles, applications of cure data – Processability Testing, Principle and Application.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- Upon completion of this course, the students will acquire the knowledge of natural rubber and other synthetic elastomers.
- They learn the basics of rubber compounding and vulcanization and rubber products manufacturing.
- They will acquire knowledge on Thermoplastic elastomers,its manufacturing and applications
- Will understand the basic processing of rubber products like hose conveyor belts etc.
- Students will learn about rubber testing,its principles and applications

**TEXT BOOKS:**

1. C.M.Blow and Hepburn, - Rubber Technology and Manufacture, 2nd edition, 1982.
2. Hoffman, Rubber Technology Handbook -, Hanser Pub. Munich - 1996

**REFERENCES:**

1. Anil .K. Bhowmic, Howard L. Stephens (Edt), Handbook of Elastomers - New Developments & Technology, Marcel Decker Inc. New York 1988.
2. Maurice Morton, Rubber Technology.,1998.

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 2 | - | 2 | 3 | 2 | - | 1 | - | 2 | 3 | 2 | 2 |
| **CO2** | 2 | 2 | 2 | 2 | - | 2 | 3 | 2 | - | 1 | - | 2 | 3 | 2 | 2 |
| **CO3** | 2 | 2 | 2 | 2 | - | 2 | 3 | 2 | - | 1 | - | 2 | 3 | 2 | 2 |
| **CO4** | 2 | 2 | 2 | 2 | - | 2 | 3 | 2 | - | 1 | - | 2 | 3 | 2 | 2 |
| **CO5** | 2 | 2 | 2 | 2 | - | 2 | 3 | 2 | - | 1 | - | 2 | 3 | 2 | 2 |
| **Overall CO** | 2 | 2 | 2 | 2 | - | 2 | 3 | 2 | - | 1 | - | 2 | 3 | 2 | 2 |

**PT3014 DESIGN AND MANUFACTURE OF COMPOSITES L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To enable the students to acquire knowledge on composite materials.
- To understand Lamina equations in field of composites manufacturing.
- To gain knowledge in designing of laminates
- To learn about design of FRP's
- To understand various production methods for composites

**UNIT I INTRODUCTION TO COMPOSITE 9**

Introduction to Composite Materials Constituents, Material forms Processing, Applications Definition – Need – General Characteristics, and Applications. Fibers – Glass, Carbon, Ceramic and Aramid fibers. Matrices – Polymer, Graphite, Ceramic and Metal Matrices –Characteristics of fibers and matrices.

**UNIT II LAMINA CONSTITUTIVE EQUATIONS 9**

Lamina Assumptions –Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Typical Commercial material properties, Rule of Mixtures. Generally Orthotropic Lamina – Transformation Matrix, Transformed Stiffness.

**UNIT III DESIGN OF LAMINATES 9**

Plate Stiffness and Compliance, Assumptions, Strains, Stress Resultants, Plate Stiffness and Compliance, Computation of Stresses, Types of Laminates -, Symmetric Laminates, Antisymmetric Laminate, Balanced Laminate, Quasi-isotropic Laminates, Cross-ply Laminate, Angleply Laminate. Orthotropic Laminate, Laminate Moduli, Hygrothermal Stresses.

**UNIT IV DESIGNING OF FIBRE REINFORCED PLASTICS 9**

Design variables; Selection of fiber-matrix and manufacturing process; Effects of mechanical, thermal, electrical and environmental properties, Fiber orientation, Symmetric and asymmetric structure; Effects of unidirectional continuous and short fibers; Lamination theory

**UNIT V MANUFACTURING PROCESSES 9**

Open mold processes – Hand layup, Spray up, Vacuum bag, Pressure bag & autoclave, Centrifugal casting, Filament winding; Closed mold processes – Compression molding, Resin transfer molding (RTM), Injection molding, Sandwich panels , Pultrusion; SMC & DMC products, etc.

**Case studies and applications**

Design for failure; FEA design packages; Design examples & case studies in FRP. Damage in composites.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

At the end of the course, the students will be able to,

- Understand the basics of composites
- Gain knowledge on design of laminates
- Acquire training in design of FRP's
- Understand various manufacturing processes for production of composites
- Gain knowledge through case studies and design examples of FRP

**TEXT BOOKS:**


1. Mechanics of Composite Materials, Autar K. Kaw, 2nd ed., CRC Press, 2006
2. Jones, R.M., "Mechanics of Composite Materials", McGraw-Hill, Kogakusha Ltd., Tokyo, 1985.


**REFERENCES:**


1. Agarwal, B.D., and Broutman, L.J., "Analysis and Performance of Fibre Composites", John Wiley and sons. Inc., New York, 1995.
2. Hyer, M.W., "Stress Analysis of Fiber-Reinforced Composite Materials", McGraw-Hill, 1998.
3. Engineering Mechanics of Composite Materials, I. M. Daniel, O. Ishai, Oxford University Press, 2006.
4. Krishnan K. Chawle. "Composite Material: Science and Engineering" Second Edition, Springer, 1998.
5. F.C. Campbell "Structural Composite Materials", Materials Park,ASM International,2010


| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 2 | - | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO3** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 2 | 2 | - | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| **CO5** | 2 | 2 | 2 | 2 | - | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| **Overall CO** | 2.4 | 2.4 | 2.4 | 2.4 | 3 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |

**PT3015 FINITE ELEMENT METHODS L T P C**
**3 0 0 3**

**OBJECTIVES:**

- Understand basics of Finite Element Analysis.
- Conduct analysis on trusses and beams
- Acquire knowledge in finite element modeling and Jacobian ,Stiffness matrix.
- Understand Importance of torsional problems
- Understand dynamic analysis

**UNIT I INTRODUCTION TO FEM 9**

Introduction to FEM, basic concepts, historical back ground, applications of FEM, general description, comparison of FEM with other methods, variational approach, Glerkin's Methods. Co-ordinates, basic element shapes, interpolation function, Virtual energy principle, Rayleigh – Ritz method, properties of stiffness matrix, treatment of boundary conditions, solution of system of equations, shape functions and characteristics, Basic equations of elasticity, strain- displacement relations.

**UNIT II 1-D STRUCTURAL PROBLEMS 9**

Axial bar element – stiffness matrix, load vector, temperature effects, Quadratic shape functions, and problems. Analysis of Trusses: Plane Trusses and Space Truss elements and problems Analysis of Beams: Hermite shape functions – stiffness matrix – Load vector – Problems.

**UNIT III 2-D PROBLEMS 9**

CST, LST, force terms, Stiffness matrix and load vectors, boundary conditions, Isoparametric elements – quadrilateral element, shape functions – Numerical Integration. Finite element modelling of Axi-symmetric solids subjected to Axi-symmetric loading with triangular elements. 3-D Problems: Tetrahedron element – Jacobian matrix – Stiffness matrix.

**UNIT IV SCALAR FIELD PROBLEMS 9**

1-D Heat conduction-Slabs – fins – 2-D heat conduction problems – Introduction to Torsional problems.

**UNIT V DYNAMIC ANALYSIS 9**

Dynamic considerations, Dynamic equations – consistent mass matrix – Eigen Values, Eigen vector, natural frequencies – mode shapes – modal analysis. Error estimates and adaptive refinement: error norms and convergence rates – h-refinement with adaptivity – adaptive refinement

**TOTAL: 45 PERIODS**

**OUTCOMES:**

At the end of the course, the student will be able to,

- Apply finite element method to solve problems in solid mechanics heat transfer.
- Formulate and solve problems in one dimensional structures including trusses, beams and frames.

- Formulate FE characteristic equations for two dimensional elements and analyze plain stress, plain strain, axi-symmetric and plate bending problems. ANSYS, ABAQUS, NASTRAN, etc
- Formulate and solve problems in three dimensional structures
- Understand the consideration and conduct of dynamic analysis.

.

**TEXT BOOKS:**

1. Introduction to Finite Element Analysis by S.Md.Jalaluddin, Anuradha Publishers.
2. Introduction to Finite Elements in Engineering, Chandrupatla, Ashok and Belegundu, Prentice – Hall.
3. Logan, D. L., A first course in the finite element method,6th Edition, Cengage Learning, 2016.
4. The Finite Element Method for Engineers – Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smith and Ted G. Byrom / John Wiley & sons (ASIA) Pte Ltd.

**REFERENCE BOOKS:**

1. An introduction to Finite Element Method / JN Reddy / Me Graw Hill
2. The Finite Element Methods in Engineering / SS Rao / Pergamon.
3. Finite Element Method and applications/R.D.Cook/WILEY publications
4. Zienkiewicz, O.C. and Taylor, R.L., "The Finite Element Method", Fourth Edition Fourth Edition, Volumes 1 & 2, McGraw Hill International Edition, Physics Services, 1991.

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 1 | - | 1 | - | 2 | 3 | 2 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 1 | - | 1 | - | 2 | 3 | 2 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 1 | - | 1 | - | 2 | 3 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 1 | - | 1 | - | 2 | 3 | 2 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 1 | - | 1 | - | 2 | 3 | 2 | 2 |
| **Overall CO** | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 1 | - | 1 | - | 2 | 3 | 2 | 2 |

**PT3016** **PVC TECHNOLOGY** **L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To provide fundamental knowledge on the PVC resin & plastics compounding.
- To impart the knowledge of additives in PVC formulation for suitable applications.
- To impart knowledge of compounding different for PVC in compliance with REACH standard.
- To impart skills in different methods of mixing additives with PVC.
- To provide knowledge on Processing & testing of PVC

**UNIT I PVC RESIN** **9**

Introduction-Manufacturing of viny chloride monomer (VCM), polymeristion of VCM (bulk, solution, emulsion, suspension),- K-value and its significance - VCM Copolymers- chemically modified PVC – Syndiotactic PVC –Chlorinated PVC – Graft copolymers of PVC –Cross linked PVC – PVC Blends and Alloys.

**UNIT II ADDITIVES FOR PVC 9**

Additives: Plasticisers - Heat stabilizers - light stabilizers - antioxidants- lubricants - flame retardants, smoke suppressants –Flow promoting agent – Fillers – Impact Modifiers–processing aids - Colourants- Miscellaneous (nucleating agents, mould release agents, slip additives, antistatic agents, antifogging agents, coupling agents, antimicrobial agents – Foaming agents ) – regulatory requirements of additives and their selection.

**UNIT III COMPOUNDING & FORMULATIONS 9**

Selection and Charaterisation of PVC – Elements of compounding – Methods of Compounding – Mixing equipment's Intensive Dry mixers, internal intensive batch mixer –high speed mixer, kneaders – continuous mixers: single-screw extruder, twin-screw extruder, reactive extrusion – colour compounding – filler compounding. Formulation for PVC product - Rigid PVC Compound –PVC pipe - PVC Conduit pipe – PVC Window Profile –interior PVC profile – PVC Siding – PVC profile – Extruded PVC Sheet & Film – calendered PVC Sheet & Film – Injection moulded fitting – Blow Moulded containers & Bottle – Shoe Sole –floor & Wall Covering – Sheet for outdoor.

**UNIT IV PVC PROCESSING TECHNOLOGY 9**

Injection Moulding, Extrusion Pipes, Tubing , Sheeting & film, Coating, Wire & cable Coating -, Blow Moulding Process, Calendering , PVC paste, PVC Lattices, PVC Solution , Cellular PVC product etc.

**UNIT V TESTING OF RESIN AND PRODUCTS 9**

Testing of PVC Resin – K- value, Bulk Density, Palsticizer Absorption –Particle Size Distribution –conductivity of Water- Powder flow –Fish eye content. & testing of PVC Compound. Testing of PVC End Product-Rigid& flexible Pipe -PVC Conduit pipe – PVC Window Profile –PVC Sheet & Film – Injection moulded fitting – Blow Moulded containers & Bottle – Shoe Sole –floor & Wall.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

At the end of the course, the students will be able to,

- Having knowledge in PVC Resin & Suitable processing method based on application.
- Suggest suitable compounding ingredients based on the requirements.
- Apply knowledge in compounding & Formulation of P VC materials & formulate polymers for suitable applications
- Suggest suitable Testing Method in compliance with Indian and international standards.
- Select suitable equipment for mixing additives.

**TEXT BOOKS:**

1. PVC Technology by AS Athalye,
2. Technology of PVC compounding and its applications by EIRI Board of Consultants & engineers.

**REFERENCES:**

1. PVC Handbook – Charles E. Wikes, James W. Summers, Charles A Daniels (Eds.)
2. PVC Technology by Titow, Elsevier, UK

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 1 | 2 | 3 | 2 | - | 1 | - | 2 | 2 | 2 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 1 | 2 | 3 | 2 | - | 1 | - | 2 | 2 | 2 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 1 | 2 | 3 | 2 | - | 1 | - | 2 | 2 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 1 | 2 | 3 | 2 | | 1 | - | 2 | 2 | 2 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 1 | 2 | 3 | 2 | - | 1 | - | 2 | 2 | 2 | 2 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Overall CO** | 3 | 3 | 3 | 3 | 1 | 2 | 3 | 2 | - | 1 | - | 2 | 2 | 2 | 2 |

**PT3017 ADVANCED EXTRUSION PROCESSING L T P C**
**3 0 0 3**

**OBJECTIVE:**

- To understand the basics, types and `process of extrusion process.
- To learn the different types of extrusion process.
- To gain knowledge on die manufacturing in regards to extrusion.
- To understand the different films, coating and lamination process.
- To analyse various secondary extrusion process and methods.

**UNIT I INTRODUCTION 9**

Introduction – Principle of Extrusion - Types of extruders – Extruders heating and cooling profile – Dual Extrusion – Metal Embedment.

**UNIT II PROFILE EXTRUSION 9**

Introduction - Profile Extrusion - Material – process – Process optimization –Process, downstream equipment –. Multi-layer films, co-extruded sheets, pipes, Corrugated pipes – Woven Sacks.

**UNIT III FILMS , COATING & LAMINATION 9**

Manufacture of oriented films – Advantages – Process – temperature control of film system – Stretching Units. Extrusion Coating & lamination – Dies, Introduction & Advantage – Paper film & Foil Lamination – Material Combination – Adhesion – pretreatment – Co-extrusion as adhesion promoter.

**UNIT IV DIE DESIGN AND PERFORMANCE 9**

Introduction to Die Design – Melt Behaviour – Die Land, Slit, Rod, Tear Drop- Manifold and Die – Co extrusion Dies – Special Dies – Die Design – Construction Materials – Maintenance – Troubleshooting.

**UNIT V SECONDARY OPERATIONS 9**

Introduction to secondary operations – Inline operations – Offline operations – Labelling – Printing - Thermoplastic Extrusion Materials- Thermosetting Extrusions.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of the course, students will be able to

- Gain Knowledge on advanced extrusion processing techniques.
- Compare and contrast manufacturing methods of various extrusion products.
- Understand the manufacturing process and defect analysis of extrusion products.
- Learn the manufacturing process of various commercial and industrial extruded products.
- Analyse the manufacturing process and end product applications.

**TEXT BOOK**

1. Ronald D. Beck , Plastics Product Design , Van Nostrand Reinhold Company , Litton Educational Publishing , 1970.
2. D.V Rosato , Extruding Plastics – A practical processing handbook , Chapman & Hall , 1998

**REFERENCES**

1. Levy, Sydney and Carley, James.F, Plastics Extrusion Technology Hand Book , Second Ed.,

Industrial Press Inc., Newyork 1989.
2. Giles, Harold F., Wagner , John R, and Mount Eldridge M., Extrusion. The Definitive Processing Guide and Handbook, William Andrew Publishing, Newyork 2005.

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | - | 1 | - | 2 | 3 | 3 | 2 |
| CO2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | - | 1 | - | 2 | 3 | 3 | 2 |
| CO3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | - | 1 | - | 2 | 3 | 3 | 2 |
| CO4 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | - | 1 | - | 2 | 3 | 3 | 2 |
| CO5 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | - | 1 | - | 2 | 3 | 3 | 2 |
| Overall CO | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | - | 1 | - | 2 | 3 | 3 | 2 |

**PT3018 ADVANCED INJECTION MOULDING TECHNOLOGY L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To enable the students to understand the basic injection process.
- To understand the moulding process of complex shapes and sizes.
- To acquire knowledge about various injection molding process.
- To understand the post processing operations, various applications of injection moulding.
- To understand the mould design involved in injection moulding.

**UNIT I ADVANCED INJECTION MOULDING – I 9**

Gas assisted injection molding – Introduction – Field of application – Materials – Gas injection system and mechanism – Continuous and discontinuous pressure generation – Gas pressure control – Gas injection units – Mold technology – Product properties – Design guidelines & quality – Troubleshooting..

**UNIT II ADVANCED INJECTION MOULDING – II 9**

Multi-layer molding –Multi Colour Injection Moulding _ Counter flow molding – Liquid Injection molding process – Structural foam molding – Low pressure & high pressure process – Merits & Demerits.

**UNIT III ADVANCED INJECTION MOULDING – III 9**

Multi cavity moulding process – Water assisted Injection moulding – Metal Injection Moulding – Thin wall injection moulding – Cube moulding – Die Casting

**UNIT IV MICROINJECTION MOLDING 9**

Introduction – Issues in molding parts with microfeatures- Influencing factors in microinjection molding – Developments in Microinjection molding technology – Troubleshooting process.

**UNIT V INJECTION MOULD DESIGN 9**

Introduction to mold design – Hot runner molds –Cold Runner multi cavity moulds – Reaction Injection molding – Split Injection moulding – Moulds for retractable core process – Mould maintenance.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completing this course, the students

- Will familiarize about the materials used in Injection molding.

- Will attain the knowledge of various injection molding process.
- Will able to understand the processing methods of various products..
- Will attain the knowledge post processing operations of injection molding products.
- Will develop the knowledge of mold design in injection process.

**TEXT BOOKS:**

1.A Guide to Injection Molding of Plastics By Bolur, P.C.,
2. Development in Injection Molding By Whelan, A & Craft, J.L.
3.. Innovation in Polymer Processing By Stevenson.,1996.

**REFERENCES:**

1. Rection Injection Moulding machinery and process , F. Melvin Sweeney..
2. Plastic Technology Handbook : Second edition , revised and expanded , manas Chanda and Sali K. Roy
3. Injection Molding By Athalye, A.S.,1997.
4. Injection Molding Technology By V.D.I.
5. Innovation in Polymer Processing By Stevenson.,1996.

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO3 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO4 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO5 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| Overall CO | 2 | 2 | 2 | 2 | 1.4 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |

**PT3019 ADVANCED BLOW MOULDING L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To enable the students to understand the basic and advance blow moulding process.
- To understand different types of blow moulding process for irregular shaped products.
- To acquire knowledge about various processing methods.
- To understand the designing of mould for blow moulding process.
- To understand the various maintenance and troubleshooting process.

**UNIT I ADVANCED BLOW MOULDING PROCESS - I 9**

Introduction – Classification of advanced blow molding process – Deep Draw double wall blow molding technology – Split molds – Versatility – Applications Press Blow Moulding Technology process – Applications – Three Dimensional Blow molding process – applications.

**UNIT II ADVANCED BLOW MOULDING PROCESS – II 9**

Stretch Blow Molding – Injection Stretch Blow Molding – Extrusion Stretch Blow Molding – Process – Merits & Demerits – Applications – Multi Layer blow molding – Process – Applications.

**UNIT III BLOW MOULDING OF IRREGULAR SHAPED PARTS 9**

Introduction – Blow molding light weight irregular shaped parts – Moving mold sections – Integral HDPE handle lid – Double wall internally threaded lid – Drum integral handling – HDPE ring –

Caps and closures – Multiple parting lines – Industrial double wall blow molding – Mold preparation and other considerations.
Types of auto feeding mechanisms – Hopper loader – screw feeder – hopper mounting & emptying devices – Metering devices. .

**UNIT IV INTRODUCTION TO MOULDS 9**

Simple blow moulds – Stretched blow mold – Preform mold – Mold materials – Control system for Blow moulding machines – Introduction – Temperature controlling system & elements – Hydraulic controlling system & elements - Electrical controlling system & selements – Micro process control – Types of sensors – Process control – Product control.

**UNIT V MAINTANANCE 9**

Maintenance of machines – Preventive & breakdown maintenance of different controlling mechanism – Start & Shut down process – Handling of dies, molds and accessories – Assembly of dies & molds – Dismantling of dies & molds – Cleaning of molds & dies – Maintenance of auxiliary equipment.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completing this course, the students

- Will familiarize about various blow molding process.
- Will attain the knowledge of designing mold for blow process.
- Will able to understand the processing methods of irregular shaped products.
- Will attain the knowledge maintenance process.
- Will develop the knowledge in advanced blow molding process.

**TEXT BOOKS:**

1. Lee, N C., Plastics blow moulding handbook , Van Nostrand Reinhold , 1990.
2. Strong , Brent A., Plastics – Material and Processing , Third Edition, Pearson Education Lts., Newyork, 2006.

**REFERENCES:**

1. G Lubin, “Hand Book of Composites”, 2nd Ed, Van Nostrand Reinhold, New York, 1982.
2. Schar J., Press blowing option for tough to blow parts, SPE ANTEC April’87
3. James F. Stevenson, Innovation in Polymer processing Moulding , Hanser Publishers , Newyork, 1996..

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO3 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO4 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO5 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| Overall CO | 2 | 2 | 2 | 2 | 1.4 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |

**PT3020 POLYURETHANE TECHNOLOGY L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To enable the students to understand the principles of PU chemistry and its applications.

- To get the knowledge in PU raw materials and processing techniques.
- To understand the concepts of PU foams, coatings and adhesives.

**UNIT I PRINCIPLES OF PU CHEMISTRY AND APPLICATIONS 9**

Reactions of isocyanate group-building blocks for PUs-polyols, isocyanates, chain extenders – Preparation methods like prepolymer process, one shot process-preparation of aqueous two phase systems – Special areas like ionomers,LCP based on PUs, hydrogels, promoters- Uses in medical areas, bio technology, optical lenses etc Structure-property relationships in hard and soft segments - Morphology of domains-Effect of cross links on PU properties, structure-property relationships in ionomers.

**UNIT II RAW MATERIALS AND PROCESSING OF PU 9**

Polyols, isocyanates – Their preparation and characteristics, conversion products of the raw materials – Additives – Industrial hygiene –Principles of PU processing

**UNIT III PU FOAMS 9**

Rigid polyurethane foams-chemistry of raw materials, manufacturing of rigid PU (manufacturing of buns, panels, foaming of applications, molded rigid foams), properties, application of rigid polyurethane. Polyurethane skin integral foam- production, properties and applications.Flexible foams-(production, properties and application slabstock foam, carpet backing, flexible molded foams & semi rigid molded foams.

**UNIT IV SOLID PU MATERIALS 9**

Solid polyurethane materials- polyurethane casting systems (cast elastomers and casting resins)-thermoplastic polyurethane elastomers: productions / processing, properties and applicationselastomers fibers, manufacture / processing and applications.

**UNIT V PU COATINGS AND ADHESIVES 9**

Solvent based coatings, air dried coatings, solvent free paints and coatings, applications of PU based coatings two components and one component adhesives based on PUs, solvent based adhesives, dispersion adhesives, hot melts, PU binders.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completing this course, the students

- Know about building blocks for Polyurethanes
- Learn about Various types of raw materials used in preparation of PU
- Study about the production of flexible and rigid polyurethane foam
- Will have the knowledge of production, properties and uses of solid polyurethane
- Will have the knowledge of PU applications as coatings and adhesives

**TEXT BOOK:**

1. Dr.GumterOertal (ed.), Polyurethane Hand Book, Hanser Publication Munich. Edition 2, 1994

**REFERENCES:**

1. George woods, The ICI Polyurethane book -published journals by ICI, John Wiley and sons, New York.
2. Hepburn C, “PU Elastomers II” Edition, Springer Science, 1992.
3. Benjamin M. Walker, Handbook of Thermoplastic Elastomer, Springer US, 1988
4. N. R. Legge, G. Holden,.H. E. Sehroeder, Thermoplastic Elastomers: A Comprehensive Review, 1987
5. J. A. Brydson, Rubber Materials & Their Compounds, Springer Netherlands, 1988

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | - | 1 | - | 2 | 2 | 2 | 2 |
| **CO2** | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | - | 1 | - | 2 | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | - | 1 | - | 2 | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | | 1 | - | 2 | 2 | 2 | 2 |
| **CO5** | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | - | 1 | - | 2 | 2 | 2 | 2 |
| **Overall CO** | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | - | 1 | - | 2 | 2 | 2 | 2 |

**PT3021 INSTRUMENTATION AND PROCESS CONTROL L T P C**
**3 0 0 3**

**OBJECTIVE:**

- To enable the students to learn the basic measurements system
- To understand the concepts of temperature pressure and flow measurements system
- To understand the instrumentation applications in polymer analytical techniques
- To enable the students to learn about various indicating & recording instruments
- To attain knowledge about analytical instruments

**UNIT I GENERAL CONCEPTS OF MEASUREMENTS 9**

Measurement -The three stages of generalized measurement system, Transducer: classification. Factors considered in selection of Transducers classification of errors, potentiometer, LVDT, tachometer. Strain gauge Types of electric strain gauges. Calibration of strain gauges, Non conduct measurements

**UNIT II TEMPERATURE AND PRESSURE MEASUREMENTS 9**

Thermometer, Resistance Temperature Detector, thermistor, thermocouple, total radiation pyrometers, optical pyrometer, Pressure measurement: Manometers, Elastic transducers, McLeod gauge, thermal conductivity gauges, calibration of pressure gauge using dead weight tester.

**UNIT III FLOW AND MISCELLANEOUS MEASUREMENTS 9**

Venturi, Orifice & nozzle meters, Pitot tube, turbine type meters, hot wire anemometer, magnetic flow meters. Level measurement: float level meters & electrical conductivity meters.

**UNIT IV INDICATING AND RECORDING INSTRUMENTS 9**

Electrical indicating instruments- analog and digital, current Galvanometer, PMMC, Electro Dynamometer–Wattmeter-ammeter, recording–analog and digital , Galvanometer recording , null typer, potentiometeric, magnetic typer, cathode ray tube.

**UNIT V INSTRUMENTATION IN ANALYTICAL TECHNIQUE 9**

IR spectroscopy, Gas chromatography, X-ray spectrometer, Thermoanalytical method, Thermal conductivity analyzer, Measurement of color.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completing this course, the students

- Will be able to understand the general concept of measurements.
- Will acquire the knowledge in instruments for measurement
- Will familiarize with the indicating and recording instruments used in industry machinery
- Will understand the role of process control in polymer machinery
- Will understand the role of analytical instruments in polymer characterization

**TEXT BOOKS:**

1. A. K. Shawhney, “A Course in Mechanical Measurements and instrumentation”, Dhanpat Rai, New Delhi, 2001 12th edition.
2. R. S. Khandpur, “Analytical Instrumentation”, Tata McGraw-Hill, New Delhi, 2004, 5th edition.

**REFERENCES:**

1. Rangan, Mani & Sharma, Instrumentation, Tata McGraw-Hill, New Delhi, 1997.
2. I.J. Nagarath and M. Gopal, Control systems engineering, 2nd Ed. New Age International Pvt. Ltd., 1982.
3. R. K. Jain, Mechanical & Industrial measurements, Khanna Publishing. 1988.
4. B. C. Nakra, K. K. Chaudhry, “Instrumentation, Measurement and Analysis”. Tata McGraw-Hill, New Delhi, 2006, 7th edition.

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | - | 1 | - | 2 | 1 | 1 | 1 |
| **CO2** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | - | 1 | - | 2 | 1 | 1 | 1 |
| **CO3** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | - | 1 | - | 2 | 1 | 1 | 1 |
| **CO4** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |  | 1 | - | 2 | 1 | 1 | 1 |
| **CO5** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | - | 1 | - | 2 | 1 | 1 | 1 |
| **Overall CO** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | - | 1 | - | 2 | 1 | 1 | 1 |

**PT3022 AUTOMATION IN POLYMER PROCESSING L T P C**
**3 0 0 3**

**OBJECTIVE:**

- To introduce the importance of automation techniques in polymer processing industries.
- To impart the role of PLC in industry automation.
- To expose to various control techniques employed in process automation.
- To develop automation system for polymer processing industries
- To impart knowledge about PLC

**UNIT I AUTOMATION IN PROCESS INDUSTRIES 9**

Introduction- Automation in production system, Principles and strategies of automation, Basic elements of an automated system, Advanced automation functions, Levels of automations, Automated flow lines and transfer mechanisms, Analysis of transfer lines without storage, Automated flow lines with storage buffers.

**UNIT II MATERIAL HANDLING AND IDENTIFICATION TECHNOLOGIES 9**

Overview of material handling systems, Types of material handling equipment, Design of the system, Conveyor system, Automated guided vehicle system, Automated storage systems, Interfacing handling and storage with manufacturing, Overview of Automatic Identification Methods.

**UNIT III AUTOMATED MANUFACTURING SYSTEMS 9**

Automated Manufacturing Systems-Components, Classification and overview of manufacturing systems, Cellular manufacturing, Flexible manufacturing system(FMS), FMS and its planning and implementation, Automated assembly system – design and types of automated assembly systems, Analysis of multi station and single station assembly machine.

**UNIT IV COMPUTER BASED INDUSTRIAL AUTOMATION 9**

Introduction to computer based industrial automation- Direct Digital Control (DDC), Distributed Control System (DCS) and supervisory control and data acquisition (SCADA) based architectures. SCADA for process industries includes understanding of RTUs, Pumping stations, Evacuation processes, Mass Flow Meters and other flow meters, Leak-flow studies of pipelines, Transport Automation.

**UNITV PROGRAMMABLE LOGIC CONTROLLER 9**

Programmable Logic Controller (PLC)- Block diagram of PLC, Programming languages of PLC, Basic instruction sets, Design of alarm and interlocks, Networking of PLC, Overview of safety of PLC with case studies. Process Safety Automation: Levels of process safety through use of PLCs, Integrating Process safety PLC and DCS, Application of international standards in process safety control.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

On completion of this course, the students will be able to

- Familiarize with various automation technologies in manufacturing and process industries.
- Understand various automation tools and methods in polymer processing industry.
- Implement various control and automation method in process industries.
- Familiarize with various communication technologies in manufacturing and process industries.
- Understand about PLC's

**TEXT BOOKS:**


1. M.P.Groover,"Automation, Production Systems and Computer Integrated Manufacturing", 5 th Edition, Pearson Education, 2009.
2. John W. Webb and Ronald A. Reis, "Programmable Logic Controllers: Principles and Applications", 5th Edition, Prentice Hall Inc., New Jersey, 2003.
3. Krishna Kant, "Computer - Based Industrial Control", 2nd Edition, Prentice Hall, New Delhi, 2011.
4. Frank D. Petruzella, "Programmable Logic Controllers", 5th Edition, McGraw- Hill, New York, 2016.


**REFERENCES:**


1. Curtis D. Johnson, "Process Control Instrumentation Technology", 8th Edition, Pearson New International, 2013.
2. Lukas M.P, "Distributed Control Systems", Van Nostrand Reinhold Co., New York, 1986.
3. N. Viswanandham, Y. Narahari, "Performance Modeling of Automated Manufacturing Systems", 1st Edition, 2009.


| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | - | 1 | - | 2 | 1 | 1 | 1 |
| **CO2** | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | - | 1 | - | 2 | 1 | 1 | 1 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | - | 1 | - | 2 | 1 | 1 | 1 |
| **CO4** | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | | 1 | - | 2 | 1 | 1 | 1 |
| **CO5** | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | - | 1 | - | 2 | 1 | 1 | 1 |
| **Overall CO** | 2.2 | 2.2 | 2.2 | 2.2 | 3 | 2 | 2 | 1 | - | 1 | - | 2 | 1 | 1 | 1 |

**PT3023 FOAM TECHNOLOGY L T P C**
**3 0 0 3**

**OBJECTIVE:**

- To understand the basics, types and chemistry of foam formation
- To gain knowledge in formulation and manufacturing of foam materials
- To gain knowledge on latex foams and their production
- To gain knowledge on fiber foams and their production
- To gain knowledge on bio foams and their production

**UNIT I INTRODUCTION 9**

Introduction to Foam-Types of foam: flexible and Rigid foam, chemistry and physics of foam formation, Foaming ingredients - Blowing agents and its effects on foam morphology, physical properties of cellular plastics, Characteristics & Application.

**UNIT II FOAM MATERIALS AND PROCESSES 9**

Formulation and manufacturing processes, Materials: Polyethylene foams, expanded polystyrene, Expanded Polyethylene, EVA foam, Polyurethene (rigid & flexible) foams, Polyethylene foam LD & HD epoxy resin foams, metallic foams and ceramic foams. Core materials in sandwich composites.

**UNIT III LATEX FOAMS 9**

Foam manufacturing industry in India – introduction to various latex foam products. Manufacture of latex foam – Dunlop and Tallalay process, different steps – deammoniation, compounding, mechanical froathing, gelling, vulcanization etc. Gelling – various gelling system – a comparative study. Some typical latex compounds for foam production. Common defects and causes.

**UNIT IV FIBER FOAM 9**

Fibre foam (Latex treated coir) and carpet backing, Characterization of fibre foam – constituents, production of coir foam– various steps. Properties, Advantages of carpet backing. Methods of applying latex to carpet backs, carpet backing formulation – Applications: Thermal insulation, Shock absorption, Acoustic-insulation

**UNIT V BIOBASED FOAMS 9**

Introduction, Biobased Polyol & Polyurethane, High density polyurethane foams, bio-polyethylene foam, Cellulose foam, composite foams – Bio fillers –Properties: Antimicrobial, flame retardancy, compressive strength, etc.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of the course, students will be able to

- Gain Knowledge on introduction and basic concepts of foams
- Compare and contrast various production methods of foams
- Understand the manufacturing process and defect analysis of latex foams
- Learn the manufacturing process and applications of fiber foams
- Analyse the manufacturing process and properties of bio foams

**TEXT BOOK**


1. Daniel Klempner and Kurt C. Frisch, Handbook of polymeric foams and foam technology, Hanser Publishers, Oxford University Press, New York, 1992
2. S T Lee, Chul B. Park,N S Ramesh, Polymeric Foams: Science and Technology, CRC Press; 1st edition (2006)


**REFERENCES**


1. Paul Stevenson, Foam Engineering: Fundamentals and Applications, Wiley (2012)

2. S T Lee, N S Ramesh, Polymeric Foams Mechanisms and Materials, CRC Press; 1st edition (2004)

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO3 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO4 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| CO5 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 1 | - | 1 | - | 2 | 2 | 3 | 2 |
| Overall CO | 2.2 | 2.2 | 2.2 | 2.2 | 1 | 2.2 | 2.2 | 1 | - | 1 | - | 2 | 2 | 2.2 | 2 |

**PT3024 MACHINING AND JOINING OF PLASTICS L T P C**
**3 0 0 3**

**OBJECTIVE:**

- To understand the machining and joining of plastics.
- To gain knowledge on different methods on joining plastics.
- To understand the concepts of adhesion and its importance.
- To understand the importance of secondary operations.
- To understand the importance of welding process.

**UNIT I INTRODUCTION 9**

Mechanical Fastening – Introduction - Machine Screws, Nuts, Bolts and Washers – Snap fits – Rivets – Staking –Swaging - Welding principles, classification of welding techniques; Oxyacetylene Gas welding, welding, metal arc, Carbon arc, submerged arc and atomic hydrogen welding - Electric resistance welding - composition, properties and function; Electrodes, Types of joints and edge preparation, Brazing and soldering

**UNIT II ULTRASONIC AND VIBRATION WELDING 9**

Ultrasonic Welding – Introduction - Process Description - Advantages and Disadvantages – Applications – Materials , Fillers and reinforcements , Additives , Equipments – Welding Parameters – Variants of Ultrasonic Welding.
Vibration Welding – Introduction - Process Description - Advantages and Disadvantages – Applications – Materials – Equipment – Process Variants.

**UNIT III SPIN & RADIO FREQUENCY WELDING 9**

Spin Welding - Process Description - Advantages and Disadvantages – Applications – Materials – Equipment – Joint Design – Welding Parameters
Radio Frequency Welding - Process Description - Advantages and Disadvantages – Applications – Materials – Equipment – Welding Parameters

**UNIT IV LASER & INFRA-RED WELDING, SEALING 9**

Laser Welding - Process Description - Advantages and Disadvantages – Applications – Materials – Equipment - Welding Parameters
Infrared Welding - Process Description - Advantages and Disadvantages – Applications – Materials – Equipment - Welding Parameters

Heat Sealing - Process Description - Advantages and Disadvantages – Applications – Materials – Equipment – Welding Parameters

**UNIT V SECONDARY OPERATIONS 9**

Microwave Welding - Process Description - Advantages and Disadvantages – Applications – Materials – Equipment – Welding Parameters

Solvent Welding - Process Description - Advantages and Disadvantages – Applications – Materials – Equipment – Application methods

Polymers in Adhesives – Solvent based adhesives – Water based adhesives – Hot Melt Adhesives – Radiation curable Adhesives.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of the course, students will be able to

- Gain Knowledge on different welding and machining process.
- Compare and contrast various machining process of plastics.
- Understand the importance of joining plastics to produce new product.
- Learn the details of different equipment involved in various process.
- Analyse the secondary operations and its importance.

**TEXT BOOK**


1. Handbook of Plastics Joining – a practical guide, Michael troughton ,William Andrew , 2008.
2. Joining of Plastics: Handbook for Designers and Engineers, Hanser Gardner Pubications, Jordan Rotheiser, 2000.


**REFERENCES**


1. Hot plate welders , Ultrasonic welders, Spin welders, Vibration welders, Thermos takers, Leak Testers, Supplier marketing literature(GC 1095), Forward Technology Industries Inc., 1995
2. S T Lee, N S Ramesh, Polymeric Foams Mechanisms and Materials, CRC Press; 1st edition (2004)


| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| **CO2** | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |
| **Overall CO** | 2.2 | 2.2 | 2.2 | 2.2 | 1 | 2 | 2 | 1 | - | 1 | - | 2 | 2 | 2 | 2 |

**PT3025 PRODUCT DESIGN AND COST ESTIMATION L T P C**
**3 0 0 3**

**OBJECTIVES:**

**To facilitate the students**

- To understand various aspects of design process & product life cycle.
- To train the student in the concept of product costing
- To gain the ideas in the field of manufacturing economics

- To acquire knowledge about optimization of product design
- To learn the recent advances in product design & development

**UNIT I PRODUCT DESIGN AND DEVELOPMENT 9**

Principles of creativity in design- integrated product development and concurrent engineering – Product analysis – Criteria for product design – Market research – Design for customer and design for manufacture – Product life cycle.

**UNIT II ECONOMICS OF DESIGN 9**

Break Even point - Selection of optimal materials and processes – Material layout planning – Value analysis – Re-engineering and its impact on product development.

**UNIT III PRODUCT MODELING 9**

Product modeling – Definition of concept - fundamental issues – Role and basic requirement of process chains and product models –Types of product models – model standardization efforts – types of process chains – industrial demands

.

**UNIT IV PRODUCT COSTING 9**

Bill of materials – Outline Process charts – Concepts of operational standard time - Work measurement by analytical estimation and synthesis of time – Budget times – Labor cost and material cost at every stage of manufacture – W.I.P. costing

**UNIT V RECENT ADVANCES AND CONCEPTS IN PRODUCT DESIGN 9**

Fundamentals of Finite Element Method (FEM) and its significance in product design – Product life cycle management – Intelligent information system – Concept of Knowledge based product and process design.

**TOTAL: 45 PERIODS**

**OUTCOMES**

Upon completion of the course, the student will be able to:

- Understand the fundamentals of product design
- Attain the knowledge in value analysis & Re-engineering
- Understand the.product modeling and standardization
- Understand the concept of costing in product design
- Gain knowledge in various advances in product design

**TEXTBOOKS:**


1. Karl T. Ulrich, Stephen D. Eppinger, “Product Design And Development”, Mcgraw-Hill, 6th Edition ,2014.
2. Sameul Eilon, “Elements Of Production Planning And Control”, Mcmillan And Company, 2015.
3. M. Bradford Clifton , Wesley P. Townsend, “Target Costing: Market Driven Product Design” CRC Press, 2003


**REFERENCES:**


1. Harry Nystrom, “Creativity and Innovation”, John Wiley & Sons, 1979
2. George e. Dieter, “Engineering Design – Materials and process approach”, Tata Mcgraw-Hill, 3rd edition,2003
3. R. Kesavan,C. Elanchezhian,B. Vijaya Ramnath ,Process Planning And Cost Estimation New Age International (P) Ltd., Publishers,2018


| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | - | 1 | 2 | 2 | 2 | 2 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 1 | - | 1 | 2 | 2 | 2 | 2 | 3 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO3 | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 1 | - | 1 | 2 | 2 | 2 | 2 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 1 | - | 1 | 2 | 2 | 2 | 2 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 1 | - | 1 | 2 | 2 | 2 | 2 | 3 |
| Overall CO | 2.8 | 2.8 | 2.8 | 2.8 | 2.6 | 1 | 2 | 1 | - | 1 | 2 | 2 | 2 | 2 | 3 |

**PT3026 ENGINEERING STATISTICS AND QUALITY CONTROL L T P C**
**3 0 0 3**

**OBJECTIVES**

- To impart knowledge on the application of statistical methods for measuring and controlling quality of processes / products.
- Enhance the student understanding of the complexities of Statistical Analysis and control chart interpretation
- To understand the concept of reliability and it's improving techniques and design of experiments
- To understand the need of control charts for attributes
- To elucidate importance and types of economic sampling

**UNIT I QUALITY FUNDAMENTALS 9**

Importance of quality- evolution of quality- definitions of quality- dimensions of quality- quality control- quality assurance- areas of quality- quality planning- quality objectives and policies-quality costs- economics of quality- quality loss function- quality Vs productivity- quality in random and selective assembly

**UNIT II CONTROL CHARTS FOR VARIABLES 9**

Process variation- preliminary decisions- control limits and their computation- construction and application of X bar, R and S charts- warning and modified control limits- process adjustment for trend,- Comparison of process variation with specification limits-O.C. curve for X bar chart.

**UNIT III STATISTICAL PROCESS CONTROL 9**

Process stability- process capability study using control charts- capability evaluation- Cp, Cpk and Cpm–capability analysis using histogram and normal probability plot- machine capability study- gauge capability study- setting statistical tolerances for components and assemblies-individual measurement charts- X-chart, moving average and moving range chart, multi-vari chart.

**UNIT IV CONTROL CHARTS FOR ATTRIBUTES 9**

Limitations of variable control charts- Control charts for fraction non-conforming- p and np charts, variable sample size, operating characteristic function, run length- Control chart for nonconformities (defects)- c, u, ku charts, demerits control chart- applications.

**UNIT V ACCEPTANCE SAMPLING 9**

Need- economics of sampling- sampling procedure- single and double sampling- O.C. curves- Average outgoing quality- Average sample number- Average total inspection- Multiple and sequential sampling- Standard sampling plans- Military, Dodge-Roming, IS 2500.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of the course, students will be able to

- Understand the importance of quality control & assurance.
- Gain knowledge on control charts like X bar, R&S charts for variables.
- Understand the process control techniques in statistics.

- Expetise in control charts like p & np, C, u,Ku etc.
- Understand the need for economic sampling and its types.

**TEXT BOOK:**

1. Douglus C. Montgomery, “Introduction to Statistical Quality Control”, John Wiley & Sons, 2004.

**REFERENCES:**

1. Eugene L. Grant and Richard S. Leaven Worth, “Statistical Quality Control”, Seventh Edition, TMH, 2000.
2. 2. Dale H. Bester field, "Quality Control", Seventh Edition, Pearson Education Asia, 2004.

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | - | 1 | 1 | 2 | 2 | 2 | 3 |
| **CO2** | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | - | 1 | 1 | 2 | 2 | 2 | 3 |
| **CO3** | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | - | 1 | 1 | 2 | 2 | 2 | 3 |
| **CO4** | 2 | 2 | 2 | 3 | 3 | 1 | 2 | 1 | - | 1 | 1 | 2 | 2 | 2 | 3 |
| **CO5** | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | - | 1 | 1 | 2 | 2 | 2 | 3 |
| **Overall CO** | 2 | 2 | 2 | 2.2 | 1.4 | 1 | 2 | 1 | - | 1 | 1 | 2 | 2 | 2 | 3 |

**PT3027 CIRCULAR ECONOMY AND EXTENDED PRODUCER RESPONSIBILITY L T P C**
**3 0 0 3**

**OBJECTIVES:**

**To facilitate the students**

- To study facts about circular economy & its building blocks
- To gain knowledge in key application areas of circular economy
- To learn various business models of circular economy.
- To acquire knowledge about ERP
- To understand sustainability management & zero waste practices.

**UNIT I INTRODUCTION 9**

Emergence of the concept and current definitions- Circular economy and Sustainable development - Global initiatives towards circular economy- Principles of the circular economy- Building Blocks of Circular Economy.

**UNIT II ACTION AREAS OF CIRCULAR ECONOMY 9**

Circular Economy in Production – Consumption – Waste Management – Innovation & Investment – Priority Areas of Circular economy- Plastics – Food Waste – Critical Raw Materials – Construction & Demolition – Biomass & Bio products- Assessment of circular economy.

**UNIT III BUSINESS MODELS OF CIRCULAR ECONOMY 9**

Circular suppliers - Resources recovery - Sharing platforms - Product life extension - Product as a service – Sharing Economy ; Industrial Symbiosis – Key benefits & steps.

**UNIT IV EXTENDED PRODUCER RESPONSIBILITY (EPR) 9**

Introduction – EPR types – Impact of EPR on environment design – Features of collective producer responsibility schemes - EPR & Informal sector: Solid Waste Management & Recycling – EPR schemes.

**UNIT V ECO-DESIGN 9**

The historical development of Eco-design - Process of Eco Design - Legal framework of eco-design - Types of Eco-design – Stages of Eco-design – Applications of Eco Design ; Supply chain : Circular Economy & supply chain – Loopy supply chain

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of the course, the student will be able to:

- Understand the fundamentals of circular economy
- Attain the knowledge in applications & building blocks of circular economy
- Understand the cSoncept of waste management & recycling
- Be familiar with eco design process
- Gain knowledge in various supply chain & its importance

**TEXTBOOKS:**


1. Walter R. Stahel, “The Circular Economy: A User's Guide” - 1st Edition - Routledge (2019)
2. Ken Webster, “The Circular Economy: A Wealth of Flows”, Ellen MacArthur Foundation Publishing; 2nd edition (2016)
3. Rui Cunha Marques, Nuno Ferreira da Cruz, “Recycling and Extended Producer Responsibility: The European Experience”, Routledge; 1st edition (6 February 2018)


**REFERENCES:**


1. Peter Lacy, Jessica Long, “The Circular Economy Handbook: Realizing the Circular Advantage” ,Palgrave Macmillan; 1st ed. 2020 edition (29 January 2020)

2. “Extended Producer Responsibility: a Guidance Manual for Governments”, Organization for Economic Co-operation and Development (OECD) (2001)

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 1 | - | 1 | 1 | 2 | 2 | 2 | 3 |
| CO2 | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 1 | - | 1 | 1 | 2 | 2 | 2 | 3 |
| CO3 | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 1 | - | 1 | 1 | 2 | 2 | 2 | 3 |
| CO4 | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 1 | - | 1 | 1 | 2 | 2 | 2 | 3 |
| CO5 | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 1 | - | 1 | 1 | 2 | 2 | 2 | 3 |
| Overall CO | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 1 | - | 1 | 1 | 2 | 2 | 2 | 3 |

**PT3028 POLLUTION, REGULATORY NORMS AND CONTROL EQUIPMENT L T P C**
**3 0 0 3**

**OBJECTIVES:**
**To enable the students**

- To understand the nature, ecosystem and role of pollution
- To train the student in the regulatory norms of pollution
- To gain the ideas in the field OHASMS
- To acquire knowledge about air , water and noise pollution
- To learn the mitigation measures and control equipment of pollution

**UNIT I ENVIRONMENTAL POLLUTION 9**

Environment- Nature and Ecosystem ;Pollution- and Preventive measures of Water, Soil, Air and Noise Pollutions- Causes, Effects and management of Solid, Hazardous and E-Waste- Case studies on Occupational Health and Safety Management system (OHASMS).

**UNIT II ENVIRONMENTAL PROTECTION & ENVIRONMENTAL LAW 9**

The Environment (Protection) Act, 1986 – Aims and Objects - Meaning of “Environment” and “Environmental Pollutant” - Powers and Functions of the Central Government - Environment Authority – Constitution - Delegation of Powers; Offences/Penalties - The Water (Prevention and Control of Pollution) Act 1974 - The Forests (Conservation) Act 1980 - The Air (Prevention and Control of Pollution) Act 1981- The Environment (Protection) Act 1986

**UNIT III AIR POLLUTION & CONTROL 9**

Introduction: sources, effects on – ecosystems, characterization of atmospheric pollutants - air pollution episodes of environmental importance - Indoor Air Pollution–sources, effects - Monitoring of particulate matter and gaseous pollutants - Air Pollution Control equipment for particulate matter & gaseous pollutants – gravity settling chambers, centrifugal collectors, wet collectors, fabric filters, electrostatic precipitator (ESP). –Adsorption, Absorption, Scrubbers, Condensation and Combustion.

**UNIT IV WATER POLLUTION & CONTROL 9**

Sources of surface and ground water pollution - water quality parameters: COD, BOD, DO - Effect of water contaminants on human health (nitrate, fluoride, arsenic, chlorine, cadmium, mercury, pesticides) - water borne diseases - concept and working of effluent treatment plants (ETPs). Sources of marine pollution: oil spill, coral reefs, coastal area management - Control- Activated Sludge Process (ASP) – Trickling Filters – oxidation ponds, fluidized bed reactors, membrane bioreactor neutralization - ETP sludge management; digesters, up flow anaerobic sludge blanket

reactor, fixed film reactors, sequencing batch reactors, hybrid reactors, bio scrubbers, bio trickling filters - regulatory framework for pollution monitoring and control - Case study: Ganga Action Plan - Yamuna Action Plan.

**UNIT V NOISE POLLUTION & CONTROL 9**

Noise -sources, measurements, effects and occupational hazards - Standards - Noise mapping - Noise attenuation equations and methods, - prediction equations - control measures - Legal aspects of noise.

**TOTAL: 45 PERIODS**

**OUTCOMES**

Upon completion of the course, the student will be able to:

- Understand the fundamentals of environmental pollution
- Attain the knowledge in various acts & laws of environmental protection
- Understand the. concept of air pollution & its mitigation
- Understand the concept of water pollution & its mitigation
- Gain knowledge in various waste management methods

**TEXTBOOKS:**


1. Philippe Sands and Jacqueline Peel, Principles of International Environmental Law (4th ed., 2018).
2. Shibani Ghosh ed., Indian Environmental Law: Key Concepts and Principles (2019).
3. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2006. Environmental and Pollution Science. Elsevier Academic Press.
4. Purohit, S.S. & Ranjan, R. 2007. Ecology, Environment & Pollution. Agrobios Publications.


**REFERENCES:**


1. P. Leelakrishnan, Environmental Law in India (5th ed., 2019)
2. Stuart Bell & Donald Mc Gillivray, Environmental Law (7th ed., 2008)
3. Purohit, S.S. & Ranjan, R. 2007. Ecology, Environment & Pollution. Agrobios Publications.


| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 2 | - | 3 | 3 | 1 | - | 1 | - | 2 | 2 | 3 | 3 |
| **CO2** | 2 | 2 | 2 | 2 | - | 3 | 3 | 1 | - | 1 | - | 2 | 2 | 3 | 3 |
| **CO3** | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 1 | - | 1 | - | 2 | 2 | 3 | 3 |
| **CO4** | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 1 | - | 1 | - | 2 | 2 | 3 | 3 |
| **CO5** | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 1 | - | 1 | - | 2 | 2 | 3 | 3 |
| **Overall CO** | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 1 | - | 1 | - | 2 | 2 | 3 | 3 |

**PT3029 FINTECH AND BLOCK CHAIN L T P C**
**3 0 0 3**

**OBJECTIVES:**

**To facilitate the students**

- To understand the several aspects of Fintech & Regtech
- To train the student in the concept of Block Chain
- To gain the ideas in the field of application & classification of Block Chain
- To acquire knowledge about the role of Block Chain in ICO & its implementation
- To learn about various block chain models

**UNIT I FINTECH 9**

FinTech: Introduction - Transformation – FinTech Evolution: Infrastructure, Banks Startups and Emerging Markets - Collaboration between Financial Institutions and Startups –FinTech Typology - Emerging Economics: Opportunities and Challenges - 8 From too-Small-To-Care to Too-Big-To-Fail – Introduction to Regulation Industry - The Future of RegTech and other Technologies Impacting it.

**UNIT II FINTECH REGULATION AND REGTECH 9**

Introduction - FinTech Regulations Evolution of RegTech – RegTech Ecosystem: Financial Institutions – RegTech Ecosystem Ensuring Compliance from the Start: Suitability and Funds – RegTech Startups: Challenges –RegTech Ecosystem: Regulators Industry – Use Case of AI in Smart Regulation and Fraud Detection – Regulatory Sandboxes – Smart Regulation – Redesigning Better Financial Infrastructure

**UNIT III INTRODUCTION TO BLOCKCHAIN 9**

Introduction to Block chain – History of Blockchain-Terminologies in Blockchain-Types of Blockchain-Applications of Blockchain- working methodology-Ingredients of Blockchain - Generic elements of Blockchain - Features of Blockchain - Types of Blockchain.

**UNIT IV BLOCK CHAIN IN BUSINESS 9**

Public versus private and permissioned versus permission less blockchains- Privacy and anonymity in Ethereum- Importance privacy and anonymity - The Ethereum Enterprise Alliance- Block Chain as-a-Service- Initial Coin Offering (ICO): Project setup for ICO implementation- Token contracts- Token sale contracts-Contract security and testing the code.

**UNIT V BLOCKCHAIN BUSINESS MODELS 9**

Introduction to Blockchain Business Models-Need for Blockchain business models-Traditional business models-Types of Blockchain Business Models- Blockchain As A Service (BaaS)-Token Economy- Utility Token Business Model-Blockchain-Based Software ProductsP2P Blockchain Business Model-Blockchain Professional Services. Block chain for Banking and Financial transactions.

**TOTAL: 45 PERIODS**

**OUTCOMES**

Upon completion of the course, the student will be able to:

- Understand the fundamentals of FinTech & its infrastructure
- Attain the knowledge in RegTech Ecosystem & RegTech Startups
- Understand the block chain concepts
- Identify the various key application areas of block chain
- Gain knowledge in various business models for block chain

**TEXTBOOKS:**


1. Brojo Kishore Mishra , Sanjay Kumar Kuanar “Handbook of IoT and Blockchain: Methods, Solutions, and Recent Advancements (Internet of Everything (IoE)) “, CRC Press; 1st edition , November 2020.
2. Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, decentralization, and smart contracts explained”, 2nd Edition, Packt Publishing Ltd, March 2018.
3. Susanne Chishti and Janos Barberis, “ The FINTECH Book: The Financial Technology Handbook for Investors, Entrepreneurs and Visionaries”, John Wiley, 1st Edition, 2016


**REFERENCES:**


1. Bellaj Badr, Richard Horrocks, Xun (Brian) Wu, “Blockchain By Example: A developer's guide to creating decentralized applications using Bitcoin, Ethereum, and Hyperledger”, Packt Publishing Limited, 2018.

2. Jai Singh Arun , Jerry Cuomo , Nitin Gaur Blockchain for Business- For Understanding transformation, growth and new models of Business -First Edition Published by Pearson Paperback–12December2019
3. Theo Lynn, John G. Mooney, Pierangelo Rosati, Mark Cummins, “Disrupting Finance: FinTech and Strategy in the 21st Century”, Palgrave, 1st edition, 2018

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | - | - | - | - | 2 | - | 2 | - | 1 | 3 | 2 | | 1 | 3 |
| CO2 | 1 | - | - | - | - | 2 | - | 2 | - | 1 | 3 | 2 | | 1 | 3 |
| CO3 | 1 | - | - | - | - | 2 | - | 2 | - | 1 | 3 | 2 | | 1 | 3 |
| CO4 | 1 | - | - | - | - | 2 | - | 2 | - | 1 | 3 | 2 | | 1 | 3 |
| CO5 | 1 | - | - | - | - | 2 | - | 2 | - | 1 | 3 | 2 | | 1 | 3 |
| Overall CO | 1 | - | - | - | - | 2 | - | 2 | - | 1 | 3 | 2 | | 1 | 3 |

**PT3030 ENTREPRENEURSHIP DEVELOPMENT L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To develop and strengthen entrepreneurial quality and motivation in students
- To impart basic entrepreneurial skills and understanding to run a business efficiently and effectively.
- To impart knowledge on small enterprises and their classification
- To elucidate the basics of finance and accounting
- To understand the various support systems available for entrepreneurs.

**UNIT I ENTREPRENEURSHIP 9**

Entrepreneur–Types of Entrepreneurs–Difference between Entrepreneur and Intrapreneur Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth.

**UNIT II MOTIVATION 9**

Major Motives Influencing an Entrepreneur–Achievement Motivation Training, Self Rating, Business Games, Thematic Apperception Test – Stress Management, Entrepreneurship Development Programs – Need, Objectives.

**UNIT III BUSINESS 9**

Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies.

**UNIT IV FINANCING AND ACCOUNTING 9**

Need – Sources of Finance, Term Loans, Capital Structure, Financial Institution, Management of working Capital, Costing, Break Even Analysis, Taxation – Income Tax, Excise Duty – Sales Tax

**UNIT V SUPPORT TO ENTREPRENEURS 9**

Sickness in small Business – Concept, Magnitude, Causes and Consequences, Corrective Measures - Business Incubators – Government Policy for Small Scale Enterprises – Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger and Sub Contracting.

**TOTAL: 45 PERIODS**

**OUTCOME:**

Upon completion of the course, students will be able

- To gain knowledge and skills needed to run a business successfully.
- To understand the basic concepts and factors affecting entrepreneurship
- To learn about small enterprises and their classification
- To understand the steps involved in setting up a business
- To acquire knowledge about finance and accounting and supports available for entrepreneurs

**TEXT BOOKS:**

1. Donald F Kuratko, “Entrepreneurship – Theory, Process and Practice”, 9 th Edition, Cengage Learning, 2014.
2. Khanka. S.S., “Entrepreneurial Development” S. Chand & Co. Ltd., Ram Nagar, New Delhi, 2013.

**REFERENCES:**

1. EDII “Faulty and External Experts – A Hand Book for New Entrepreneurs Publishers: Entrepreneurship Development”, Institute of India, Ahmadabad, 1986.
2. Hisrich R D, Peters M P, “Entrepreneurship” 8th Edition, Tata McGraw-Hill, 2013.
3. Mathew J Manimala, "Enterprenuership theory at cross roads: paradigms and praxis” 2nd Edition Dream tech, 2005.
4. Rajeev Roy, "Entrepreneurship" 2 Edition, Oxford University Press, 2011.

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | - | 2 | 2 | 2 | 1 | 1 | 3 |
| CO2 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | - | 2 | 2 | 2 | 1 | 1 | 3 |
| CO3 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | - | 2 | 2 | 2 | 1 | 1 | 3 |
| CO4 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | - | 2 | 2 | 2 | 1 | 1 | 3 |
| CO5 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | - | 2 | 2 | 2 | 1 | 1 | 3 |
| Overall CO | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | - | 2 | 2 | 2 | 1 | 1 | 3 |

**PT3031 INTELLECTUAL PROPERTY RIGHTS (IPR) L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To give an idea about IPR, registration and its enforcement.
- To give an overview of the research methodology and explain the technique of defining a research problem.
- To explain the art of interpretation and the art of writing research reports.
- To discuss leading International Instruments concerning Intellectual Property Rights.
- To understand the types of patents & various process for patent application

**UNIT I PRINCIPLES OF IPR 9**

Introduction to Intellectual Property Rights -Concept and Theories -Kinds of Intellectual Property Rights- Economic analysis of Intellectual Property Rights -Need for Private Rights versus Public Interests - Advantages and Disadvantages of IPR.

**UNIT II PATENT LAW AND PRACTICES 9**

Introduction to Patents -Overview ,Historical development Concepts, Novelty, Utility Patent Act 1970 – amendments of 1999, 2000, 2002 and 2005 Patentable subject matter, Patentability criteria - non-patentable inventions Rights of patentee Procedure for granting a patent and obtaining patents Grounds for opposition - Working of Patents, Compulsory License Acquisition, Surrender, Revocation, restoration - Transfer of patent rights - Infringement

**UNIT III COPYRIGHT LAW AND PRACTICES 9**

Copyright concept and principles -Historical background and Development of Copyright Law - Copyright Act, 1957 Terms of Copyright conditions for grant of copyright - extent of rights exception to copyright protection - fair use provision, assignment and licensing- Author Special Rights - Right of Broadcasting and performers - Copyright Registrar and Copyright Board-Power and Procedure Copyright Societies, Ownership, Assignment, License - Translation of Copyright, Compulsory Licenses, Infringement-Criteria of Infringement, Infringement of Copyright-Films, Literary and Dramatic works, Importation and Infringement.

**UNIT IV TRADEMARK LAW AND PRACTICES 9**

Introduction to Trademarks - Need for Protection - Kinds of trademarks - Concepts of well-known trademarks - Registration of trademark - Grounds of refusal of registration - Procedure of registration of trademark opposition and its grounds - Infringement of trademark - Remedies for infringement and passing off - Civil remedies - Criminal remedies

**UNIT V EMERGING ISSUES AND CHALLENGES 9**

Public health and Intellectual Property Rights - Case study—Novartis Pharmaceuticals Bayer Pharmaceuticals - TRIPS Flexibities and access to medicine - IPR and Climate change Patents and Biotechnology - Traditional knowledge and IPR- Bio piracy- Domain Name Disputes a- Cyber squatting

**TOTAL: 45 PERIODS**

**OUTCOMES**

- Ability to manage Intellectual Property portfolio to enhance the value of the firm.
- Formulate a research problem for a given engineering domain.
- Analyse the available literature for given research problem.
- Develop the technical writing and presentation skills.
- To understand the concept related to IPR
- Comprehend concepts related to patents, trademark and copyright

**TEXT BOOKS :**


1. William Cornish , David Llewelyn ," Intellectual Property: Patents, Copyrights, Trademarks & Allied Rights", Sweet & Maxwell; 6th edition (2007)
2. N.S. Gopalakrishnan & T.G. Agitha, "Principles of Intellectual Property" (2009), Eastern Book Company, Lucknow
3. Shibani Ghosh ed., "Indian Environmental Law: Key Concepts and Principles"(2019).


**REFERENCES:**


1. Dr. S.R. Myneni, Law of Intellectual Property. Asia Law House; 10th edition (January 2020)
2. Dr. Meenu Pandey, Dr.Prabhat Pandey "Intellectual Property Rights", Technical Publications; 1st edition (2020)
3. P. Narayanan, "Intellectual Property Law", Eastern Law House Private Ltd; Third Edition (2001)

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 1 | 2 |
| CO2 | 3 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 1 | 2 |
| CO3 | 3 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 1 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 1 | 2 |
| CO5 | 1 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 1 | 2 |
| CO6 | 1 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 1 | 2 |
| Overall CO | 2 | 2.5 | 2.5 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 1 | 2 |

**PT3032 ENGINEERING MANAGEMENT L T P C**
**3 0 0 3**

**OBJECTIVE:**

- To introduce the employment trends and challenges in engineering sector
- To impart knowledge on business essentials
- To elucidate the importance of Engineers as Managers/Leaders
- To impart knowledge about ethics in industrial and business sector
- To brief new trends and growth of engineering management

**UNIT I INTRODUCTION TO MANAGEMENT CHALLENGES FOR ENGINEERS 9**

Introduction–Definitions–Employment Trend in Industries–STEM Professionals–Management and Leadership–Function of Engineering Management–Planning–Types of Planning –Planning roles of Engineering Managers–Tools for Planning – Planning Activities –Some Specific Advice on Planning –Organizing–Activities of Organizing – Developing Organizational Structure-Concurrent Engineering Teams- Leading–Styles of Leadership – Deciding-Communicating- Motivating–Developing people- Controlling–Setting Performance Standards – benchmarking – Control of Business relationships.

**UNIT II BUSINESS ESSENTIALS FOR ENGINEERING MANAGERS 9**

Cost Accounting for Engineering Managers – Product or Service Costing – Application of ABC in industry – Risk Analysis and Cost Estimation under Uncertainty- Economic quantity of Ordering-Simple cost-based decision models. Financial Accounting and Management for Engineering Managers –Financial accounting principles- key financial statements – fundamental of financial analysis-balanced scorecard- capital formation – capital assets valuation- Acquisitions and Joint Ventures. Marketing Management for Engineering Managers- Function of Marketing–Market Forecast: four steps, Market Segmentation, Product/Service strategy, Pricing Strategy, Marketing Communication, Customers, Others Factors Affecting Marketing Success.

**UNIT III ENGINEERING LEADERSHIP IN THE NEW MILLENNIUM 9**

Engineers as Managers/Leaders–Career Path of a Typical Engineer – Factors affecting promotion to manager – factors causing engineers to fail as managers – Leaders and Managers – Styles, Qualities and attributes – Leadership skill for the twenty-First Century – Career Strategies for the twenty-first Century. Creativity and Innovation–Creativity and Creative Thinking Strategies – Generation of New/Products/Services ideas by deepthink–Innovation development process – Protection of Inventions and Innovation.

**UNIT IV ETHICS, OPERATIONAL EXCELLENCE AND GLOBALIZATION 9**

Introduction – Ethics in the Workplace –Guidelines for making tough ethical decisions- Corporate Ethics Programs- Affirmative Action and Workforce Decisions-Global issues of Ethics. Operational Excellence–Tools for Achieving Operational Excellence – Implementation of Operational

Excellence. Globalization – Global Trends and Commerce – Great Philosophical debate about globalization- Impact of Catastrophic events on globalization- New opportunities offered by globalization- preparation for globalization – Implementation issues related to globalization- Production Engineering in a global economy- Job migration induced by globalization.

**UNIT V ENGINEERING MANAGEMENT IN NEW MILLENNIUM 9**

Introduction–Future trends- Customer focus, ERP and Application Integration, Knowledge management, changes in organizational settings– Old economy and Knowledge economy companies-Characteristics of Progressive Companies- Transition to the Knowledge Economy-Personal Strategies for the future- Contributions in the New millennium-Technologies, Innovations, Value addition to E-Transitions-Customer and Knowledge-Social responsibility and Leadership.

**TOTAL: 45 PERIODS**

**OUTCOME:**

Upon successful completion of the course, students will be able to:

- Gain knowledge in basics of industrial management
- Learn about business essentials like Cost Accounting, Marketing and finance Accounting
- Learn the prerequisites and career plan leading to turn engineers as managers
- Learn about the work place ethics, golobalisation and operational excellence
- Gain ideas on scope of new techniques in engineering management.

**TEXT BOOK**

1. Engineering Management meeting the global challenges , C. M. Chang, CRC Press, Taylor and Francis Group, 2nd Edition, ISBN-13:978-1-4987-3009-9(e-book-PDF)
2. Engineering Management: An Irreverent Primer by Jack L. Wells , ISBN: 145630075X

| CO/ PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO1 0 | PO1 1 | PO1 2 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | - | - | - | - | 2 | - | 2 | - | 1 | 3 | 2 | - | 1 | 3 |
| CO2 | 1 | - | - | - | - | 2 | - | 2 | - | 1 | 3 | 2 | - | 1 | 3 |
| CO3 | 1 | - | - | - | - | 2 | - | 2 | - | 1 | 3 | 2 | - | 1 | 3 |
| CO4 | 1 | - | - | - | - | 2 | - | 2 | - | 1 | 3 | 2 | - | 1 | 3 |
| CO5 | 1 | - | - | - | - | 2 | - | 2 | - | 1 | 3 | 2 | - | 1 | 3 |
| Overall CO | 1 | - | - | - | - | 2 | - | 2 | - | 1 | 3 | 2 | - | 1 | 3 |

**GE3751 PRINCIPLES OF MANAGEMENT L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- Sketch the Evolution of Management.
- Extract the functions and principles of management.
- Learn the application of the principles in an organization.
- Study the various HR related activities.
- Analyze the position of self and company goals towards business.

**UNIT I INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS 9**

Definition of Management – Science or Art – Manager Vs Entrepreneur- types of managers-managerial roles and skills – Evolution of Management –Scientific, human relations, system and contingency approaches– Types of Business organization- Sole proprietorship, partnership, company-public and private sector enterprises- Organization culture and Environment – Current trends and issues in Management.

**UNIT II PLANNING 9**

Nature and purpose of planning – Planning process – Types of planning – Objectives – Setting objectives – Policies – Planning premises – Strategic Management – Planning Tools and Techniques – Decision making steps and process.

**UNIT III ORGANISING 9**

Nature and purpose – Formal and informal organization – Organization chart – Organization structure – Types – Line and staff authority – Departmentalization – delegation of authority – Centralization and decentralization – Job Design - Human Resource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management.

**UNIT IV DIRECTING 9**

Foundations of individual and group behaviour– Motivation – Motivation theories – Motivational techniques – Job satisfaction – Job enrichment – Leadership – types and theories of leadership – Communication – Process of communication – Barrier in communication – Effective communication – Communication and IT.

**UNIT V CONTROLLING 9**

System and process of controlling – Budgetary and non - Budgetary control techniques – Use of computers and IT in Management control – Productivity problems and management – Control and performance – Direct and preventive control – Reporting.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

CO1: Upon completion of the course, students will be able to have clear understanding of managerial functions like planning, organizing, staffing, leading & controlling.
CO2: Have same basic knowledge on international aspect of management.
CO3: Ability to understand management concept of organizing.
CO4: Ability to understand management concept of directing.
CO5: Ability to understand management concept of controlling.

**TEXT BOOKS:**

1. Harold Koontz and Heinz Weihrich “Essentials of management” Tata McGraw Hill,1998.
2. Stephen P. Robbins and Mary Coulter, “ Management”, Prentice Hall (India)Pvt. Ltd., 10th Edition, 2009.

**REFERENCES:**

1. Robert Kreitner and MamataMohapatra, “ Management”, Biztantra, 2008.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, “Fundamentals of Management” Pearson Education, 7th Edition, 2011.
3. Tripathy PC and Reddy PN, “Principles of Management”, Tata Mcgraw Hill, 1999.

| CO’s | PO’s | | | | | | | | | | | | PSO’s | | |
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| 2 | - | 1 | 1 | - | - | - | - | - | - | - | - | - | 2 | 1 | - |
| 3 | 1 | | - | 2 | - | - | 1 | - | 2 | - | 1 | 1 | - | - | 2 |
| 4 | - | 1 | 1 | 1 | 2 | - | - | 1 | 2 | - | - | - | 1 | 1 | 1 |
| 5 | 1 | | - | - | 1 | 1 | - | - | - | 3 | - | 1 | 1 | - | 1 |
| AVg. | 1.66 | 1 | 1 | 1.5 | 1.5 | 1 | 1 | 1 | 2 | 3 | 1 | 1 | 1.5 | 1 | 1.25 |

**GE3752 TOTAL QUALITY MANAGEMENT L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- Teach the need for quality, its evolution, basic concepts, contribution of quality gurus, TQMframework, Barriers and Benefits of TQM.
- Explain the TQM Principles for application.
- Define the basics of Six Sigma and apply Traditional tools, New tools, Benchmarking andFMEA.
- Describe Taguchi's Quality Loss Function, Performance Measures and apply Techniqueslike QFD, TPM, COQ and BPR.
- Illustrate and apply QMS and EMS in any organization.

**UNIT I INTRODUCTION 9**

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality –Definition of TQM-- Basic concepts of TQM - Gurus of TQM (Brief introduction) -- TQM Framework- Barriers to TQM –Benefits of TQM.

**UNIT II TQM PRINCIPLES 9**

Leadership - Deming Philosophy, Quality Council, Quality statements and Strategic planning- Customer Satisfaction –Customer Perception of Quality, Feedback, Customer complaints, Service Quality, Kano Model and Customer retention – Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition & Reward and Performance Appraisal-- Continuous process improvement –Juran Trilogy, PDSA cycle, 5S and Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating and Relationship development.

**UNIT III TQM TOOLS & TECHNIQUES I 9**

The seven traditional tools of quality - New management tools - Six-sigma Process Capability- Bench marking - Reasons to benchmark, Benchmarking process, What to Bench Mark, Understanding Current Performance, Planning, Studying Others, Learning from the data, Using the findings, Pitfalls and Criticisms of Benchmarking - FMEA - Intent , Documentation, Stages: Design FMEA and Process FMEA.

**UNIT IV TQM TOOLS & TECHNIQUES II 9**

Quality circles – Quality Function Deployment (QFD) - Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures- Cost of Quality - BPR.

**UNIT V QUALITY MANAGEMENT SYSTEM 9**

Introduction-Benefits of ISO Registration-ISO 9000 Series of Standards-Sector-Specific Standards - AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements-Implementation-Documentation- Internal Audits-Registration-ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001-Benefits of EMS.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1 :** Ability to apply TQM concepts in a selected enterprise.
**CO2:** Ability to apply TQM principles in a selected enterprise.
**CO3:** Ability to understand Six Sigma and apply Traditional tools, New tools, Benchmarking andFMEA.
**CO4:** Ability to understand Taguchi's Quality Loss Function, Performance Measures and apply QFD, TPM, COQ and BPR.
**CO5:** Ability to apply QMS and EMS in any organization.

**TEXT BOOK:**

1. Dale H.Besterfiled, Carol B.Michna,Glen H. Bester field,MaryB.Sacre, HemantUrdhwareshe and RashmiUrdhwareshe, "Total Quality Management", Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression,2013.

**REFERENCES:**

1 Joel.E. Ross, "Total Quality Management – Text and Cases",Routledge.,2017.
2. Kiran.D.R, "Total Quality Management: Key concepts and case studies, Butterworth – Heinemann Ltd, 2016.
3. Oakland, J.S. "TQM – Text with Cases", Butterworth – Heinemann Ltd., Oxford, Third Edition,2003.
4. Suganthi,L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd.,2006 .

**CO's- PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
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| 3 | | | | | 3 | | | | 3 | | | | | 2 | 3 |
| 4 | | 2 | | | 3 | 2 | 3 | 2 | | | | 3 | 3 | 2 | |
| 5 | | | 3 | | | 3 | 3 | 2 | | | | | | | |
| AVg. | | 2.5 | 3 | | 3 | 2.6 | 3 | 2 | 3 | | | 3 | 2.5 | 2 | 3 |

**GE3753 ENGINEERING ECONOMICS AND FINANCIAL ACCOUNTING L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- Understanding the concept of Engineering Economics.
- Implement various micro economics concept in real life.
- Gaining knowledge in the field of macro economics to enable the students to have better
- Understanding of various components of macro economics.
- Understanding the different procedures of pricing.
- Learn the various cost related concepts in micro economics.

**UNIT I DEMAND & SUPPLY ANALYSIS 9**

Managerial Economics - Relationship with other disciplines - Firms: Types, objectives and goals - Managerial decisions - Decision analysis.Demand - Types of demand - Determinants of demand - Demand function – Demand elasticity - Demand forecasting - Supply - Determinants of supply - Supply function -Supply elasticity.

**UNIT II PRODUCTION AND COST ANALYSIS 9**

Production function - Returns to scale - Production optimization - Least cost input - Isoquants - Managerial uses of production function.
Cost Concepts - Cost function - Determinants of cost - Short run and Long run cost curves - Cost Output Decision - Estimation of Cost.

**UNIT III PRICING 9**

Determinants of Price - Pricing under different objectives and different market structures - Price discrimination - Pricing methods in practice.

**UNIT IV FINANCIAL ACCOUNTING (ELEMENTARY TREATMENT) 9**

Balance sheet and related concepts - Profit & Loss Statement and related concepts - - Financial Ratio Analysis - Cash flow analysis - Funds flow analysis - Comparative financial statements - Analysis & Interpretation of financial statements.

**UNIT V CAPITAL BUDGETING (ELEMENTARY TREATMENT) 9**

Investments - Risks and return evaluation of investment decision - Average rate of return - Payback Period - Net Present Value - Internal rate of return.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES: Students able to**

**CO1:** Upon successful completion of this course, students will acquire the skills to apply the basics of economics and cost analysis to engineering and take economically sound decisions

**CO2**: Evaluate the economic theories, cost concepts and pricing policies

**CO3**: Understand the market structures and integration concepts

**CO4**: Understand the measures of national income, the functions of banks and concepts of globalization

**CO5:** Apply the concepts of financial management for project appraisal

**TEXT BOOKS:**

1. Panneer Selvam, R, “Engineering Economics”, Prentice Hall of India Ltd, New Delhi,2001.
2. Managerial Economics: Analysis, Problems and Cases - P. L. Mehta, Edition, 13. Publisher, Sultan Chand, 2007.

**REFERENCES:**


1. Chan S.Park, “Contemporary Engineering Economics”, Prentice Hall of India, 2011.
2. Donald.G. Newman, Jerome.P.Lavelle, “Engineering Economics and analysis” Engg. Press, Texas, 2010.
3. Degarmo, E.P., Sullivan, W.G and Canada, J.R, “Engineering Economy”, Macmillan, New York, 2011.
4. Zahid A khan: Engineering Economy, "Engineering Economy", Dorling Kindersley, 2012
5. Dr. S. N. Maheswari and Dr. S.K. Maheshwari: Financial Accounting, Vikas, 2009


**MAPPING OF COS AND POS:**

| CO’s | PO’s | | | | | | | | | | | | PSO’s | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | | 3 | | | | | | | | 2 | | | 1 | 3 | |
| 2 | | 3 | | | | | | | | | | | | 2 | 2 |
| 3 | | 2 | | | | | | | | | | | | | |
| 4 | 2 | 3 | 3 | | 2 | | | | | | | | 2 | 3 | |
| 5 | 3 | 3 | 3 | | 2 | | | | | | | | 2 | | 2 |
| AVg. | 2.5 | 2.4 | 3 | | 2 | | | | | 2 | | | 1.8 | 2.6 | 2 |

**GE3754 HUMAN RESOURCE MANAGEMENT L T P C**
**3 0 0 3**

**OBJECTIVE:**

- To provide knowledge about management issues related to staffing,
- To provide knowledge about management issues related to training,
- To provide knowledge about management issues related to performance
- To provide knowledge about management issues related to compensation
- To provide knowledge about management issues related to human factors consideration and compliance with human resource requirements.

**UNIT I INTRODUCTION TO HUMAN RESOURCE MANAGEMENT 9**

The importance of human resources – Objective of Human Resource Management - Human resource policies - Role of human resource manager.

**UNIT II HUMAN RESOURCE PLANNING 9**

Importance of Human Resource Planning – Internal and External sources of Human Resources - Recruitment - Selection – Socialization.

**UNIT III TRAINING AND EXECUTIVE DEVELOPMENT 9**

Types of training and Executive development methods – purpose – benefits.

**UNIT IV EMPLOYEE COMPENSATION 9**

Compensation plan – Reward – Motivation – Career Development - Mentor – Protege relationships.

**UNIT V PERFORMANCE EVALUATION AND CONTROL 9**

Performance evaluation – Feedback - The control process – Importance – Methods – grievances – Causes – Redressal methods.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1**: Students would have gained knowledge on the various aspects of HRM
**CO2**: Students will gain knowledge needed for success as a human resources professional.
**CO3**: Students will develop the skills needed for a successful HR manager.
**CO4**: Students would be prepared to implement the concepts learned in the workplace.
**CO5**: Students would be aware of the emerging concepts in the field of HRM

**TEXT BOOKS**:

1. Decenzo and Robbins, "Human Resource Management", 8th Edition, Wiley, 2007.
2. John Bernardin. H., "Human Resource Management – An Experimental Approach", 5th Edition, Tata McGraw Hill, 2013, New Delhi.

**REFERENCES:**

1. Luis R,. Gomez-Mejia, DavidB. Balkin and Robert L. Cardy, “Managing Human Resources", 7th Edition, PHI, 2012.
2. Dessler, "Human Resource Management", Pearson Education Limited, 2007.

**CO's- PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 2 | 2 | 1 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 3 | 1 | 2 | 1 | 1 | 2 | 1 |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 1 | 2 | 1 | 1 | 2 | 1 |
| 4 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| 5 | 3 | 3 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| AVg. | 2.8 | 2.8 | 1.8 | 2.6 | 2.6 | 2.2 | 1.8 | 1.8 | 2.4 | 1 | 1.4 | 1 | 1 | 1.4 | 1 |

**GE3755 KNOWLEDGE MANAGEMENT L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

The student should be made to:

Learn the Evolution of Knowledge management.

- Be familiar with tools.
- Be exposed to Applications.
- Be familiar with some case studies

**UNIT I INTRODUCTION 9**

Introduction: An Introduction to Knowledge Management - The foundations of knowledge management- including cultural issues- technology applications organizational concepts and processes- management aspects- and decision support systems. The Evolution of Knowledge management: From Information Management to Knowledge Management - Key Challenges Facing the Evolution of Knowledge Management - Ethics for Knowledge Management.

**UNIT II CREATING THE CULTURE OF LEARNING AND KNOWLEDGE SHARING 9**

Organization and Knowledge Management - Building the Learning Organization. Knowledge Markets: Cooperation among Distributed Technical Specialists – Tacit Knowledge and Quality Assurance.

**UNIT III KNOWLEDGE MANAGEMENT-THE TOOLS 9**

Telecommunications and Networks in Knowledge Management - Internet Search Engines and Knowledge Management - Information Technology in Support of Knowledge Management - Knowledge Management and Vocabulary Control - Information Mapping in Information Retrieval - Information Coding in the Internet Environment - Repackaging Information.

**UNIT IV KNOWLEDGE MANAGEMENT APPLICATION 9**

Components of a Knowledge Strategy - Case Studies (From Library to Knowledge Center, Knowledge Management in the Health Sciences, Knowledge Management in Developing Countries).

**UNIT V FUTURE TRENDS AND CASE STUDIES 9**

Advanced topics and case studies in knowledge management - Development of a knowledge management map/plan that is integrated with an organization's strategic and business plan - A case study on Corporate Memories for supporting various aspects in the process life -cycles of an organization.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, the student should be able to:

**CO1:** Understand the process of acquiry knowledge from experts

**CO2**: Understand the learning organization.

**CO3**: Use the knowledge management tools.

**CO4**: Develop knowledge management Applications.
**CO5**: Design and develop enterprise applications.

**CO's- PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
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| 3 | | | | | 2 | | | | | | | | | 2 | |
| 4 | | | | 1 | 1 | | | | 1 | | | | | 1 | |
| 5 | | | | 1 | 1 | | | | 1 | | | | | 1 | |
| AVg. | | | | 1 | 1.4 | | | | 1 | | | | 1 | 1.33 | |

**TEXT BOOK:**

1. Srikantaiah, T.K., Koenig, M., "Knowledge Management for the Information Professional" Information Today, Inc., 2000.

**REFERENCE:**

1. Nonaka, I., Takeuchi, H., "The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation", Oxford University Press, 1995.

**GE3792 INDUSTRIAL MANAGEMENT L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- To study the basic concepts of management; approaches to management; contributors to management studies; various forms of business organization and trade unions function in professional organizations.
- To study the planning; organizing and staffing functions of management in professional organization.
- To study the leading; controlling and decision making functions of management in professional organization.
- To learn the organizational theory in professional organization.
- To learn the principles of productivity and modern concepts in management in professional organization.

**UNIT – I INTRODUCTION TO MANAGEMENT 9**

Management: Introduction; Definition and Functions – Approaches to the study of Management – Mintzberg's Ten Managerial Roles – Principles of Taylor; Fayol; Weber; Parker – Forms of Organization: Sole Proprietorship; Partnership; Company (Private and Public); Cooperative – Public Sector Vs Private Sector Organization – Business Environment: Economic; Social; Political; Legal – Trade Union: Definition; Functions; Merits & Demerits.

**UNIT – II FUNCTIONS OF MANAGEMENT - I 9**

Planning: Characteristics; Nature; Importance; Steps; Limitation; Planning Premises; Strategic Planning; Vision & Mission statement in Planning– Organizing: Organizing Theory; Principles; Types; Departmentalization; Centralization and Decentralization; Authority & Responsibility – Staffing: Systems Approach; Recruiting and Selection Process; Human Resource Development (HRD) Concept and Design.

**UNIT – III FUNCTIONS OF MANAGEMENT - II 9**

Directing (Leading): Leadership Traits; Style; Morale; Managerial Grids (Blake-Mounton, Reddin) – Communication: Purpose; Model; Barriers – Controlling: Process; Types; Levels; Guidelines; Audit (External, Internal, Merits); Preventive Control – Decision Making: Elements; Characteristics; Nature; Process; Classifications.

**UNIT – IV ORGANIZATION THEORY 9**

Organizational Conflict: Positive Aspects; Individual; Role; Interpersonal; Intra Group; Inter Group; Conflict Management – Maslow's hierarchy of needs theory; Herzberg's motivation-hygiene theory; McClelland's three needs motivation theory; Vroom's valence-expectancy theory – Change Management: Concept of Change; Lewin's Process of Change Model; Sources of Resistance; Overcoming Resistance; Guidelines to managing Conflict.

**UNIT – V PRODUCTIVITY AND MODERN TOPICS 9**

Productivity: Concept; Measurements; Affecting Factors; Methods to Improve – Modern Topics (concept, feature/characteristics, procedure, merits and demerits): Business Process Reengineering (BPR); Benchmarking; SWOT/SWOC Analysis; Total Productive Maintenance; Enterprise Resource Planning (ERP); Management of Information Systems (MIS).

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course the students would be able to

CO1 Explain basic concepts of management; approaches to management; contributors to management studies; various forms of business organization and trade unions function in professional organizations.

CO2 Discuss the planning; organizing and staffing functions of management in professional organization.

CO3 Apply the leading; controlling and decision making functions of management in professional organization.

CO4 Discuss the organizational theory in professional organization.

CO5 Apply principles of productivity and modern concepts in management in professional organization.

**TEXTBOOKS:**


**1** M. Govindarajan and S. Natarajan, "Principles of Management", Prentice Hall of India, New Delhi, 2009.

2 Koontz. H. and Weihrich. H., "Essentials of Management: An International Perspective", 8th Edition, Tata McGrawhill, New Delhi, 2010.


**REFERENCES:**


**1** Joseph J, Massie, "Essentials of Management", 4th Edition, Pearson Education, 1987.

**2** Saxena, P. K., "Principles of Management: A Modern Approach", Global India Publications, 2009.

3 S.Chandran, "Organizational Behaviours", Vikas Publishing House Pvt. Ltd., 1994.

4 Richard L. Daft, "Organization Theory and Design", South Western College Publishing, 11th Edition, 2012.

5 S. TrevisCerto, "Modern Management Concepts and Skills", Pearson Education, 2018.

**MAPPING OF COS AND POS:**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 3 | 2 | 3 | 1 | 3 | 1 | 1 | 1 |
| 2 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 3 | 2 | 3 | 1 | 3 | 1 | 1 | 1 |
| 3 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 3 | 2 | 3 | 1 | 3 | 1 | 1 | 1 |
| 4 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 3 | 2 | 3 | 1 | 3 | 1 | 1 | 1 |
| 5 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 3 | 2 | 3 | 1 | 3 | 1 | 1 | 1 |

## MANDATORY COURSES I

**MX3081 INTRODUCTION TO WOMEN AND GENDER STUDIES L T P C**
**3 0 0 0**

**COURSE OUTLINE**

**UNIT I CONCEPTS**
Sex vs. Gender, masculinity, femininity, socialization, patriarchy, public/ private, essentialism, binaryism, power, hegemony, hierarchy, stereotype, gender roles, gender relation, deconstruction, resistance, sexual division of labour.

**UNIT II FEMINIST THEORY**
Liberal, Marxist, Socialist, Radical, Psychoanalytic, postmodernist, ecofeminist.

**UNIT III WOMEN'S MOVEMENTS: GLOBAL, NATIONAL AND LOCAL**
Rise of Feminism in Europe and America.
Women's Movement in India.

**UNIT IV GENDER AND LANGUAGE**
Linguistic Forms and Gender.
Gender and narratives.

**UNIT V GENDER AND REPRESENTATION**
Advertising and popular visual media.

Gender and Representation in Alternative Media.
Gender and social media.

**TOTAL : 45 PERIODS**

**MX3082** **ELEMENTS OF LITERATURE** **L T P C**
**3 0 0 0**

**OBJECTIVE:**

- To make the students aware about the finer sensibilities of human existence through an art form. The students will learn to appreciate different forms of literature as suitable modes of expressing human experience.

**1. COURSE CONTENTS**

Introduction to Elements of Literature

1. **Relevance of literature**
   a) Enhances Reading, thinking, discussing and writing skills.
   b) Develops finer sensibility for better human relationship.
   c) Increases understanding of the problem of humanity without bias.
   d) Providing space to reconcile and get a cathartic effect.

2. **Elements of fiction**
   a) Fiction, fact and literary truth.
   b) Fictional modes and patterns.
   c) Plot character and perspective.

3. **Elements of poetry**
   a) Emotions and imaginations.
   b) Figurative language.
   c) (Simile, metaphor, conceit, symbol, pun and irony).
   d) Personification and animation.
   e) Rhetoric and trend.

4. **Elements of drama**
   a) Drama as representational art.
   b) Content mode and elements.
   c) Theatrical performance.
   d) Drama as narration, mediation and persuasion.
   e) Features of tragedy, comedy and satire.

**3. READINGS:**


1. An Introduction to the Study of English Literature, W.H. Hudson, Atlantic, 2007.
2. An Introduction to Literary Studies, Mario Klarer, Routledge, 2013.
3. The Experience of Poetry, Graham Mode, Open college of Arts with Open Unv Press, 1991.
4. The Elements of Fiction: A Survey, Ulf Wolf (ed), Wolfstuff, 2114.
5. The Elements of Drama, J.L.Styan, Literary Licensing, 2011.


3.1 Textbook:

3.2 *Reference Books:: To be decided by the teacher and student, on the basis of individual student so as to enable him or her to write the term paper.

**4. OTHER SESSION:**

4.1*Tutorials:

4.2*Laboratory:

4.3*Project: The students will write a term paper to show their understanding of a particular piece of literature

**5.*ASSESSMENT:**

5.1HA:

5.2Quizzes-HA:

5.3Periodical Examination: one

5.4Project/Lab: one (under the guidance of the teachers the students will take a volume of poetry, fiction or drama and write a term paper to show their understanding of it in a given context; sociological, psychological, historical, autobiographical etc.

5.5Final Exam:

**TOTAL: 45 PERIODS**

**OUTCOME OF THE COURSE:**

- Students will be able to understand the relevance of literature in human life and appreciate its aspects in developing finer sensibilities.

**MX3083 FILM APPRECIATION L T P C**
**3 0 0 0**

In this course on film appreciation, the students will be introduced broadly to the development of film as an art and entertainment form. It will also discuss the language of cinema as it evolved over a century. The students will be taught as to how to read a film and appreciate the various nuances of a film as a text. The students will be guided to study film joyfully.

**Theme - A: The Component of Films**

A-1: The material and equipment
A-2: The story, screenplay and script
A-3: The actors, crew members, and the director
A-4: The process of film making… structure of a film

**Theme - B: Evolution of Film Language**

B-1: Film language, form, movement etc.
B-2: Early cinema… **silent film** (Particularly French)
B-3: The emergence of feature films: **Birth of a Nation**
B-4: Talkies

**Theme - C: Film Theories and Criticism/Appreciation**

C-1: Realist theory; Auteurists
C-2: Psychoanalytic, Ideological, Feminists
C-3: How to read films?
C-4: Film Criticism / Appreciation

**Theme – D: Development of Films**

D-1: Representative Soviet films
D-2: Representative Japanese films
D-3: Representative Italian films
D-4: Representative Hollywood film and the studio system

**Theme - E: Indian Films**

E-1: The early era
E-2: The important films made by the directors
E-3: The regional films
E-4: The documentaries in India

**READING:**

A Reader containing important articles on films will be prepared and given to the students. The students must read them and present in the class and have discussion on these.

**MX3084 DISASTER RISK REDUCTION AND MANAGEMENT L T P C**
**3 0 0 0**

**COURSE OBJECTIVE**

- To impart knowledge on concepts related to disaster, disaster risk reduction, disaster management
- To acquaint with the skills for planning and organizing disaster response

**UNIT I HAZRADS, VULNERABILITY AND DISASTER RISKS 9**

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Types of Disasters: Natural, Human induced, Climate change induced –Earthquake, Landslide, Flood, Drought, Fire etc – Technological disasters- Structural collapse, Industrial accidents, oil spills -Causes, Impacts including social, Economic, political, environmental, health, psychosocial, etc.- Disaster vulnerability profile of India and Tamil Nadu - Global trends in disasters: urban disasters, pandemics, Complex emergencies, - -, Inter relations between Disasters and Sustainable development Goals

**UNIT II DISASTER RISK REDUCTION (DRR) 9**

Sendai Framework for Disaster Risk Reduction**,** Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community Based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions / Urban Local Bodies (PRIs/ULBs), States, Centre, and other stakeholders- Early Warning System – Advisories from Appropriate Agencies.- Relevance of indigenous Knowledge, appropriate technology and Local resources.

**UNIT III DISASTER MANAGEMENT 9**

Components of Disaster Management – Preparedness of rescue and relief, mitigation, rehabilitation and reconstruction- Disaster Risk Management and post disaster management – Compensation and Insurance- Disaster Management Act (2005) and Policy - Other related policies, plans, programmers and legislation - Institutional Processes and Framework at State and Central Level- (NDMA –SDMA-DDMA-NRDF- Civic Volunteers)

**UNIT IV TOOLS AND TECHNOLOGY FOR DISASTER MANAGEMENT 9**

Early warning systems -Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment. - Elements of Climate Resilient

Development –Standard operation Procedure for disaster response – Financial planning for disaster Management

**UNIT V DISASTER MANAGEMENT: CASE STUDIES 9**

Discussion on selected case studies to analyse the potential impacts and actions in the contest of disasters-Landslide Hazard Zonation: Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.- Field work-Mock drill -

**TOTAL : 45 PERIODS**

**TEXT BOOKS:**


1 Taimpo (2016), Disaster Management and Preparedness, CRC Publications
2 Singh R (2017), Disaster Management Guidelines for earthquakes, Landslides, Avalanches and tsunami, Horizon Press Publications
3 Singhal J.P. “Disaster Management”, Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
4 Tushar Bhattacharya, “Disaster Science and Management”, McGraw Hill India Education Pvt. Ltd., 2012. **ISBN-10:** 1259007367, **ISBN-13:** 978-1259007361]


**REFERENCES**


1. Govt. of India: Disaster Management Act, Government of India, New Delhi, 2005.
2. Government of India, National Disaster Management Policy, 2009.
3. Shaw R (2016), Community based Disaster risk reduction, Oxford University Press


**COURSE OUTCOME:**

**CO1:** To impart knowledge on the concepts of Disaster, Vulnerability and Disaster Risk reduction (DRR)
**CO2:** To enhance understanding on Hazards, Vulnerability and Disaster Risk Assessment prevention and risk reduction
**CO3:** To develop disaster response skills by adopting relevant tools and technology
**CO4:** Enhance awareness of institutional processes for Disaster response in the country and
**CO5:** Develop rudimentary ability to respond to their surroundings with potential Disaster response in areas where they live, with due sensitivity

**CO’s – PO’s & PSO’s MAPPING**

| CO’s | PO’s | | | | | | | | | | | | PSO’s | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 3 | 2 | 3 | - | - | 2 | 2 | - | - | 2 | - | 2 | - | 1 |
| 2 | 3 | 3 | 3 | 3 | - | - | 2 | 1 | - | - | 2 | - | 2 | - | 1 |
| 3 | 3 | 3 | 3 | 3 | - | - | 2 | 2 | - | - | - | - | 2 | - | 1 |
| 4 | 3 | 3 | 2 | 3 | - | - | 2 | 1 | - | - | 2 | - | 2 | - | 1 |
| 5 | 3 | 3 | 2 | 3 | - | - | 2 | 2 | - | - | 2 | - | 3 | - | 1 |
| AVG | 3 | 3 | 3 | 3 | - | - | 2 | 2 | - | - | 2 | - | 2 | - | 1 |

## MANDATORY COURSES II

**MX3085 WELL-BEING WITH TRADITIONAL PRACTICES-YOGA, AYURVEDA AND SIDDHA** **L T P C**
**3 0 0 0**

**COURSE OBJECTIVES:**

- To enjoy life happily with fun filled new style activities that help to maintain health also
- To adapt a few lifestyle changes that will prevent many health disorders
- To be cool and handbill every emotion very smoothly in every walk of life
- To learn to eat cost effective but healthy foods that are rich in essential nutrients
- To develop immunity naturally that will improve resistance against many health disorders

**UNIT I HEALTH AND ITS IMPORTANCE** **2+4**

**Health: Definition - Importance of maintaining health -** More importance on prevention than treatment
Ten types of health one has to maintain - Physical health - Mental health - Social health - Financial health - Emotional health - Spiritual health - Intellectual health - Relationship health - Environmental health - Occupational/Professional heath.

**Present health status -** The life expectancy-present status - mortality rate - dreadful diseases - Non-communicable diseases (NCDs) the leading cause of death - 60% - heart disease – cancer – diabetes - chronic pulmonary diseases - risk factors – tobacco – alcohol - unhealthy diet - lack of physical activities.

**Types of diseases and disorders -** Lifestyle disorders – Obesity – Diabetes - Cardiovascular diseases – Cancer – Strokes – COPD - Arthritis - Mental health issues.

**Causes of the above diseases / disorders - Importance of prevention of illness -** Takes care of health - Improves quality of life - Reduces absenteeism - Increase satisfaction - Saves time

**Simple lifestyle modifications to maintain health -** Healthy Eating habits (Balanced diet according to age) Physical Activities (Stretching exercise, aerobics, resisting exercise) - Maintaining BMI-Importance and actions to be taken

**UNIT II DIET** **4+6**

**Role of diet in maintaining health -** energy one needs to keep active throughout the day - nutrients one needs for growth and repair - helps one to stay strong and healthy - helps to prevent diet-related illness, such as some cancers - keeps active and - helps one to maintain a healthy weight - helps to reduce risk of developing lifestyle disorders like diabetes – arthritis – hypertension – PCOD – infertility – ADHD – sleeplessness -helps to reduce the risk of heart diseases - keeps the teeth and bones strong.

**Balanced Diet and its 7 Components -** Carbohydrates – Proteins – Fats – Vitamins – Minerals - Fibre and Water.

**Food additives and their merits & demerits -** Effects of food additives - Types of food additives - Food additives and processed foods - Food additives and their reactions

**Definition of BMI and maintaining it with diet**
Importance - Consequences of not maintaining BMI - different steps to maintain optimal BM

**Common cooking mistakes**

Different cooking methods, merits and demerits of each method

**UNIT III ROLE OF AYURVEDA & SIDDHA SYSTEMS IN MAINTAINING HEALTH 4+4**

**AYUSH systems and their role in maintaining health -** preventive aspect of AYUSH - AYUSH as a soft therapy.
**Secrets of traditional healthy living -** Traditional Diet and Nutrition - Regimen of Personal and Social Hygiene - Daily routine (Dinacharya) - Seasonal regimens (Ritucharya) - basic sanitation and healthy living environment - Sadvritta (good conduct) - for conducive social life.
**Principles of Siddha & Ayurveda systems -** Macrocosm and Microcosm theory - Pancheekarana Theory / **(**Five Element Theory) 96 fundamental Principles - Uyir Thathukkal **(**Tri-Dosha Theory) - Udal Thathukkal

**Prevention of illness with our traditional system of medicine**
Primary Prevention - To decrease the number of new cases of a disorder or illness - Health promotion/education, and - Specific protective measures - Secondary Prevention - To lower the rate of established cases of a disorder or illness in the population (prevalence) - Tertiary Prevention - To decrease the amount of disability associated with an existing disorder.

**UNIT IV MENTAL WELLNESS 3+4**
**Emotional health -** Definition and types - Three key elements: the subjective experience - the physiological response - the behavioral response - Importance of maintaining emotional health - Role of emotions in daily life -Short term and long term effects of emotional disturbances - Leading a healthy life with emotions - Practices for emotional health - Recognize how thoughts influence emotions - Cultivate positive thoughts - Practice self-compassion - Expressing a full range of emotions.

**Stress management -** Stress definition - Stress in daily life - How stress affects one's life - Identifying the cause of stress - Symptoms of stress - Managing stress (habits, tools, training, professional help) - Complications of stress mismanagement.

**Sleep -** Sleep and its importance for mental wellness - Sleep and digestion.
**Immunity -** Types and importance - Ways to develop immunity

**UNIT V YOGA 2+12**
**Definition and importance of yoga -** Types of yoga - How to Choose the Right Kind for individuals according to their age - The Eight Limbs of Yoga - Simple yogasanas for cure and prevention of health disorders - What yoga can bring to our life.

**TOTAL : 45 PERIODS**

**TEXT BOOKS:**

1. Nutrition and Dietetics - Ashley Martin, Published by White Word Publications, New York, NY 10001, USA
2. Yoga for Beginners_ 35 Simple Yoga Poses to Calm Your Mind and Strengthen Your Body, by Cory Martin, Copyright © 2015 by Althea Press, Berkeley, California

**REFERENCES:**


1. WHAT WE KNOW ABOUT EMOTIONAL INTELLIGENCE How It Affects Learning, Work, Relationships, and Our Mental Health, by Moshe Zeidner, Gerald Matthews, and Richard D. Roberts
   A Bradford Book, The MIT Press, Cambridge, Massachusetts, London, England
2. The Mindful Self-Compassion Workbook, Kristin Neff, Ph.D Christopher Germer, Ph.D, Published by The Guilford Press A Division of Guilford Publications, Inc.370 Seventh Avenue, Suite 1200, New York, NY 10001

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4799645/

2. **Simple lifestyle modifications to maintain health** https://www.niddk.nih.gov/health-information/diet-nutrition/changing-habits-better-health#:~:text=Make%20your%20new%20healthy%20habit,t%20have%20time%20to%20cook.
3. **Read more**: https://www.legit.ng/1163909-classes-food-examples-functions.html
4. https://www.yaclass.in/p/science-state-board/class-9/nutrition-and-health-5926
5. **Benefits of healthy eating** https://www.cdc.gov/nutrition/resources-publications/benefits-of-healthy-eating.html
6. **Food additives** https://www.betterhealth.vic.gov.au/health/conditionsandtreatments/food-additives
7. **BMI** https://www.hsph.harvard.edu/nutritionsource/healthy-weight/ https://www.who.int/europe/news-room/fact-sheets/item/a-healthy-lifestyle---who-recommendations
8. **Yoga** https://www.healthifyme.com/blog/types-of-yoga/ https://yogamedicine.com/guide-types-yoga-styles/ **Ayurveda** : https://vikaspedia.in/health/ayush/ayurveda-1/concept-of-healthy-living-in-ayurveda
9. **Siddha** : http://www.tkdl.res.in/tkdl/langdefault/Siddha/Sid_Siddha_Concepts.asp
10. **CAM :** https://www.hindawi.com/journals/ecam/2013/376327/
11. **Preventive** herbs : https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3847409/

**COURSE OUTCOMES:**

After completing the course, the students will be able to:

- Learn the importance of different components of health
- Gain confidence to lead a healthy life
- Learn new techniques to prevent lifestyle health disorders
- Understand the importance of diet and workouts in maintaining health

**MX3086 HISTORY OF SCIENCE AND TECHNOLOGY IN INDIA L T P C**
**3 0 0 0**

**UNIT-I CONCEPTS AND PERSPECTIVES**

Meaning of History

Objectivity, Determinism, Relativism, Causation, Generalization in History; Moral judgment in history

Extent of subjectivity, contrast with physical sciences, interpretation and speculation, causation verses evidence, concept of historical inevitability, Historical Positivism.

Science and Technology-Meaning, Scope and Importance, Interaction of science, technology & society, Sources of history on science and technology in India.

**UNIT-II HISTORIOGRAPHY OF SCIENCE AND TECHNOLOGY IN INDIA**

Introduction to the works of D.D. Kosambi, Dharmpal, Debiprasad Chattopadhyay, Rehman, S. Irfan Habib, Deepak Kumar, Dhruv Raina, and others.

**UNIT-III SCIENCE AND TECHNOLOGY IN ANCIENT INDIA**

Technology in pre-historic period

Beginning of agriculture and its impact on technology

Science and Technology during Vedic and Later Vedic times

Science and technology from 1st century AD to C-1200.

**UNIT-IV SCIENCE AND TECHNOLOGY IN MEDIEVAL INDIA**

Legacy of technology in Medieval India, Interactions with Arabs

Development in medical knowledge, interaction between Unani and Ayurveda and alchemy
Astronomy and Mathematics: interaction with Arabic Sciences
Science and Technology on the eve of British conquest

**UNIT-V SCIENCE AND TECHNOLOGY IN COLONIAL INDIA**
Science and the Empire
Indian response to Western Science
Growth of techno-scientific institutions

**UNIT-VI SCIENCE AND TECHNOLOGY IN A POST-INDEPENDENT INDIA**
Science, Technology and Development discourse
Shaping of the Science and Technology Policy
Developments in the field of Science and Technology
Science and technology in globalizing India
Social implications of new technologies like the Information Technology and Biotechnology

**TOTAL : 45 PERIODS**

**MX3087 POLITICAL AND ECONOMIC THOUGHT FOR A HUMANE SOCIETY L T P C**
**3 0 0 0**

Pre-Requisite**:** None. (Desirable: Universal Human Values 1, Universal Human Values 2)

**OBJECTIVES:**

- This course will begin with a short overview of human needs and desires and how different political-economic systems try to fullfill them. In the process, we will end with a critique of different systems and their implementations in the past, with possible future directions.

**COURSE TOPICS:**
Considerations for humane society, holistic thought, human being's desires, harmony in self, harmony in relationships, society, and nature, societal systems. **(9 lectures, 1 hour each)**

(Refs: A Nagaraj, M K Gandhi, JC Kumarappa)

Capitalism – Free markets, demand-supply, perfect competition, laissez-faire, monopolies, imperialism. Liberal democracy. **(5 lectures)**

(Refs: Adam smith, J S Mill)

Fascism and totalitarianism. World war I and II. Cold war. **(2 lectures)**

Communism – Mode of production, theory of labour, surplus value, class struggle, dialectical materialism, historical materialism, Russian and Chinese models.

(Refs: Marx, Lenin, Mao, M N Roy) **(5 lectures)**

Welfare state. Relation with human desires. Empowered human beings, satisfaction. **(3 lectures)**

Gandhian thought. Swaraj, Decentralized economy & polity, Community. Control over one's lives. Relationship with nature. **(6 lectures)**

(Refs: M K Gandhi, Schumacher, Kumarappa)

Essential elements of Indian civilization. **(3 lectures)**

(Refs: Pt Sundarlal, R C Mazumdar, Dharampal)

Technology as driver of society, Role of education in shaping of society. Future directions. **(4 lectures)** (Refs: Nandkishore Acharya, David Dixon, Levis Mumford)

**Conclusion (2 lectures)**

**Total lectures: 39**

**Preferred Textbooks:** See Reference Books

**Reference Books:** Authors mentioned along with topics above. Detailed reading list will be provided.

**GRADING:**

| | |
|---|---|
| Mid sems | 30 |
| End sem | 20 |
| Home Assign | 10 |
| Term paper | 40 |

**TOTAL : 45 PERIODS**

**OUTCOME:**

- The students will get an understanding of how societies are shaped by philosophy, political and economic system, how they relate to fulfilling human goals & desires with some case studies of how different attempts have been made in the past and how they have fared.

**MX3088 STATE, NATION BUILDING AND POLITICS IN INDIA L T P C**
**3 0 0 0**

**OBJECTIVE:**

The objective of the course is to provide an understanding of the state, how it works through its main organs, primacy of politics and political process, the concept of sovereignty and its changing contours in a globalized world. In the light of this, an attempt will be made to acquaint the students with the main development and legacies of national movement and constitutional development in India, reasons for adopting a Parliamentary-federal system, the broad philosophy of the Constitution of India and the changing nature of Indian Political System. Challenges/ problems and issues concerning national integration and nation-building will also be discussed in the contemporary context with the aim of developing a future vision for a better India.

**TOPICS:**

Understanding the need and role of State and politics.

Development of Nation-State, sovereignty, sovereignty in a globalized world.

Organs of State – Executive, Legislature, Judiciary. Separation of powers, forms of government-unitary-federal, Presidential-Parliamentary,

The idea of India.

1857 and the national awakening.

1885 Indian National Congress and development of national movement – its legacies. Constitution making and the Constitution of India.
Goals, objective and philosophy.
Why a federal system?
National integration and nation-building.

Challenges of nation-building – State against democracy (Kothari)
New social movements.
The changing nature of Indian Political System, the future scenario. What can we do?

**TOTAL: 45 PERIODS**

**OUTCOME OF THE COURSE:**

It is expected that this course will make students aware of the theoretical aspect of the state, its organs, its operationalization aspect, the background and philosophy behind the founding of the present political system, broad streams and challenges of national integration and nation-building in India. It will equip the students with the real understanding of our political system/ process in correct perspective and make them sit up and think for devising ways for better participation in the system with a view to making the governance and delivery system better for the common man who is often left unheard and unattended in our democratic setup besides generating a lot of dissatisfaction and difficulties for the system.

**SUGGESTED READING:**


i. Sunil Khilnani, The Idea of India. Penguin India Ltd., New Delhi.
ii. Madhav Khosla, The Indian Constitution, Oxford University Press. New Delhi, 2012.
iii. Brij Kishore Sharma, Introduction to the Indian Constitution, PHI, New Delhi, latest edition.
iv. Sumantra Bose, Transforming India: Challenges to the World's Largest Democracy, Picador India, 2013.
v. Atul Kohli, Democracy and Discontent: India's Growing Crisis of Governability, Cambridge University Press, Cambridge, U. K., 1991.
vi. M. P. Singh and Rekha Saxena, Indian Politics: Contemporary Issues and Concerns, PHI, New Delhi, 2008, latest edition.
vii. Rajni Kothari, Rethinking Democracy, Orient Longman, New Delhi, 2005.


**MX3089 INDUSTRIAL SAFETY L T P C**
**3 0 0 0**

**OBJECTIVES**

- To Understand the Introduction and basic Terminologies safety.
- To enable the students to learn about the Important Statutory Regulations and standards.
- To enable students to Conduct and participate the various Safety activities in the Industry.
- To have knowledge about Workplace Exposures and Hazards.
- To assess the various Hazards and consequences through various Risk Assessment Techniques.

**UNIT I SAFETY TERMINOLOGIES**

Hazard-Types of Hazard- Risk-Hierarchy of Hazards Control Measures-Lead indicators- lag Indicators-Flammability- Toxicity Time-weighted Average (TWA) - Threshold LimitValue (TLV) -

Short Term Exposure Limit (STEL)- Immediately dangerous to life or health (IDLH)- acute and chronic Effects- Routes of Chemical Entry-Personnel Protective Equipment- Health and Safety Policy-Material Safety Data Sheet MSDS

**UNIT II STANDARDS AND REGULATIONS**

Indian Factories Act-1948- Health- Safety- Hazardous materials and Welfare- ISO 45001:2018 occupational health and safety (OH&S) - Occupational Safety and Health Audit IS14489:1998- Hazard Identification and Risk Analysis- code of practice IS 15656:2006

**UNIT III SAFETY ACTIVITIES**

Toolbox Talk- Role of safety Committee- Responsibilities of Safety Officers and Safety Representatives- Safety Training and Safety Incentives- Mock Drills- On-site Emergency Action Plan- Off-site Emergency Action Plan- Safety poster and Display- Human Error Assessment

**UNIT IV WORKPLACE HEALTH AND SAFETY**

Noise hazard- Particulate matter- musculoskeletal disorder improper sitting poster and lifting Ergonomics RULE & REBA- Unsafe act & Unsafe Condition- Electrical Hazards- Crane Safety- Toxic gas Release

**UNIT V HAZARD IDENTIFICATION TECHNIQUES**

Job Safety Analysis-Preliminary Hazard Analysis-Failure mode and Effects Analysis- Hazard and Operability- Fault Tree Analysis- Event Tree Analysis Qualitative and Quantitative Risk Assessment- Checklist Analysis- Root cause analysis- What-If Analysis- and Hazard Identification and Risk Assessment

**COURSE OUTCOMES**

Course outcomes on completion of this course the student will be able:

- Understand the basic concept of safety.
- Obtain knowledge of Statutory Regulations and standards.
- Know about the safety Activities of the Working Place.
- Analyze on the impact of Occupational Exposures and their Remedies
- Obtain knowledge of Risk Assessment Techniques.

**TEXTBOOKS:**


1. R.K. Jain and Prof. Sunil S. Rao Industrial Safety, Health and Environment Management Systems KHANNA PUBLISHER
2. L. M. Deshmukh Industrial Safety Management: Hazard Identification and Risk Control McGraw-Hill Education


**REFERENCES:**


1. Frank Lees (2012) 'Lees' Loss Prevention in Process Industries.Butterworth-Heinemann publications, UK, 4th Edition.
2. John Ridley & John Channing (2008)Safety at Work: Routledge, 7th Edition.
3. Dan Petersen (2003) Techniques of Safety Management: A System Approach.
4. Alan Waring.(1996).Safety management system: Chapman &Hall,England
5. Society of Safety Engineers, USA


**ONLINE RESOURCES**

ISO 45001:2018 occupational health and safety (OH&S) International Organization for Standardization https://www.iso.org/standard/63787.html

Indian Standard code of practice on occupational safety and health audit https://law.resource.org/pub/in/bis/S02/is.14489.1998.pdf

Indian Standard code of practice on Hazard Identification and Risk Analysis IS 15656:2006 https://law.resource.org/pub/in/bis/S02/is.15656.2006.pdf

| Course Outcomes | Statement | Program Outcome | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO1 | PSO2 | PSO3 |
| CO1 | Understand the basic concept of safety. | 3 | 3 | 3 | 1 | 1 | 3 | 2 | 2 | 3 | 3 | 1 | 3 | 3 | 3 | 3 |
| CO2 | Obtain knowledge of Statutory Regulations and standards. | 2 | 3 | 2 | 2 | 1 | 3 | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 3 | 3 |
| CO3 | Know about the safety Activities of the Working Place. | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 3 | 2 | 1 | 2 | 3 | 3 | 3 |
| CO4 | Analyze on the impact of Occupational Exposures and their Remedies | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 1 | 3 | 3 | 3 | 3 |
| CO5 | Obtain knowledge of Risk Assessment Techniques. | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 3 | 3 |
| **Industrial safety** | | 3 | 3 | 3 | 2 | 1 | 3 | 2 | 2 | 3 | 2 | 1 | 3 | 3 | 3 | 3 |

## OPEN ELECTIVE I AND II

**OCS351 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FUNDAMENTALS**

**L T P C**
**2 0 2 3**

**OBJECTIVES**:

The main objectives of this course are to:

1. Understand the importance, principles, and search methods of AI
2. Provide knowledge on predicate logic and Prolog.
3. Introduce machine learning fundamentals
4. Study of supervised learning algorithms.
5. Study about unsupervised learning algorithms.

**UNIT I INTELLIGENT AGENT AND UNINFORMED SEARCH 6**

**Introduction** - Foundations of AI - History of AI - The state of the art - Risks and Benefits of AI - **Intelligent Agents** - Nature of Environment - Structure of Agent - Problem Solving Agents - Formulating Problems - **Uninformed Search** - Breadth First Search - Dijkstra's algorithm or uniform-cost search - Depth First Search - Depth Limited Search

**UNIT II PROBLEM SOLVING WITH SEARCH TECHNIQUES 6**

**Informed Search** - Greedy Best First - A* algorithm - Adversarial Game and Search - **Game theory** - Optimal decisions in game - Min Max Search algorithm - Alpha-beta pruning - **Constraint**

**Satisfaction Problems (CSP)** - Examples - Map Coloring - Job Scheduling - Backtracking Search for CSP

**UNIT III LEARNING 6**

Machine Learning: Definitions – Classification - Regression - approaches of machine learning models - Types of learning - Probability - Basics - Linear Algebra – Hypothesis space and inductive bias, Evaluation. Training and test sets, cross validation, Concept of over fitting, under fitting, Bias and Variance - **Regression**: Linear Regression - Logistic Regression

**UNIT IV SUPERVISED LEARNING 6**

**Neural Network:** Introduction, Perceptron Networks – Adaline - Back propagation networks - **Decision Tree:** Entropy – Information gain - Gini Impurity - classification algorithm - Rule based Classification - **Naïve Bayesian classification** - **Support Vector Machines** (SVM)

**UNIT V UNSUPERVISED LEARNING 6**

**Unsupervised Learning** – Principle Component Analysis - **Neural Network**: Fixed Weight Competitive Nets - Kohonen Self-Organizing Feature Maps – **Clustering**: Definition - Types of Clustering – Hierarchical clustering algorithms – k-means algorithm

**TOTAL : 30 PERIODS**

**PRACTICAL EXERCISES**: 30 PERIODS

**Programs for Problem solving with Search**

1. Implement breadth first search
2. Implement depth first search
3. Analysis of breadth first and depth first search in terms of time and space
4. Implement and compare Greedy and A* algorithms.

**Supervised learning**

5. Implement the non-parametric locally weighted regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs
6. Write a program to demonstrate the working of the decision tree based algorithm.
7. Build an artificial neural network by implementing the back propagation algorithm and test the same using appropriate data sets.
8. Write a program to implement the naïve Bayesian classifier.

**Unsupervised learning**

9. Implementing neural network using self-organizing maps
10. Implementing k-Means algorithm to cluster a set of data.
11. Implementing hierarchical clustering algorithm.

Note:

- Installation of gnu-prolog, Study of Prolog (gnu-prolog).
- The programs can be implemented in using C++/JAVA/ Python or appropriate tools can be used by designing good user interface
- Data sets can be taken from standard repositories (https://archive.ics.uci.edu/ml/datasets.html) or constructed by the students.

**OUTCOMES:**

CO1: Understand the foundations of AI and the structure of Intelligent Agents
CO2: Use appropriate search algorithms for any AI problem
CO3: Study of learning methods
CO4: Solving problem using Supervised learning
CO5: Solving problem using Unsupervised learning

**TOTAL PERIODS: 60**

**TEXT BOOK**

1. S. Russell and P. Norvig, “Artificial Intelligence: A Modern Approach”, Prentice Hall, Fourth Edition, 2021

2. S.N.Sivanandam and S.N.Deepa, Principles of soft computing-Wiley India.3 rd ed,

**REFERENCES**

1. Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.
2. I. Bratko, "Prolog: Programming for Artificial Intelligencell, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.
3. C. Muller & Sarah Alpaydin, Ethem. Introduction to machine learning. MIT press, 2020.

**OCS352 IOT CONCEPTS AND APPLICATIONS L T P C**
**2 0 2 3**

**OBJECTIVES:**

- To apprise students with basic knowledge of IoT that paves a platform to understand physical and logical design of IOT
- To teach a student how to analyse requirements of various communication models and protocols for cost-effective design of IoT applications on different IoT platforms.
- To introduce the technologies behind Internet of Things(IoT).
- To explain the students how to code for an IoT application using Arduino/Raspberry Pi open platform.
- To apply the concept of Internet of Things in real world scenario.

**UNIT I INTRODUCTION TO INTERNET OF THINGS 5**

Evolution of Internet of Things – Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT Models – Simplified IoT Architecture and Core IoT Functional Stack – Fog, Edge and Cloud in IoT

**UNIT II COMPONENTS IN INTERNET OF THINGS 5**

Functional Blocks of an IoT Ecosystem – Sensors, Actuators, and Smart Objects – Control Units - Communication modules (Bluetooth, Zigbee,Wifi, GPS, GSM Modules)

**UNIT III PROTOCOLS AND TECHNOLOGIES BEHIND IOT 6**

IOT Protocols - IPv6, 6LoWPAN, MQTT, CoAP - RFID, Wireless Sensor Networks, BigData Analytics, Cloud Computing, Embedded Systems.

**UNIT IV OPEN PLATFORMS AND PROGRAMMING 7**

IOT deployment for Raspberry Pi /Arduino platform-Architecture –Programming – Interfacing – Accessing GPIO Pins – Sending and Receiving Signals Using GPIO Pins – Connecting to the Cloud.

**UNIT V IOT APPLICATIONS 7**

Business models for the internet of things, Smart city, Smart mobility and transport, Industrial IoT, Smart health, Environment monitoring and surveillance – Home Automation – Smart Agriculture

**30 PERIODS**

**PRACTICAL EXERCISES: 30 PERIODS**

1. Introduction to Arduino platform and programming
2. Interfacing Arduino to Zigbee module
3. Interfacing Arduino to GSM module
4. Interfacing Arduino to Bluetooth Module
5 Introduction to Raspberry PI platform and python programming

6. Interfacing sensors to Raspberry PI
7. Communicate between Arduino and Raspberry PI using any wireless medium
8. Setup a cloud platform to log the data
9. Log Data using Raspberry PI and upload to the cloud platform
10.Design an IOT based system

**OUTCOMES:**

**CO 1:**Explain the concept of IoT.
**CO 2:**Understand the communication models and various protocols for IoT.
**CO 3:**Design portable IoT using Arduino/Raspberry Pi /open platform
**CO 4:**Apply data analytics and use cloud offerings related to IoT.
**CO 5:**Analyze applications of IoT in real time scenario.

**TOTAL:60 PERIODS**

**TEXTBOOKS**


1. Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, CISCO Press, 2017
2. Samuel Greengard, The Internet of Things, The MIT Press, 2015


**REFERENCES**


1. Perry Lea, “Internet of things for architects”, Packt, 2018
2. Olivier Hersent, David Boswarthick, Omar Elloumi , “The Internet of Things – Key applications and Protocols”, Wiley, 2012
3. IOT (Internet of Things) Programming: A Simple and Fast Way of Learning, IOT Kindle Edition.
4. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), “Architecting the Internet of Things”, Springer, 2011.
5. ArshdeepBahga, Vijay Madisetti, “Internet of Things – A hands-on approach”, Universities Press, 2015
6. https://www.arduino.cc/
   https://www.ibm.com/smarterplanet/us/en/?ca=v_smarterplanet


**OCS353 DATA SCIENCE FUNDAMENTALS L T P C**
**2 0 2 3**

**COURSE OBJECTIVES:**

- Familiarize students with the data science process.
- Understand the data manipulation functions in Numpy and Pandas.
- Explore different types of machine learning approaches.
- Understand and practice visualization techniques using tools.
- Learn to handle large volumes of data with case studies.

**UNIT I INTRODUCTION 6**

Data Science: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – Retrieving data – data preparation - Exploratory Data analysis – build the model – presenting findings and building applications - Data Mining - Data Warehousing – Basic statistical descriptions of Data

**UNIT II DATA MANIPULATION 9**

Python Shell - Jupyter Notebook - IPython Magic Commands - NumPy Arrays-Universal Functions – Aggregations – Computation on Arrays – Fancy Indexing – Sorting arrays – Structured data –

Data manipulation with Pandas – Data Indexing and Selection – Handling missing data – Hierarchical indexing – Combining datasets – Aggregation and Grouping – String operations – Working with time series – High performance

**UNIT III MACHINE LEARNING 5**

The modeling process - Types of machine learning - Supervised learning - Unsupervised learning - Semi-supervised learning- Classification, regression - Clustering – Outliers and Outlier Analysis

**UNIT IV DATA VISUALIZATION 5**

Importing Matplotlib – Simple line plots – Simple scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three dimensional plotting - Geographic Data with Basemap - Visualization with Seaborn

**UNIT V HANDLING LARGE DATA 5**

Problems - techniques for handling large volumes of data - programming tips for dealing with large data sets- Case studies: Predicting malicious URLs, Building a recommender system - Tools and techniques needed - Research question - Data preparation - Model building – Presentation and automation.

**30 PERIODS**

**PRACTICAL EXERCISES: 30 PERIODS**

**LAB EXERCISES**

1. Download, install and explore the features of Python for data analytics.
2. Working with Numpy arrays
3. Working with Pandas data frames
4. Basic plots using Matplotlib
5. Statistical and Probability measures
    a) Frequency distributions
    b) Mean, Mode, Standard Deviation
    c) Variability
    d) Normal curves
    e) Correlation and scatter plots
    f) Correlation coefficient
    g) Regression

6. Use the standard benchmark data set for performing the following:
a) Univariate Analysis: Frequency, Mean, Median, Mode, Variance, Standard Deviation, Skewness and Kurtosis.
b) Bivariate Analysis: Linear and logistic regression modelling.
7. Apply supervised learning algorithms and unsupervised learning algorithms on any data set.
8. Apply and explore various plotting functions on any data set.

**Note: Example data sets like: UCI, Iris, Pima Indians Diabetes etc.**

**COURSE OUTCOMES:**

**At the end of this course, the students will be able to:**

**CO1:** Gain knowledge on data science process.
**CO2:** Perform data manipulation functions using Numpy and Pandas.
**CO3** Understand different types of machine learning approaches.
**CO4:** Perform data visualization using tools.
**CO5:** Handle large volumes of data in practical scenarios.

**TOTAL PERIODS:60**

**TEXT BOOKS**

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, “Introducing Data Science”, Manning Publications, 2016.

2. Jake VanderPlas, “Python Data Science Handbook”, O’Reilly, 2016.

**REFERENCES**

1. Robert S. Witte and John S. Witte, “Statistics”, Eleventh Edition, Wiley Publications, 2017.
2. Allen B. Downey, “Think Stats: Exploratory Data Analysis in Python”, Green Tea Press,2014.

**CCS333 AUGMENTED REALITY/VIRTUAL REALITY L T P C**
**2 0 2 3**

**OBJECTIVES:**

- To impart the fundamental aspects and principles of AR/VR technologies.
- To know the internals of the hardware and software components involved in the development of AR/VR enabled applications.
- To learn about the graphical processing units and their architectures.
- To gain knowledge about AR/VR application development.
- To know the technologies involved in the development of AR/VR based applications.

**UNIT I INTRODUCTION 7**

Introduction to Virtual Reality and Augmented Reality – Definition – Introduction to Trajectories and Hybrid Space-Three I’s of Virtual Reality – Virtual Reality Vs 3D Computer Graphics – Benefits of Virtual Reality – Components of VR System – Introduction to AR-AR Technologies-Input Devices – 3D Position Trackers – Types of Trackers – Navigation and Manipulation Interfaces – Gesture Interfaces – Types of Gesture Input Devices – Output Devices – Graphics Display – Human Visual System – Personal Graphics Displays – Large Volume Displays – Sound Displays – Human Auditory System**.**

**UNIT II VR MODELING 6**

Modeling – Geometric Modeling – Virtual Object Shape – Object Visual Appearance – Kinematics Modeling – Transformation Matrices – Object Position – Transformation Invariants –Object Hierarchies – Viewing the 3D World – Physical Modeling – Collision Detection – Surface Deformation – Force Computation – Force Smoothing and Mapping – Behavior Modeling – Model Management.

**UNIT III VR PROGRAMMING 6**

VR Programming – Toolkits and Scene Graphs – World ToolKit – Java 3D – Comparison of World ToolKit and Java 3D

**UNIT IV APPLICATIONS 6**

Human Factors in VR – Methodology and Terminology – VR Health and Safety Issues – VR and Society-Medical Applications of VR – Education, Arts and Entertainment – Military VR Applications – Emerging Applications of VR – VR Applications in Manufacturing – Applications of VR in Robotics – Information Visualization – VR in Business – VR in Entertainment – VR in Education.

**UNIT V AUGMENTED REALITY 5**

Introduction to Augmented Reality-Computer vision for AR-Interaction-Modelling and Annotation-Navigation-Wearable devices

**30 PERIODS**

**PRACTICAL EXERCISES: 30 PERIODS**

1. Study of tools like Unity, Maya, 3DS MAX, AR toolkit, Vuforia and Blender.

2. Use the primitive objects and apply various projection types by handling camera.
3. Download objects from asset store and apply various lighting and shading effects.
4. Model three dimensional objects using various modelling techniques and apply textures over them.
5. Create three dimensional realistic scenes and develop simple virtual reality enabled mobile applications which have limited interactivity.
6. Add audio and text special effects to the developed application.
7. Develop VR enabled applications using motion trackers and sensors incorporating full haptic interactivity.
8. Develop AR enabled applications with interactivity like E learning environment, Virtual walkthroughs and visualization of historic places.
9. Develop AR enabled simple applications like human anatomy visualization, DNA/RNA structure visualization and surgery simulation.
10. Develop simple MR enabled gaming applications.

**TOTAL:60 PERIODS**

**OUTCOMES:**

**On completion of the course, the students will be able to:**

**CO1:** Understand the basic concepts of AR and VR
**CO2:** Understand the tools and technologies related to AR/VR
**CO3**: Know the working principle of AR/VR related Sensor devices
**CO4:** Design of various models using modeling techniques
**CO5:** Develop AR/VR applications in different domains

**TEXTBOOKS:**


1. Charles Palmer, John Williamson, "Virtual Reality Blueprints: Create compelling VR experiences for mobile", Packt Publisher, 2018
2. Dieter Schmalstieg, Tobias Hollerer, "Augmented Reality: Principles & Practice", Addison Wesley, 2016
3. John Vince, "Introduction to Virtual Reality", Springer-Verlag, 2004.
4. William R. Sherman, Alan B. Craig: Understanding Virtual Reality – Interface, Application, Design", Morgan Kaufmann, 2003


**CO's – PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | |
| 1 | 3 | 2 | 2 | - | 3 | - | - | - | 2 | 2 | 1 | 2 | 2 | 1 | 2 | |
| 2 | 3 | 2 | 2 | 1 | 3 | - | - | - | 3 | 2 | 2 | 3 | 3 | 1 | 2 | |
| 3 | 3 | 3 | 2 | 2 | 3 | - | - | - | 3 | 2 | 1 | 2 | 3 | 2 | 2 | |
| 4 | 3 | 3 | 3 | 2 | 3 | - | - | - | 3 | 2 | 2 | 3 | 3 | 2 | 2 | |
| 5 | 3 | 3 | 3 | 3 | 3 | - | - | - | 3 | 3 | 3 | 3 | 3 | 3 | 3 | |
| AVg. | 3.00 | 2.60 | 2.40 | 2.00 | 3.00 | - | - | - | 2.80 | 2.20 | 1.80 | 2.60 | 2.80 | 1.80 | 2.20 | |

## OPEN ELCTIVE III

**OHS351 ENGLISH FOR COMPETITIVE EXAMINATIONS L T P C**
**3 0 0 3**

**COURSE DESCRIPTION:**

Students aspiring to take up competitive exams of which the English language is a vital component will find this course useful. Designed for students in the higher semesters, the course will help students to familiarise themselves with those aspects of English that are tested in these examinations.

**OBJECTIVES:**

- To train the students in the language components essential to face competitive examinations both at the national (UPSC, Banking, Railway, Defence) and the international level (GRE, TOEFL, IELTS).
- To enhance an awareness of the specific patterns in language testing and the respective skills to tackle verbal reasoning and verbal ability tests.
- To inculcate effective practices in language-learning in order to improve accuracy in usage of grammar and coherence in writing.
- To improve students' confidence to express their ideas and opinions in formal contexts
- To create awareness of accuracy and precision in communication

**UNIT I** **9**

Orientation on different formats of competitive exams - Vocabulary – Verbal ability – Verbal reasoning - Exploring the world of words – Essential words – Meaning and their usage – Synonyms-antonyms – Word substitution – Word analogy – Idioms and phrases – Commonly confused words – Spellings – Word expansion – New words in use.

**UNIT II** **9**

Grammar – Sentence improvement –Sentence completion – Rearranging phrases into sentences – Error identification –Tenses – Prepositions – Adjectives – Adverbs – Subject-verb agreement – Voice – Reported speech – Articles – Clauses – Speech patterns.

**UNIT III** **9**

Reading - Specific information and detail – Identifying main and supporting ideas – Speed reading techniques – Improving global reading skills – Linking ideas – Summarising – Understanding argument – Identifying opinion/attitude and making inferences - Critical reading.

**UNIT IV** **9**

Writing – Pre-writing techniques – Mindmap - Describing pictures and facts - Paragraph structure – organising points – Rhetoric writing – Improving an answer – Drafting, writing and developing an argument – Focus on cohesion – Using cohesive devices –Analytic writing – Structure and types of essay – Mind maps – Structure of drafts, letters, memos, emails – Statements of Purpose – Structure, Content and Style.

**UNIT V** **9**

Listening and Speaking – Contextual listening – Listening to instructions – Listening for specific information – Identifying detail, main ideas – Following signpost words – Stress, rhythm and intonation - Speaking to respond and elicit ideas – Guided speaking – Opening phrases – Interactive communication – Dysfluency -Sentence stress – Speaking on a topic – Giving opinions – Giving an oral presentation – Telling a story or a personal anecdote – Talking about oneself - Utterance – Speech acts- Brainstorming ideas – Group discussion.

**TOTAL: 45 PERIODS**

**LEARNING OUTCOMES:**

At the end of the course, learners will be able

- expand their vocabulary and gain practical techniques to read and comprehend a wide range of texts with the emphasis required
- identify errors with precision and write with clarity and coherence
- understand the importance of task fulfilment and the usage of task-appropriate vocabulary
- communicate effectively in group discussions, presentations and interviews
- write topic based essays with precision and accuracy

**CO-PO & PSO MAPPING**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 1 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 1 | 3 | 1 | 3 | - | - | - |
| 2 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | - | - | - |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| 4 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | - | - | - |
| 5 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | - | - | - |
| AVg. | 2 | 2.6 | 2.6 | 2 | 2.6 | 2.6 | 2.6 | 2.6 | 2 | 3 | 2.4 | 3 | - | - | - |

- 1-low, 2-medium, 3-high, '-"- no correlation

**Note:** The average value of this course to be used for program articulation matrix.

**TEACHING METHODS:**

Instructional methods will involve discussions, taking mock tests on various question papers – Objective, multiple-choice and descriptive. Peer evaluation, self-check on improvement and peer feedback - Practice sessions on speaking assessments, interview and discussion – Using multimedia.

**Evaluative Pattern:**

Internal Tests – 50%
End Semester Exam - 50%

**TEXTBOOKS:**

1. R.P.Bhatnagar - *General English for Competitive Examinations.* Macmillan India Limited, 2009.

**REFERENCEBOOKS:**


1. Educational Testing Service - The Official Guide to the GRE Revised General Test, Tata McGraw Hill, 2010.
2. The Official Guide to the TOEFL Test, Tata McGraw Hill, 2010.
3. R Rajagopalan- General English for Competitive Examinations, McGraw Hill Education (India) Private Limited, 2008.


**Websites**

http://www.examenglish.com/, http://www.ets.org/ , http://www.bankxams.com/
http://civilservicesmentor.com/, http://www.educationobserver.com
http://www.cambridgeenglish.org/in/

**OCE353 LEAN CONCEPTS, TOOLS AND PRACTICES L T P C**
**3 0 0 3**

**OBJECTIVE:**

- To impart knowledge about the basics of lean principles, tools and techniques, and implementation in the construction industry.

**UNIT I INTRODUCTION 9**

Introduction and overview of the construction project management - Review of Project Management & Productivity Measurement Systems - Productivity in Construction - Daily Progress Report-The state of the industry with respect to its management practices -construction project phases - The problems with current construction management techniques.

**UNIT II LEAN MANAGEMENT 9**

Introduction to lean management - Toyota's management principle-Evolution of lean in construction industry - Production theories in construction –Lean construction value - Value in construction - Target value design - Lean project delivery system- Forms of waste in construction industry - Waste Elimination.

**UNIT III CORE CONCEPTS IN LEAN 9**

Concepts in lean thinking – Principles of lean construction – Variability and its impact – Traditional construction and lean construction – Traditional project delivery - Lean construction and workflow reliability – Work structuring – Production control.

**UNIT IV LEAN TOOLS AND TECHNIQUES 9**

Value Stream Mapping – Work sampling – Last planner system – Flow and pull based production – Last Planner System – Look ahead schedule – constraint analysis – weekly planning meeting-Daily Huddles – Root cause analysis – Continuous improvement – Just in time.

**UNIT V LEAN IMPLEMENTATION IN CONSTRUCTION INDUSTRY 9**

Lean construction implementation- Enabling lean through information technology - Lean in design - Design Structure - BIM (Building Information Modelling) - IPD (Integrated Project Delivery) – Sustainability through lean construction approach.

**TOTAL : 45 PERIODS**

**OUTCOME:**

On completion of this course, the student is expected to be able to

**CO1** Explains the contemporary management techniques and the issues in present scenario.
**CO2** Apply the basics of lean management principles and their evolution from manufacturing industry to construction industry.
**CO3** Develops a better understanding of core concepts of lean construction tools and techniques and their importance in achieving better productivity.
**CO4** Apply lean techniques to achieve sustainability in construction projects.
**CO5** Apply lean construction techniques in design and modeling.

**REFERENCES:**


1. Corfe, C. and Clip, B., Implementing lean in construction: Lean and the sustainability agenda, CIRIA, 2013.
2. Shang Gao and Sui Pheng Low, Lean Construction Management: The Toyota Way, Springer, 2014.
3. Dave, B., Koskela, L., Kiviniemi, A., Owen, R., andTzortzopoulos, P.,Implementing lean in construction: Lean construction and BIM, CIRIA, 2013.
4. Ballard, G., Tommelein, I., Koskela, L. and Howell, G., Lean construction tools and techniques, 2002.
5. Salem, O., Solomon, J., Genaidy, A. and Luegring, M., Site implementation and Assessment of Lean Construction Techniques, Lean Construction Journal, 2005.

**OMG352 NGOS AND SUSTAINABLE DEVELOPMENT L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- . to understand the importance of sustainable development
- to acquire a reasonable knowledge on the legal frameworks pertaining to pollution control and environmental management
- to comprehend the role of NGOs in attaining sustainable development

**UNIT I ENVIRONMENTAL CONCERNS 9**

Introduction to sustainable development goals, Global responsibility of environmental concern, Importance of environmental preservation, Environmental threats, Pollution and its types, Effects of Pollution, Pollution control, Treatment of wastes

**UNIT II ROLE OF NGOS 9**

Role of NGO's in national development, NGO's and participatory management, Challenges and limitations of NGO's, Community Development programmes, Role of NGO's in Community Development programmes, Participation of NGO's in environment management, Corporate Social responsibility, NGO's and corporate social responsibility

**UNIT III SUSTAINABLE DEVELOPMENT 9**

Issues and Challenges of Sustainable Development, Bioenergy, Sustainable Livelihoods and Rural Poor in Sustainable Development, Protecting ecosystem services for sustainable development, Non-renewable sources of energy and its effect, Renewable sources of energy for sustainability, Nuclear resources and Legal Regulation of Hazardous Substances, Sustainable Development: Programme and Policies, Sustainability assessment and Indicators

**UNIT IV NGO'S FOR SUSTAINABILITY 9**

Civil Society Initiatives in Environment Management, Civil Society Initiatives for Sustainable Development, Global Initiatives in Protecting Global Environment, World Summit on Sustainable Development (Johannesburg Summit 2002), Ecological economics, Environmental sustainability, Social inclusion, Health for all, education for all, Food security and Water security, NGOs and Sustainable Development strategies

**UNIT V LEGAL FRAMEWORKS 9**

Need for a Legal framework and its enforcement, Legal measures to control pollution, Environmental Legislations in India, Mechanism to implement Environmental Laws in India, Legal Protection of Forests Act 1927, Legal Protection of Wild Life, Role of NGO's in implementing environmental laws, Challenges in the implementation of environmental legislation

**TOTAL 45 : PERIODS**

**OUTCOMES**

Upon completion of this course, the student will :

CO1 Have a thorough grounding on the issues and challenges being faced in attaining sustainable development

CO2 have a knowledge on the role of NGOs towards sustainable developemnt

CO 3 present strategies for NGOs in attaining sustainable development

CO 4 recognize the importance of providing energy, food security and health equity to all members of the society without damaging the environment

CO 5 understand the environmental legislations

**REFERENCE BOOKS**

1. Kulsange, S and Kamble, R. (2019). Environmental NGO's: Sustainability Stewardship, Lap Lambert Academic Publishing, India, ISBN-13: 978-6200442444.

2. Dodds, F. (2007). NGO diplomacy: The influence of nongovernmental organizations in international environmental negotiations. Mit Press, Cambridge, ISBN-13: 978-0262524766.
3. Ghosh, S. (Ed.). (2019). Indian environmental law: Key concepts and principles. Orient BlackSwan, India, ISBN-13: 978-9352875795.
4. Alan Fowler and Chiku Malunga (2010) NGO Management: The Earthscan Companion, Routledge, ISBN-13 : 978-1849711197.

**OMG353 DEMOCRACY AND GOOD GOVERNANCE**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**UNIT-I** **(9)**

Structure and Process of Governance: Indian Model of Democracy, Parliament, Party Politics and Electoral Behaviour, Federalism, the Supreme Court and Judicial Activism, Units of Local Governance

**UNIT-II** **(9)**

Regulatory Institutions – SEBI, TRAI, Competition Commission of India,

**UNIT-III** **(9)**

Lobbying Institutions: Chambers of Commerce and Industries, Trade Unions, Farmers Associations, etc.

**UNIT- IV** **(9)**

Contemporary Political Economy of Development in India: Policy Debates over Models of Development in India, Recent trends of Liberalisation of Indian Economy in different sectors, E-governance

**UNIT-V** **(9)**

Dynamics of Civil Society: New Social Movements, Role of NGO's, Understanding the political significance of Media and Popular Culture.

**TOTAL 45 : PERIODS**

**REFERENCES:**

1. Atul Kohli (ed.): The Success of India's Democracy, Cambridge University Press, 2001.
2. Corbridge, Stuart and John Harris: Reinventing India: Liberalisation, Hindu Nationalism and Popular Democracy, Oxford University Press, 2000.
3. J.Dreze and A.Sen, India: Economic Development and Social Opportunity, Clarendon, 1995.
4. Saima Saeed: Screening the Public Sphere: Media and Democracy in India,2013
5. Himat Singh: Green Revolution Reconsidered: The Rural World of Punjab, OUP, 2001.
6. Jagdish Bhagwati: India in Transition: Freeing The Economy, 1993.
7. Smitu Kothari: Social Movements and the Redefinition of Democracy, Boulder, Westview, 1993.

**CME365 RENEWABLE ENERGY TECHNOLOGIES**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES**

1 To know the Indian and global energy scenario

2 To learn the various solar energy technologies and its applications.
3 To educate the various wind energy technologies.
4 To explore the various bio-energy technologies.
5 To study the ocean and geothermal technologies.

**UNIT – I ENERGY SCENARIO 9**

Indian energy scenario in various sectors – domestic, industrial, commercial, agriculture, transportation and others – Present conventional energy status – Present renewable energy status-Potential of various renewable energy sources-Global energy status-Per capita energy consumption - Future energy plans

**UNIT – II SOLAR ENERGY 9**

Solar radiation – Measurements of solar radiation and sunshine – Solar spectrum - Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems – Solar PV applications.

**UNIT – III WIND ENERGY 9**

Wind data and energy estimation – Betz limit - Site selection for windfarms – characteristics - Wind resource assessment - Horizontal axis wind turbine – components - Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems – Environmental issues - Applications.

**UNIT – IV BIO-ENERGY 9**

Bio resources – Biomass direct combustion – thermochemical conversion - biochemical conversion-mechanical conversion - Biomass gasifier - Types of biomass gasifiers - Cogeneration –- Carbonisation – Pyrolysis - Biogas plants – Digesters –Biodiesel production – Ethanol production - Applications.

**UNIT – V OCEAN AND GEOTHERMAL ENERGY 9**

Small hydro - Tidal energy – Wave energy – Open and closed OTEC Cycles – Limitations – Geothermal energy – Geothermal energy sources - Types of geothermal power plants – Applications - Environmental impact.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

At the end of the course the students would be able to

- Discuss the Indian and global energy scenario.
- Describe the various solar energy technologies and its applications.
- Explain the various wind energy technologies.
- Explore the various bio-energy technologies.
- Discuss the ocean and geothermal technologies.

**TEXT BOOKS:**

- Fundamentals and Applications of Renewable Energy | Indian Edition, by Mehmet Kanoglu, Yunus A. Cengel, John M. Cimbala, cGraw Hill; First edition (10 December 2020), ISBN-10 : 9390385636
- Renewable Energy Sources and Emerging Technologies, by Kothari, Prentice Hall India Learning Private Limited; 2nd edition (1 January 2011), ISBN-10 : 8120344707

**REFERENCES:**

1. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, U.K., 2012.
2. Rai.G.D., “Non-Conventional Energy Sources”, Khanna Publishers, New Delhi, 2014.

3. Sukhatme.S.P., “Solar Energy: Principles of Thermal Collection and Storage”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2009.
4. Tiwari G.N., “Solar Energy – Fundamentals Design, Modelling and applications”, Alpha Science Intl Ltd, 2015.
5. Twidell, J.W. & Weir A., “Renewable Energy Resources”, EFNSpon Ltd., UK, 2015.

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 2 | 2 | 1 | 1 | 3 | 2 | 1 | 2 |
| 2 | 3 | 2 | 2 | 1 | 1 | 1 | 3 | 1 | 1 | 1 | 2 | 3 | 2 | 1 | 2 |
| 3 | 3 | 2 | 3 | 1 | 2 | 1 | 3 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 2 |
| 4 | 2 | 2 | 2 | 1 | 2 | 1 | 3 | 1 | 1 | 1 | 2 | 3 | 2 | 2 | 2 |
| 5 | 2 | 1 | 2 | 1 | 2 | 1 | 3 | 1 | 1 | 1 | 1 | 3 | 2 | 1 | 2 |
| Low (1) ; Medium (2) ; High (3) | | | | | | | | | | | | | | | |

**OME354 APPLIED DESIGN THINKING L T P C**
**3 0 0 3**

**OBJECTIVES**:
The course aims to
- Introduce tools & techniques of design thinking for innovative product
- development Illustrate customer-centric product innovation using on simple
- use cases Demonstrate development of Minimum usable Prototypes
- Outline principles of solution concepts & their evaluation
- Describe system thinking principles as applied to complex systems

**UNIT I DESIGN THINKING PRINCIPLES 9**
Exploring Human-centered Design - Understanding the Innovation process, discovering areas of opportunity, Interviewing & empathy-building techniques, Mitigate validation risk with FIR [Forge Innovation rubric] - Case studies

**UNIT II ENDUSER-CENTRIC INNOVATION 9**
Importance of customer-centric innovation - Problem Validation and Customer Discovery - Understanding problem significance and problem incidence - Customer Validation. Target user, User persona & user stories. Activity: Customer development process - Customer interviews and field visit

**UNIT III APPLIED DESIGN THINKING TOOLS 9**
Concept of Minimum Usable Prototype [MUP] - MUP challenge brief - Designing & Crafting the value proposition - Designing and Testing Value Proposition; Design a compelling value proposition; Process, tools and techniques of Value Proposition Design

**UNIT IV CONCEPT GENERATION 9**
Solution Exploration, Concepts Generation and MUP design- Conceptualize the solution concept; explore, iterate and learn; build the right prototype; Assess capability, usability and feasibility. Systematic concept generation; evaluation of technology alternatives and the solution concepts

**UNIT V SYSTEM THINKING 9**

System Thinking, Understanding Systems, Examples and Understandings, Complex Systems

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

**At the end of the course, learners will be able to:**

- Define & test various hypotheses to mitigate the inherent risks in product innovations.
- Design the solution concept based on the proposed value by exploring alternate solutions to achieve value-price fit.
- Develop skills in empathizing, critical thinking, analyzing, storytelling & pitching
- Apply system thinking in a real-world scenario

**TEXT BOOKS**


1. Steve Blank, (2013), The four steps to epiphany: Successful strategies for products that win, Wiley.
2. Alexander Osterwalder, Yves Pigneur, Gregory Bernarda, Alan Smith, Trish Papadakos, (2014), Value
3. Proposition Design: How to Create Products and Services Customers Want, Wiley
4. Donella H. Meadows, (2015), "Thinking in Systems -A Primer", Sustainability Institute.
5. Tim Brown,(2012) "Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation", Harper Business.


**REFERENCES**


1. https://www.ideou.com/pages/design-thinking#process
2. https://blog.forgefor ward.in/valuation-risk-versus-validation-risk-in-product-innovations-49f253ca86 24
3. https://blog.forgefor ward.in/product-innovation-rubric-adf5ebdfd356
4. https://blog.forgefor ward.in/evaluating-product-innovations-e8178e58b86e
5. https://blog.forgefor ward.in/user-guide-for-product-innovation-rubric-857181b253dd
6. https://blog.forgefor ward.in/star tup-failure-is-like-true-lie-7812cdfe9b85


**MF3003 REVERSE ENGINEERING LT P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- The main learning objective of this course is to prepare students for:
- Applying the fundamental concepts and principles of reverse engineering in product design and development.
- Applying the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
- Applying the concept and principles of material identification and process verification in reverse engineering of product design and development.
- Analysing the various legal aspect and applications of reverse engineering in product design and development.
- Understand about 3D scanning hardware & software operations and procedure to generate 3D model

**UNIT I INTRODUCTION & GEOMETRIC FORM 9 Hours**

Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering - Surface and Solid Model Reconstruction – Dimensional Measurement – Prototyping.

**UNIT II MATERIAL CHARACTERISTICS AND PROCESS IDENTIFICATION 9 Hours**

.Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength – Hardness –Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure Material Specification - Composition Determination - Microstructure Analysis - Manufacturing Process Verification.

**UNIT III DATA PROCESSING 9 Hours**

Statistical Analysis – Data Analysis – Reliability and the Theory of Interference – Weibull Analysis – Data Conformity and Acceptance – Data Report – Performance Criteria – Methodology of Performance Evaluation – System Compatibility.

**UNIT IV 3D SCANNING AND MODELLING 9 Hours**

Introduction, working principle and operations of 3D scanners: Laser, White Light, Blue Light - Applications- Software for scanning and modelling: Types- Applications- Preparation techniques for Scanning objects- Scanning and Measuring strategies - Calibration of 3D Scanner- Step by step procedure: 3D scanning - Geometric modelling – 3D inspection- Case studies.

**UNIT V INDUSTRIAL APPLICATIONS 9 Hours**

Reverse Engineering in the Automotive Industry; Aerospace Industry; Medical Device Industry. Case studies and Solving Industrial projects in Reverse Engineering.Legality: Patent – Copyrights –Trade Secret – Third-Party Materials.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- Apply the fundamental concepts and principles of reverse engineering in product design and development.
- Apply the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
- Apply the concept and principles of material identification and process verification in reverse engineering of product design and development.
- Apply the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.
- Analyze the various legal aspect
- Applications of reverse engineering in product design and development.

**TEXT BOOKS:**


1. Robert W. Messler, Reverse Engineering: Mechanisms, Structures, Systems & Materials, 1st Edition, McGraw-Hill Education, 2014
2. Wego Wang, Reverse Engineering Technology of Reinvention, CRC Press, 2011


**REFERENCES:**


1. Scott J. Lawrence , Principles of Reverse Engineering, Kindle Edition, 2022
2. Kevin Otto and Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Prentice Hall, 2001
3. Kathryn, A. Ingle, “Reverse Engineering”, McGraw-Hill, 1994.
4. Linda Wills, “Reverse Engineering”, Kluver Academic Publishers, 1996
5. Vinesh Raj and Kiran Fernandes, “Reverse Engineering: An Industrial Perspective”, Springer-Verlag London Limited 2008.

**OPR351 SUSTAINABLE MANUFACTURING L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To be acquainted with sustainability in manufacturing and its evaluation.
- To provide knowledge in environment and social sustainability.
- To provide the student with the knowledge of strategy to achieve sustainability.
- To familiarize with trends in sustainable operations.
- To create awareness in current sustainable practices in manufacturing industry.

**UNIT – I ECONOMIC SUSTAINABILITY 9**

Industrial Revolution-Economic sustainability: globalization and international issues Sustainability status - Emerging issues- Innovative products- Reconfiguration manufacturing enterprises - Competitive manufacturing strategies - Performance evaluation- Management for sustainability - Assessments of economic sustainability

**UNIT – II SOCIAL AND ENVIRONMENTAL SUSTAINABILITY 9**

Social sustainability – Introduction-Work management -Human rights - Societal commitment - Customers -Business practices -Modelling and assessing social sustainability. Environmental issues pertaining to the manufacturing sector: Pollution - Use of resources -Pressure to reduce costs - Environmental management: Processes that minimize negative environmental impacts - environmental legislation and energy costs - need to reduce the carbon footprint of manufacturing Operations-Modelling and assessing environmental sustainability

**UNIT – III SUSTAINABILITY PRACTICES 9**

Sustainability awareness - Measuring Industry Awareness-Drivers and barriers -Availability of sustainability indicators -Analysis of sustainability practicing -Modeling and assessment of sustainable practicing -Sustainability awareness -Sustainability drivers and barriers - Availability of sustainability indicators- Designing questionnaires- Optimizing Sustainability Indexes-Elements – Cost and time model.

**UNIT – IV MANUFACTURING STRATEGY FOR SUSTAINABILITY 9**

Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs.

**UNIT – V TRENDS IN SUSTAINABLE OPERATIONS 9**

Principles of sustainable operations - Life cycle assessment manufacturing and service activities - influence of product design on operations - Process analysis – Capacity management - Quality management -Inventory management - Just-In-Time systems - Resource efficient design - Consumerism and sustainable well-being.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

CO1: Discuss the importance of economic sustainability.
CO2: Describe the importance of sustainable practices.
CO3: Identify drivers and barriers for the given conditions.
CO4: Formulate strategy in sustainable manufacturing.
CO5: Plan for sustainable operation of industry with environmental, cost consciousness.

**TEXT BOOKS**:

1. Ibrahim Garbie, “Sustainability in Manufacturing Enterprises Concepts, Analyses and Assessments for Industry 4.0”, Springer International Publishing., United States, 2016, ISBN-13: 978-3319293042.
2. Davim J.P., “Sustainable Manufacturing”, John Wiley & Sons., United States, 2010,ISBN: 978-1-848-21212-1.

**REFERENCES:**

1. Jovane F, Ęmper, W.E. and Williams, D.J., “The ManuFuture Road: Towards Competitive and Sustainable High-Adding-Value Manufacturing”, Springer,2009, United States, ISBN 978-3-540-77011-4.
2. Kutz M., “Environmentally Conscious Mechanical Design”, John Wiley & Sons., United States, 2007, ISBN: 978-0-471-72636-4.
3. Seliger G., “Sustainable Manufacturing: Shaping Global Value Creation”, Springer, United States, 2012, ISBN 978-3-642-27289-9.

| **Mapping of COs with POs and PSOs** | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/Pos** | POs | | | | | | | | | | | | PSOs | | |
| **&PSOs** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| **CO1** | 3 | - | 2 | - | - | - | 2 | 2 | - | 1 | 1 | 2 | 2 | 2 | 1 |
| **CO2** | 3 | - | - | - | - | - | 2 | - | - | 1 | 1 | 2 | 1 | 2 | 2 |
| **CO3** | 3 | - | - | - | - | - | 2 | 3 | - | 1 | 1 | 2 | 1 | 2 | 2 |
| **CO4** | 3 | - | 3 | - | - | - | 2 | | - | 1 | 1 | 2 | 2 | 2 | 1 |
| **CO5** | 3 | - | 3 | - | - | - | 2 | 2 | - | 1 | 1 | 2 | 2 | 2 | 1 |
| **CO/PO & PSO Average** | 3 | - | 3 | - | - | - | 2 | 2 | - | 1 | 1 | 2 | 2 | 2 | 1 |
| 1 – Slight, 2 – Moderate, 3 – Substantial | | | | | | | | | | | | | | | |

**AU3791 ELECTRIC AND HYBRID VEHICLES L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

The objective of this course is to prepare the students to know about the general aspects of Electric and Hybrid Vehicles (EHV), including architectures, modelling, sizing, and sub system design and hybrid vehicle control.

**UNIT I DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES 9**

Need for Electric vehicle- Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. - Design requirement for electric vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refuelling Systems.

**UNIT II ENERGY SOURCES 9**

Battery Parameters- - Different types of batteries – Lead Acid- Nickel Metal Hydride - Lithium ion- Sodium based- Metal Air. Battery Modelling - Equivalent circuits, Battery charging- Quick Charging devices. Fuel Cell- Fuel cell Characteristics- Fuel cell types-Half reactions of fuel cell. Ultra capacitors. Battery Management System.

**UNIT III MOTORS AND DRIVES 9**

Types of Motors- DC motors- AC motors, PMSM motors, BLDC motors, Switched reluctance motors working principle, construction and characteristics.

**UNIT IV POWER CONVERTERS AND CONTROLLERS 9**

Solid state Switching elements and characteristics – BJT, MOSFET, IGBT, SCR and TRIAC - Power Converters – rectifiers, inverters and converters - Motor Drives - DC, AC motor, PMSM motors, BLDC motors, Switched reluctance motors – four quadrant operations –operating modes

**UNIT V HYBRID AND ELECTRIC VEHICLES 9**

Main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle - Economy of hybrid Vehicles - Case study on specification of electric and hybrid vehicles.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of this course, the student will be able to

1. Understand the operation and architecture of electric and hybrid vehicles
2. Identify various energy source options like battery and fuel cell
3. Select suitable electric motor for applications in hybrid and electric vehicles.
4. Explain the role of power electronics in hybrid and electric vehicles
5. Analyze the energy and design requirement for hybrid and electric vehicles.

**TEXT BOOKS:**

1. Iqbal Husain, " Electric and Hybrid Vehicles-Design Fundamentals", CRC Press,2003
2. Mehrdad Ehsani, " Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRCPress,2005.

**REFERENCES:**

1. James Larminie and John Lowry, "Electric Vehicle Technology Explained " John Wiley & Sons,2003
2. Lino Guzzella, " Vehicle Propulsion System" Springer Publications,2005
3. Ron HodKinson, "Light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication,2005.

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| **1** | 1 | 1 | 2 | 1 | | 3 | 2 | | | | | 2 | | 1 | 3 |
| **2** | 1 | 1 | 2 | 1 | | 3 | 2 | | | | | 2 | | 1 | 3 |
| **3** | 1 | 1 | 2 | 1 | | 3 | 2 | | | | | 2 | | 1 | 3 |
| **4** | 1 | 1 | 2 | 1 | | 3 | 2 | | | | | 2 | | 1 | 3 |
| **5** | 1 | 1 | 2 | 1 | | 3 | 2 | | | | | 2 | | 1 | 3 |
| **Avg.** | 1 | 1 | 2 | 1 | | 3 | 2 | | | | | 2 | | 1 | 3 |

**OAS352 SPACE ENGINEERING L T P C**

**3 0 0 3**

**OBJECTIVES:**

- Use the standard atmosphere tables and equations.
- Find lift and drag coefficient data from NACA plots.
- Apply the concept of static stability to flight vehicles.
- Describe the concepts of stress, strain, Young's modulus, Poisson's ratio, yield strength.
- Demonstrate a basic knowledge of dynamics relevant to orbital mechanics.

**UNIT I STANDARD ATMOSPHERE 6**

History of aviation – standard atmosphere - pressure, temperature and density altitude.

**UNIT II AERODYNAMICS 10**

Aerodynamic forces – Lift generation Viscosity and its implications - Shear stress in a velocity profile - Lagrangian and Eulerian flow field - Concept of a streamline – Aircraft terminology and geometry - Aircraft types - Lift and drag coefficients using NACA data.

**UNIT III PERFORMANCE AND PROPULSION 9**

Viscous and pressure drag - flow separation - aerodynamic drag - thrust calculations -thrust/power available and thrust/power required.

**UNIT IV AIRCRAFT STABILITY AND STRUCTURAL THEORY 10**

Degrees of freedom of aircraft motions - stable, unstable and neutral stability - concept of static stability - Hooke's Law- brittle and ductile materials - moment of inertia - section modulus.

**UNIT V SPACE APPLICATIONS 10**

History of space research - spacecraft trajectories and basic orbital manoeuvres - six orbital elements - Kepler's laws of orbits - Newtons law of gravitation.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- Illustrate the history of aviation & developments over the years
- Ability to identify the types & classifications of components and control systems
- Explain the basic concepts of flight & Physical properties of Atmosphere
- Identify the types of fuselage and constructions.
- Distinguish the types of Engines and explain the principles of Rocket

**TEXT BOOKS:**

1. John D. Anderson, Introduction to Flight, 8 th Ed., McGraw-Hill Education, New York,2015.
2. E Rathakrishnan, "Introduction to Aerospace Engineering: Basic Principles of Flight", John Wiley, NJ, 2021.
3. Stephen. A. Brandt, " Introduction to Aeronautics: A design perspective " American Institute of Aeronautics & Astronautics,1997.

**REFERENCE:**

1. Kermode, A.C., "Mechanics of Flight", Himalayan Book, 1997.

**OIM351 INDUSTRIAL MANAGEMENT L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- To introduce fundamental concepts of industrial management
- To understand the approaches to the study of Management
- To learn about Decision Making, Organizing and leadership
- To analyze the Managerial Role and functions
- To know about the Supply Chain Management'

**UNIT I INTRODUCTION 9**

Technology Management - Definition - Functions - Evolution of Modern Management - Scientific Management Development of Management Thought. Approaches to the study of Management, Forms of Organization -Individual Ownership - Partnership - Joint Stock Companies - Co-operative Enterprises - Public Sector Undertakings, Corporate Frame Work- Share Holders - Board of

Directors - Committees - Chief Executive Line and Functional Managers,-Financial-Legal-Trade Union

**UNIT II FUNCTIONS OF MANAGEMENT 9**

Planning - Nature and Purpose - Objectives - Strategies – Policies and Planning Premises - Decision Making - Organizing - Nature and Process - Premises - Departmentalization - Line and staff - Decentralization -Organizational culture, Staffing - selection and training .Placement - Performance appraisal - Career Strategy – Organizational Development. Leading - Managing human factor - Leadership .Communication, Controlling - Process of Controlling - Controlling techniques, productivity and operations management - Preventive control, Industrial Safety.

**UNIT III ORGANIZATIONAL BEHAVIOUR 9**

Definition - Organization - Managerial Role and functions -Organizational approaches, Individual behaviour - causes - Environmental Effect - Behaviour and Performance, Perception - Organizational Implications. Personality - Contributing factors - Dimension – Need Theories - Process Theories - Job Satisfaction, Learning and Behaviour-Learning Curves, Work Design and approaches.

**UNIT IV GROUPDYNAMICS 9**

Group Behaviour - Groups - Contributing factors - Group Norms, Communication - Process - Barriers to communication - Effective communication, leadership - formal and informal characteristics – Managerial Grid - Leadership styles - Group Decision Making - Leadership Role in Group Decision, Group Conflicts - Types -Causes - Conflict Resolution -Inter group relations and conflict, Organization centralization and decentralization - Formal and informal - Organizational Structures Organizational Change and Development -Change Process – Resistance to Change - Culture and Ethics.

**UNIT V MODERN CONCEPTS 9**

Management by Objectives (MBO) - Management by Exception (MBE),Strategic Management - Planning for Future direction - SWOT Analysis -Evolving development strategies, information technology in management Decisions support system-Management Games Business Process Re-engineering(BPR) –Enterprises Resource Planning (ERP) - Supply Chain Management (SCM) - Activity Based Management (AM) - Global Perspective - Principles and Steps Advantages and disadvantage

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

CO1: Understand the basic concepts of industrial management
CO2: Identify the group conflicts and its causes.
CO3: Perform swot analysis
CO4 : Analyze the learning curves
CO5 : Understand the placement and performance appraisal

**REFERENCES:**

Maynard H.B, “Industrial Engineering Hand book”, McGraw-Hill, sixth 2008

| CO’s | PO’s | | | | | | | | | | | | PSO’s | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 2 | 1 | | | | | | | | | | | 2 | 1 | |
| 2 | | 3 | 2 | 3 | | | | | | | | | | | 2 |
| 3 | 2 | 3 | 2 | 3 | | | | | | | | | 1 | 2 | 3 |
| 4 | 2 | 2 | 3 | 3 | | | | | | | | | | 3 | 3 |
| 5 | 2 | 2 | | | | | | | | | | | 2 | | |
| AVg. | 2 | 2.2 | 2.3 | 3 | | | | | | | | | 1.8 | 2 | 2.6 |

**OIE354** **QUALITY ENGINEERING** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- Developing a clear knowledge in the basics of various quality concepts.
- Facilitating the students in understanding the application of control charts and its techniques.
- Developing thespecialcontrolproceduresforserviceandprocessorientedindustries.
- Analyzing and understanding the process capability study.
- Developing the acceptance sampling procedures for incoming raw material.

**UNIT I INTRODUCTION** **9**

Quality Dimensions–Quality definitions–Inspection-Quality control–Quality Assurance–Quality planning-Quality costs–Economics of quality– Quality loss function

**UNIT II CONTROLCHARTS** **9**

Chance and assignable causes of process variation, statistical basis of the control chart, control charts for variables- $\bar{X}$ , R and S charts, attribute control charts - p, np, c and u- Construction and application.

**UNIT III SPECIAL CONTROL PROCEDURES** **9**

Warning and modified control limits, control chart for individual measurements, multi-vari chart, *X*chart with a linear trend, chart for moving averages and ranges, cumulative-sum and exponentially weighted moving average control charts.

**UNIT IV STATISTICALPROCESSCONTROL** **9**

Process stability, process capability analysis using a Histogram or probability plots and control chart.Gauge capability studies,setting specification limits.

**UNITV ACCEPTANCESAMPLING** **9**

The acceptance sampling fundamental, OC curve, sampling plans for attributes, simple, double, multiple and sequential, sampling plans for variables,MIL-STD-105DandMIL-STD-414E&IS2500 standards.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Students will be able to:

**CO1**: Control the quality of processes using control charts for variables in manufacturing industries.
**CO2:** Control the occurrence of defective product and the defects in manufacturing companies.
**CO3:** Control the occurrence of defects in services.
**CO4:** Analyzing and understanding the process capability study.
**CO5:** Developing the acceptance sampling procedures for incoming raw material.

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 2 | 3 | 3 | | 3 | | | 1 | 2 | | | 2 | 1 | | |
| 2 | | 3 | 3 | | 3 | 3 | | | 3 | | | 3 | | 2 | |
| 3 | 3 | 3 | 3 | | 3 | | | | 3 | | | 3 | 1 | | |
| 4 | 3 | | 2 | | 3 | | | | | | 1 | | 1 | | |
| 5 | | 2 | | | 3 | | | | 3 | | | 3 | | | 1 |
| AVg. | 2.6 | 2.7 | 2.7 | | 3 | 3 | | 1 | 2.7 | | 1 | 2.7 | 1 | 2 | 1 |

**OSF351 FIRE SAFETY ENGINEERING L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

1:To enable the students to acquire knowledge of Fire and Safety Studies
2:To learn about the effect of fire on materials used for construction, the method of test for non-combustibility & fire resistance
3:To learn about fire area, fire stopped areas and different types of fire-resistant doors
4:To learn about the method of fire protection of structural members and their repair due to fire damage.
5:To develop safety professionals for both technical and management through systematic and quality-based study programmes

**UNIT I INHERENT SAFETY CONCEPTS 9**

Compartment fire-factors controlling fire severity, ventilation controlled and fuel controlled fires; Spread of fire in rooms, within building and between buildings. Effect of temperature on the properties of structural materials- concrete, steel, masonry and wood; Behavior of non-structural materials on fire- plastics, glass, textile fibres and other house hold materials.

**UNIT II PLANT LOCATIONS 9**

Compartment temperature-time response at pre-flashover and post flashover periods; Equivalence of fire severity of compartment fire and furnace fire; Fire resistance test on structural elements-standard heating condition, Indian standard test method, performance criteria.

**UNIT III WORKING CONDITIONS 9**

Fire separation between building- principle of calculation of safe distance. Design principles of fire resistant walls and ceilings; Fire resistant screens- solid screens and water curtains; Local barriers; Fire stopped areas-in roof, in fire areas and in connecting structures; Fire doors- Low combustible, Non-combustible and Spark-proof doors; method of suspension of fire doors; Air-tight sealing of doors;

**UNIT IV FIRE SEVERITY AND REPAIR TECHNIQUES 9**

Fabricated fire proof boards-calcium silicate, Gypsum, Vermiculite, and Perlite boards; Fire protection of structural elements - Wooden, Steel and RCC.. Reparability of fire damaged structures- Assessment of damage to concrete, steel, masonry and timber structures, Repair techniques- repair methods to reinforced concrete Columns, beams and slabs, Repair to steel structural members, Repair to masonry structures.

**UNIT V WORKING AT HEIGHTS 9**

Safe Access - Requirement for Safe Work Platforms- Stairways - Gangways and Ramps-Fall Prevention & Fall Protection - Safety Belts - Safety nets - Fall Arrestors- Working on Fragile Roofs - Work Permit Systems-Accident Case Studies.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES**

On completion of the course the student will be able to

**CO1**:Understand the effect of fire on materials used for construction
**CO2**:Understand the method of test for non-combustibility and fire resistance; and will be able to select different structural elements and their dimensions for a particular fire resistance rating of a building.
**CO3**:To understand the design concept of fire walls, fire screens, local barriers and fire doors and able to select them appropriately to prevent fire spread.
**CO4**:To decide the method of fire protection to RCC, steel, and wooden structural elements and their repair methods if damaged due to fire.
**CO5**:Describe the safety techniques and improve the analytical and intelligence to take the right decision at right time.

**TEXT BOOKS**

1. Roytman, M. Y,"Principles of fire safety standards for building construction". Amerind Publishing Co. Pvt. Ltd., New Delhi,1975
2. John A. Purkiss,"Fire safety engineering design of structures" (2nd edn.), Butterworth Heinemann, Oxford, UK,2009.

**REFERENCES:**

3. Smith, E.E. and Harmathy, T.Z. (Editors),"Design of buildings for fire safety". ASTM Special Publication 685, American Society for Testing and Materials, Boston, U.S.A,1979.
4. Butcher, E. G. and Parnell, A. C, "Designing of fire safety". JohnWiley and Sons Ltd., New York, U.S.A.1983.
5. Jain, V.K,"Fire safety in buildings" (2nd edn.). New Age International(P) Ltd., New Delhi,2010. 4. Hazop&Hazan,"Identifying and Assessing Process Industry Hazards", Fourth Edition ,1999
6. Frank R. Spellman, Nancy E. Whiting,"The Handbook of Safety Engineering: Principles and Applications", 2009

**CO's- PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| **1** | 2 | - | 1 | - | - | 1 | - | - | - | - | - | - | - | - | - |
| **2** | - | - | 3 | - | - | - | - | - | - | - | - | - | - | - | - |
| **3** | 1 | - | 2 | - | - | - | 3 | - | - | 1 | - | - | - | - | - |
| **4** | - | - | - | - | - | 1 | 1 | - | - | - | - | - | - | - | - |
| **5** | 2 | - | 1 | - | - | 1 | 1 | 1 | - | 1 | - | 1 | - | - | - |
| **AVg.** | 1.3 | - | 1.75 | - | - | 1 | 1.3 | 1 | | 1 | - | 1 | - | - | - |

**OMR351 MECHATRONICS**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

1. Selecting sensors to develop mechatronics systems.
2. Explaining the architecture and timing diagram of microprocessor, and also interpret and develop programs.
3. Designing appropriate interfacing circuits to connect I/O devices with microprocessor.
4. Applying PLC as a controller in mechatronics system.
5. Designing and develop the apt mechatronics system for an application.

**UNIT – I INTRODUCTION AND SENSORS 9**

Introduction to Mechatronics – Systems – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers: Static and Dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance Sensors – Strain Gauges – Eddy Current Sensor – Hall Effect Sensor –Temperature Sensors – Light Sensors.

**UNIT – II 8085 MICROPROCESSOR 9**

Introduction – Pin Configuration - Architecture of 8085 – Addressing Modes – Instruction set, Timing diagram of 8085.

**UNIT – III PROGRAMMABLE PERIPHERAL INTERFACE 9**

Introduction – Architecture of 8255, Keyboard Interfacing, LED display – Interfacing, ADC and DAC Interface, Temperature Control – Stepper Motor Control – Traffic Control Interface.

**UNIT – IV PROGRAMMABLE LOGIC CONTROLLER 9**

Introduction – Architecture – Input / Output Processing – Programming with Timers, Counters and Internal relays – Data Handling – Selection of PLC.

**UNIT – V ACTUATORS AND MECHATRONICS SYSTEM DESIGN 9**

Types of Stepper and Servo motors – Construction – Working Principle – Characteristics, Stages of Mechatronics Design Process – Comparison of Traditional and Mechatronics Design Concepts with Examples – Case studies of Mechatronics Systems – Pick and Place Robot – Engine Management system – Automatic Car Park Barrier.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

CO1: Select sensors to develop mechatronics systems.

CO2: Explain the architecture and timing diagram of microprocessor, and also interpret and develop programs.

CO3: Design appropriate interfacing circuits to connect I/O devices with microprocessor.

CO 4: Apply PLC as a controller in mechatronics system.

CO 5: Design and develop the apt mechatronics system for an application.

| Mapping of COs with POs and PSOs | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs & PSOs** | **POs** | | | | | | | | | | | | **PSOs** | | |
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** |
| CO1 | 3 | 2 | 1 | 3 | | 2 | | | | | | 2 | 3 | 2 | 3 |
| CO2 | 3 | 2 | 1 | 3 | | 2 | | | | | | 2 | 3 | 2 | 3 |
| CO3 | 3 | 2 | 1 | 3 | | 2 | | | | | | 2 | 3 | 2 | 3 |
| CO4 | 3 | 2 | 1 | 3 | | 2 | | | | | | 2 | 3 | 2 | 3 |
| CO5 | 3 | 2 | 1 | 3 | | 2 | | | | | | 2 | 3 | 2 | 3 |
| CO/PO & PSO Average | 3 | 2 | 1 | 3 | | 2 | | | | | | 2 | 3 | 2 | 3 |
| 1 – Slight, 2 – Moderate, 3 – Substantial | | | | | | | | | | | | | | | |

**TEXT BOOKS**


1. Bolton W., “Mechatronics”, Pearson Education, 6th Edition, 2015.
2. Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, Penram International Publishing Private Limited, 6th Edition, 2013.


**REFERENCES**


1. Bradley D.A., Dawson D., Buru N.C. and Loader A.J., “Mechatronics”, Chapman and Hall, 1993.
2. Davis G. Alciatore and Michael B. Histand, “Introduction to Mechatronics and Measurement systems”, McGraw Hill Education, 2011.
3. Devadas Shetty and Richard A. Kolk, “Mechatronics Systems Design”, Cengage Learning, 2010.
4. Nitaigour Premchand Mahalik, “Mechatronics Principles, Concepts and Applications”, McGraw Hill Education, 2015.
5. Smaili. A and Mrad. F, “Mechatronics Integrated Technologies for Intelligent Machines”, Oxford University Press, 2007.

| ORA351 | FOUNDATION OF ROBOTICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

1. To study the kinematics, drive systems and programming of robots.
2. To study the basics of robot laws and transmission systems.
3. To familiarize students with the concepts and techniques of robot manipulator, its kinematics.
4. To familiarize students with the various Programming and Machine Vision application in robots.
5. To build confidence among students to evaluate, choose and incorporate robots in engineering systems.

**UNIT – I FUNDAMENTALS OF ROBOT 9**

Robot – Definition – Robot Anatomy – Co-ordinate systems, Work Envelope, types and classification – specifications – Pitch, yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Robot Parts and their functions – Need for Robots – Different Applications.

**UNIT – II ROBOT KINEMATICS 9**

Forward kinematics, inverse kinematics and the difference: forward kinematics and inverse Kinematics of Manipulators with two, three degrees of freedom (in 2 dimensional), four degrees of freedom (in 3 dimensional) – derivations and problems. Homogeneous transformation matrices, translation and rotation matrices.

**UNIT – III ROBOT DRIVE SYSTEMS AND END EFFECTORS 9**

Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications and Comparison of All These Drives. End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic grippers, vacuum grippers, internal grippers and external grippers, selection and design considerations of a gripper

**UNIT – IV SENSORS IN ROBOTICS 9**

Force sensors, touch and tactile sensors, proximity sensors, non-contact sensors, safety considerations in robotic cell, proximity sensors, fail safe hazard sensor systems, and compliance mechanism. Machine vision system - camera, frame grabber, sensing and digitizing image data – signal conversion, image storage, lighting techniques, image processing and analysis – data reduction, segmentation, feature extraction, object recognition, other algorithms, applications – Inspection, identification, visual serving and navigation.

**UNIT – V PROGRAMMING AND APPLICATIONS OF ROBOT 9**

Teach pendant programming, lead through programming, robot programming languages – VAL programming – Motion Commands, Sensors commands, End-Effector Commands, and simple programs - Role of robots in inspection, assembly, material handling, underwater, space and medical fields.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES**

At the end of the course, students will be able to:

CO1: Interpret the features of robots and technology involved in the control.

CO2: Apply the basic engineering knowledge and laws for the design of robotics.

CO3: Explain the basic concepts like various configurations, classification and parts of end effectors compare various end effectors and grippers and tools and sensors used in robots.

CO4: Explain the concept of kinematics, degeneracy, dexterity and trajectory planning.

CO5: Demonstrate the image processing and image analysis techniques by machine vision system.

| Mapping of COs with POs and PSOs | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs&PSOs** | **POs** | | | | | | | | | | | | **PSOs** | | |
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** |
| CO1 | 3 | 2 | 1 | 1 | | | | | | | | 1 | | | 3 |
| CO2 | 3 | 2 | 1 | 1 | | | | | | | | 1 | | | 3 |
| CO3 | 3 | 2 | 1 | 1 | | | | | | | | 1 | | | 3 |
| CO4 | 3 | 2 | 1 | 1 | | | | | | | | 1 | | | 3 |
| CO5 | 3 | 2 | 1 | 1 | | | | | | | | 1 | | | 3 |
| CO/PO & PSO Average | | | | | | | | | | | | | | | |
| 1 – Slight, 2 – Moderate, 3 – Substantial | | | | | | | | | | | | | | | |

**TEXT BOOKS:**

1. Ganesh.S.Hedge,"A textbook of Industrial Robotics", Lakshmi Publications, 2006.
2. Mikell.P.Groover , "Industrial Robotics – Technology, Programming and applications" McGraw Hill 2ND edition 2012.

**REFERENCES**:

1. Fu K.S. Gonalz R.C. and ice C.S.G."Robotics Control, Sensing, Vision and Intelligence", McGraw Hill book co. 2007.
2. YoramKoren, "Robotics for Engineers", McGraw Hill Book, Co., 2002.
3. Janakiraman P.A., "Robotics and Image Processing", Tata McGraw Hill 2005.
4. John. J.Craig, "Introduction to Robotics: Mechanics and Control" 2nd Edition, 2002.
5. Jazar, "Theory of Applied Robotics: Kinematics, Dynamics and Control", Springer India reprint, 2010.

**OAE352 FUNDAMENTALS OF AERONAUTICAL ENGINEERING L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To acquire the knowledge on the Historical evaluation of Airplanes
- To learn the different component systems and functions
- To know the concepts of basic properties and principles behind the flight
- To learn the basics of different structures & construction
- To learn the various types of power plants used in aircrafts

**UNIT I HISTORY OF FLIGHT 8**

Balloon flight-ornithopter-Early Airplanes by Wright Brothers, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years.

**UNIT II AIRCRAFT CONFIGURATIONS AND ITS CONTROLS 10**

Different types of flight vehicles, classifications-Components of an airplane and their functions-Conventional control, powered control- Basic instruments for flying-Typical systems for control actuation.

**UNIT III BASICS OF AERODYNAMICS 9**

Physical Properties and structures of the Atmosphere, Temperature, pressure and altitude relationships, Newton's Law of Motions applied to Aeronautics-Evolution of lift, drag and moment. Aerofoils, Mach number, Maneuvers.

**UNIT IV BASICS OF AIRCRAFT STRUCTURES 9**

General types of construction, Monocoque, semi-monocoque and geodesic constructions, typical wing and fuselage structure. Metallic and non-metallic materials. Use of Aluminium alloy, titanium, stainless steel and composite materials. Stresses and strains-Hooke's law- stress-strain diagrams-elastic constants-Factor of Safety.

**UNIT V BASICS OF PROPULSION 9**

Basic ideas about piston, turboprop and jet engines – use of propeller and jets for thrust production- Comparative merits, Principle of operation of rocket, types of rocket and typical applications, Exploration into space.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- Illustrate the history of aircraft & developments over the years
- Ability to identify the types & classifications of components and control systems
- Explain the basic concepts of flight & Physical properties of Atmosphere
- Identify the types of fuselage and constructions.
- Distinguish the types of Engines and explain the principles of Rocket

**TEXT BOOKS**

**1.** Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition , 2015
2. E Rathakrishnan, "Introduction to Aerospace Engineering: Basic Principles of Flight", John Wiley, NJ, 2021
3. Stephen.A. Brandt, Introduction to aeronautics: A design perspective, 2nd edition, AIAA Education Series, 2004.

**REFERENCE**

1. SADHU SINGH, "INTERNAL COMBUSTION ENGINES AND GAS TURBINE"-, SS Kataraia & sons, 2015
2. KERMODE , "FLIGHT WITHOUT FORMULAE", -, Pitman; 4th Revised edition 1989

**OGI351 REMOTE SENSING CONCEPTS L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To introduce the concepts of remote sensing processes and its components.
- To expose the various remote sensing platforms and sensors and to introduce the elements of data interpretation

**UNIT I REMOTE SENSING AND ELECTROMAGNETIC RADIATION 9**

Definition – components of RS – History of Remote Sensing – Merits and demerits of data collation between conventional and remote sensing methods - Electromagnetic Spectrum – Radiation principles - Wave theory, Planck's law, Wien's Displacement Law, Stefan's Boltzmann law, Kirchoff's law – Radiation sources: active & passive - Radiation Quantities

**UNIT II EMR INTERACTION WITH ATMOSPHERE AND EARTH MATERIAL 9**

Standard atmospheric profile – main atmospheric regions and its characteristics – interaction of radiation with atmosphere – Scattering, absorption and refraction – Atmospheric windows - Energy balance equation – Specular and diffuse reflectors – Spectral reflectance & emittance – Spectroradiometer – Spectral Signature concepts – Typical spectral reflectance curves for vegetation, soil and water – solid surface scattering in microwave region.

**UNIT III ORBITS AND PLATFORMS 9**

Motions of planets and satellites – Newton's law of gravitation - Gravitational field and potential - Escape velocity - Kepler's law of planetary motion - Orbit elements and types – Orbital perturbations and maneuvers – Types of remote sensing platforms - Ground based, Airborne platforms and Space borne platforms – Classification of satellites – Sun synchronous and Geosynchronous satellites – Lagrange Orbit.

**UNIT IV SENSING TECHNIQUES 9**

Classification of remote sensors – Resolution concept : spatial, spectral, radiometric and temporal resolutions - Scanners - Along and across track scanners – Optical-infrared sensors – Thermal sensors – microwave sensors – Calibration of sensors - High Resolution Sensors - LIDAR , UAV – Orbital and sensor characteristics of live Indian earth observation satellites

**UNIT V DATA PRODUCTS AND INTERPRETATION 9**

Photographic and digital products – Types, levels and open source satellite data products –- selection and procurement of data– Visual interpretation: basic elements and interpretation keys - Digital interpretation – Concepts of Image rectification, Image enhancement and Image classification

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course, the student is expected to

**CO 1** Understand the concepts and laws related to remote sensing
**CO 2** Understand the interaction of electromagnetic radiation with atmosphere and earth material
**CO 3** Acquire knowledge about satellite orbits and different types of satellites
**CO 4** Understand the different types of remote sensors
**CO 5** Gain knowledge about the concepts of interpretation of satellite imagery

**TEXTBOOKS:**


1. Thomas M.Lillesand, Ralph W. Kiefer and Jonathan W. Chipman, Remote Sensing and Image interpretation, John Wiley and Sons, Inc, New York,2015.
2. George Joseph and C Jeganathan, Fundamentals of Remote Sensing,Third Edition Universities Press (India) Private limited, Hyderabad, 2018


**REFERENCES:**


1. Janza, F.Z., Blue H.M. and Johnson,J.E. Manual of Remote Sensing. Vol.1, American Society of Photogrametry, Virginia, USA, 2002.
2. Verbyla, David, Satellite Remote Sensing of Natural Resources. CRC Press, 1995
3. Paul Curran P.J. Principles of Remote Sensing. Longman, RLBS, 1988.
4. Introduction to Physics and Techniques of Remote Sensing , Charles Elachi and Jacob Van Zyl, 2006 Edition II, Wiley Publication.
5. Basudeb Bhatta, Remote Sensing and GIS, Oxford University Press, 2011


**CO-PO MAPPING**

| PO | Graduate Attribute | Course Outcome | | | | | Average |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| PO1 | Engineering Knowledge | 3 | 3 | 3 | 3 | 3 | 3 |
| PO2 | Problem Analysis | | | | 3 | 3 | 3 |
| PO3 | Design/Development of Solutions | | | | 3 | 3 | 3 |
| PO4 | Conduct Investigations of Complex Problems | | | | 3 | 3 | 3 |
| PO5 | Modern Tool Usage | | | | 3 | 3 | 3 |
| PO6 | The Engineer and Society | | | | | | |
| PO 7 | Environment and Sustainability | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| PO 8 | Ethics | | | | | | |
| PO 9 | Individual and Team Work | | | | | | |
| PO 10 | Communication | | | | | | |
| PO 11 | Project Management and Finance | | | | | | |
| PO 12 | Life-long Learning | 3 | | 3 | 3 | 3 | 3 |
| PSO 1 | Knowledge of Geoinformatics discipline | 3 | 3 | 3 | 3 | 3 | 3 |
| PSO 2 | Critical analysis of Geoinformatics Engineering problems and innovations | 3 | 3 | 3 | 3 | 3 | 3 |
| PSO 3 | Conceptualization and evaluation of Design solutions | 3 | 3 | 3 | 3 | 3 | 3 |

**OAI351 URBAN AGRICULTURE L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To introduce the students the principles of agricultural crop production and the production practices of crops in modern ways.
- To delineate the role of agricultural engineers in relation to various crop production practices.

**UNIT I INTRODUCTION 9**

Benefits of urban agriculture- economic benefits, environmental benefits, social and cultural benefits, educational, skill-building and job training benefits, health, nutrition and food accessibility benefits.

**UNIT II VERTICAL FARMING 9**

Vertical farming- types, green facade, living/green wall-modular green wall **,** vegetated mat wall**-** Structures and components for green wall system: plant selection, growing media, irrigation and plant nutrition: Design, light, benefits of vertical gardening. Roof garden and its types. Kitchen garden, hanging baskets**:** The house plants/ indoor plants

**UNIT III SOIL LESS CULTIVATION 9**

Hydroponics, aeroponics, aquaponics: merits and limitations, costs and Challenges, backyard gardens- tactical gardens- street landscaping- forest gardening, greenhouses, urban beekeeping

**UNIT IV MODERN CONCEPTS 9**

Growth of plants in vertical pipes in terraces and inside buildings, micro irrigation concepts suitable for roof top gardening, rain hose system, Green house, polyhouse and shade net system of crop production on roof tops

**UNIT V WASTE MANAGEMENT 9**

Concept, scope and maintenance of waste management- **recycle of organic waste, garden wastes- solid waste management-scope,** microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues, waste utilization.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

1. Demonstrate the principles behind crop production and various parameters that influences the crop growth on roof tops
2. Explain different methods of crop production on roof tops
3. Explain nutrient and pest management for crop production on roof tops
4. Illustrate crop water requirement and irrigation water management on roof tops

5. Explain the concept of waste management on roof tops

**TEXT BOOKS:**

1. Martellozzo F and J S Landry. 2020. Urban Agriculture. Scitus Academics Llc.
2. Rob Roggema. 2016. Sustainable Urban Agriculture and Food Planning. Routledge Taylor and Francis Group.
3. Akrong M O. 2012. Urban Agriculture. LAP Lambert Academic Publishing.

**REFERENCES:**

1. Agha Rokh A. 2008. Evaluation of ornamental flowers and fishes breeding in Bushehr urban wastewater using a pilot-scale aquaponic system. Water and Wastewater, 19 (65): 47–53.
2. Agrawal M, Singh B, Rajput M, Marshall F and Bell J. N. B. 2003. Effect of air pollution on peri-urban agriculture: A case study. Environmental Pollution, 126 (3): 323–329. https://www.sciencedirect.com/science/article/pii/S0269749103002458#aep-section-id24.
3. Jac Smit and Joe Nasr. 1992. Urban agriculture for sustainable cities: using wastes and idle land and water bodies as resources. Environment and Urbanization, 4 (2):141-152.

**CO-PO MAPPING**

| **PO/PSO** | | **CO1** | **CO2** | **CO3** | **CO4** | **CO5** | **Overall correlation of COs with POs** |
|---|---|---|---|---|---|---|---|
| PO1 | Engineering Knowledge | 1 | 2 | 1 | 1 | 2 | 1 |
| PO2 | Problem Analysis | 1 | 1 | 1 | 1 | 1 | 2 |
| PO3 | Design/ Development of Solutions | 1 | 2 | 1 | 1 | 3 | 2 |
| PO4 | Conduct Investigations of Complex Problems | 1 | 1 | 2 | 2 | 1 | 1 |
| PO5 | Modern Tool Usage | 1 | 2 | 1 | 1 | 1 | 2 |
| PO6 | The Engineer and Society | 1 | 2 | 1 | 2 | 1 | 1 |
| PO7 | Environment and sustainability | 1 | 2 | 1 | 1 | 2 | 1 |
| PO8 | Ethics | 2 | 1 | 1 | 1 | 2 | 1 |
| PO9 | Individual and team work: | 1 | 1 | 2 | 1 | 1 | 1 |
| PO10 | Communication | 1 | 2 | 1 | 1 | 2 | 1 |
| PO11 | Project management and finance | 1 | 1 | 1 | 1 | 1 | 2 |
| PO12 | Life-long learning: | 1 | 2 | 1 | 1 | 3 | 2 |
| PSO1 | To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill | 1 | 2 | 1 | 1 | 2 | 1 |
| PSO2 | To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies. | 2 | 1 | 2 | 1 | 1 | 1 |
| PSO3 | To inculcate entrepreneurial skills through strong Industry-Institution linkage. | 1 | 2 | 1 | 2 | 1 | 2 |

**OEN351 DRINKING WATER SUPPLY AND TREATMENT L T P C**

**3 0 0 3**

**OBJECTIVE:**

- To equip the students with the principles and design of water treatment units and distribution system.

**UNIT I SOURCES OF WATER 9**

Public water supply system – Planning, Objectives, Design period, Population forecasting; Water demand – Sources of water and their characteristics, Surface and Groundwater – Impounding Reservoir – Development and selection of source – Source Water quality – Characterization – Significance – Drinking Water quality standards.

**UNIT II CONVEYANCE FROM THE SOURCE 9**

Water supply – intake structures – Functions; Pipes and conduits for water – Pipe materials – Hydraulics of flow in pipes – Transmission main design – Laying, jointing and testing of pipes – appurtenances – Types and capacity of pumps – Selection of pumps and pipe materials.

**UNIT III WATER TREATMENT 9**

Objectives – Unit operations and processes – Principles, functions, and design of water treatment plant units, aerators of flash mixers, Coagulation and flocculation –- sand filters - Disinfection –- Construction, Operation and Maintenance aspects.

**UNIT IV ADVANCED WATER TREATMENT 9**

Water softening – Desalination- R.O. Plant – demineralization – Adsorption - Ion exchange- Membrane Systems - Iron and Manganese removal - Defluoridation - Construction and Operation and Maintenance aspects

**UNIT V WATER DISTRIBUTION AND SUPPLY 9**

Requirements of water distribution – Components – Selection of pipe material – Service reservoirs - Functions – Network design – Economics - Computer applications – Appurtenances – Leak detection - Principles of design of water supply in buildings – House service connection – Fixtures and fittings, systems of plumbing and types of plumbing.

**TOTAL: 45 PERIODS**

OUTCOMES

CO1: an understanding of water quality criteria and standards, and their relation to public health

CO2: the ability to design the water conveyance system

CO3: the knowledge in various unit operations and processes in water treatment

CO4: an ability to understand the various systems for advanced water treatment

CO5: an insight into the structure of drinking water distribution system

**TEXTBOOKS :**


1. Garg. S.K., "Water Supply Engineering", Khanna Publishers, Delhi, September 2008.
2. Punmia B.C, Arun K.Jain, Ashok K.Jain, " Water supply Engineering" Lakshmi publication private limited, New Delhi, 2016.
3. Rangwala "Water Supply and Sanitary Engineering", February 2022
4. Birdie.G.S., "Water Supply and Sanitary Engineering", Dhanpat Rai and sons, 2018.


**REFERENCES :**


1. Fair. G.M., Geyer.J.C., "Water Supply and Wastewater Disposal", John Wiley and Sons, 1954.
2. Babbit.H.E, and Donald.J.J, "Water Supply Engineering" , McGraw Hill book Co, 1984.
3. Steel. E.W.et al., "Water Supply Engineering" , Mc Graw Hill International book Co, 1984.

4. Duggal. K.N., “Elememts of public Health Engineering”, S.Chand and Company Ltd, New Delhi, 1998.

**CO’s- PO’s & PSO’s MAPPING**

| CO’s | PO’s | | | | | | | | | | | | PSO’s | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | | 3 | | | | | | 3 | | 3 | | | 3 | | |
| 2 | | 3 | | 2 | | 2 | | | | 3 | | | 3 | | |
| 3 | | | | 2 | | 2 | | | | 3 | | | 3 | | |
| 4 | | | 3 | 2 | | | | 3 | 2 | 3 | | | 3 | | |
| 5 | | | 3 | 2 | | | 1 | | 2 | 3 | | 1 | | | |
| Avg. | | 3 | 3 | 2 | | 2 | 1 | 3 | 2 | 3 | | 1 | 3 | | |

**1.low, 2-medium, 3-high, ‘-“- no correlation**
**Note: The average value of this course to be used for program articulation matrix.**

**OEE352 ELECTRIC VEHICLE TECHNOLOGY L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- To provide knowledge about electric machines and special machine
- To understand the basics of power converters
- To know the concepts of controlling DC and AC drive systems
- To understand the architecture and power train components.
- To impart knowledge on vehicle control for standard drive cycles of hybrid electrical vehicles (HEVs)

**UNIT I ROTATING POWER CONVERTERS 9**

Magnetic circuits- DC machine and AC machine –Working principle of Generator and Motor-DC and AC - Voltage and torque equations – Characteristics and applications. Working principle of special machines like: Brushless DC motor, Switched reluctance motor and PMSM.

**UNIT II STATIC POWER CONVERTERS 9**

Working and Characteristics of Power Diodes, MOSFET and IGBT. Working of uncontrolled rectifiers, controlled rectifiers (Single phase and Three phase), DC choppers, single and three phase inverters, Multilevel inverters and Matrix Converters.

**UNIT III CONTROL OF DC AND AC MOTOR DRIVES 9**

Speed control for constant torque, constant HP operation of all electric motors - DC/DC chopper based four quadrant operation of DC motor drives, inverter based V/f Operation (motoring and braking) of induction motor drives, Transformation theory, vector control operation of Induction motor and PMSM, Brushless DC motor drives, Switched reluctance motor (SRM) drives

**UNIT IV HYBRID ELECTRIC VEHICLE ARCHITECTURE AND POWER TRAIN COMPONENTS 9**

History of evolution of Electric Vehicles - Comparison of Electric Vehicles with Internal Combustion Engines - Architecture of Electric Vehicles (EV) and Hybrid Electric Vehicles (HEV) – Plug-in Hybrid Electric Vehicles (PHEV)- Power train components and sizing, Gears, Clutches, Transmission and Brakes.

**UNIT V MECHANICS OF HYBRID ELECTRIC VEHICLES AND CONTROL OF VEHICLES** **9**

Fundamentals of vehicle mechanics - tractive force, power and energy requirements for standard drive cycles of HEV's - motor torque and power rating and battery capacity. HEV supervisory control - Selection of modes - power spilt mode - parallel mode - engine brake mode - regeneration mode - series parallel mode

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

CO1: Able to understand the principles of conventional and special electrical machines.
CO2: Acquired the concepts of power devices and power converters
CO3: Able to understand the control for DC and AC drive systems.
CO4: Learned the electric vehicle architecture and power train components.
CO5: Acquired the knowledge of mechanics of electric vehicles and control of electric vehicles.

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | 3 | | | | | | | | 3 | 3 | 3 |
| **CO2** | 3 | 2 | 2 | | | 3 | | | 3 | | | | 3 | 3 | 3 |
| **CO3** | 3 | | | 3 | | 2 | 2 | | | | | | 3 | 3 | 3 |
| **CO4** | 3 | 2 | 2 | | 3 | | | | | | | | 3 | 3 | 3 |
| **CO5** | 3 | | 2 | | | | | | | | 2 | | 3 | 3 | 3 |
| **Avg** | 3 | 2 | 2 | 3 | 3 | 1 | 2 | | 3 | | 2 | | 3 | 3 | 3 |

**REFERENCES:**


1 Stephen D. Umans, “Fitzgerald & Kingsley’s Electric Machinery”, Tata McGraw Hill, 7th Edition, 2020.
2 Bogdan M. Wilamowski, J. David Irwin, The Industrial Electronics Handbook, Second Edition, Power Electronics and Motor Drives, CRC Press, 2011
3 Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven D. Pekarek “Analysis of Electric Machinery and Drive Systems”, 3rd Edition, Wiley-IEEE Press, 2013.
4 Rashid M.H., “Power Electronics Circuits, Devices and Applications ", Pearson, fourth Edition, 10th Impression 2021.
5 Iqbal Husain, ‘Electric and Hybrid Electric Vehicles’, CRC Press, 2021.
6 Wei Liu, ‘Hybrid Electric Vehicle System Modeling and Control’, Second Edition, WILEY, 2017
7 James Larminie and John Lowry, ‘Electric Vehicle Technology Explained’, Second Edition, Wiley, 2012


**OEI353 INTRODUCTION TO PLC PROGRAMMING** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

1. Understand basic PLC terminologies digital principles, PLC architecture and operation.
2. Familiarize different programming language of PLC.
3. Develop PLC logic for simple applications using ladder logic.
4. Understand the hardware and software behind PLC and SCADA.
5. Exposures about communication architecture of PLC/SCADA.

**UNIT I INTRODUCTION TO PLC 9**

Introduction to PLC: Microprocessor, I/O Ports, Isolation, Filters, Drivers, Microcontrollers/DSP, PLC/DDC- PLC Construction: What is a PLC, PLC Memories, PLC I/O, , PLC Special I/O, PLC Types.

**UNIT II PLC INSTRUCTIONS 9**

PLC Basic Instructions: PLC Ladder Language- Function block Programming- Ladder/Function Block functions- PLC Basic Instructions, Basic Examples (Start Stop Rung, Entry/Reset Rung)- Configuration of Sensors, Switches, Solid State Relays-Interlock examples- Timers, Counters, Examples.

**UNIT III PLC PROGRAMMING 9**

Different types of PLC program, Basic Ladder logic, logic functions, PLC module addressing, registers basics, basic relay instructions, Latching Relays, arithmetic functions, comparison functions, data handling, data move functions, timer-counter instructions, input-output instructions, sequencer instructions

**UNIT IV COMMUNICATION OF PLC AND SCADA 9**

Communication Protocol – Modbus, HART, Profibus- Communication facilities SCADA: - Hardware and software, Remote terminal units, Master Station and Communication architectures

**UNIT V CASE STUDIES 9**

Stepper Motor Control- Elevator Control-CNC Machine Control- conveyor control-Interlocking Problems

**TOTAL: 45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 5**

1. Market survey of the recent PLCs and comparison of their features.
2. Summarize the PLC standards
3. Familiarization of any one programming language (Ladder diagram/ Sequential Function Chart/ Function Block Diagram/ Equivalent open source software)
4. Market survey of Communication Network Used for PLC/SCADA.

**COURSE OUTCOMES:**

**CO1** Know the basic requirement of a PLC input/output devices and architecture. (L1)
**CO2** Ability to apply Basics Instruction Sets used for ladder Logic and Function Block Programming.(L2)
**CO3** Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function BIock.(L3)
**CO4** Able to develop a PLC logic for a specific application on real world problem. (L5)
**CO5** Ability to Understand the Concepts of Communication used for PLC/SCADA.(L1)

**TEXT BOOKS:**

1. Frank Petruzzula, Programmable Logic Controllers, Tata Mc-Graw Hill Edition
2. John W. Webb, Ronald A. Reis, Programmable Logic Controllers Principles and Applications, PHI publication

**REFERENCES:**

1. MadhuchanndMitra and SamerjitSengupta, Programmable Logic Controllers Industrial Automation an Introduction, Penram International Publishing Pvt. Ltd.
2. J. R. Hackworth and F. D. Hackworth, Programmable Logic Controllers Principles andApplications, Pearson publication

**List of Open Source Software/ Learning website:**

1. https://nptel.ac.in/courses/108105063
2. https://www.electrical4u.com/industrial-automation/
3. https://www.etf.ues.rs.ba/~slubura/Procesni%20racunari/Programmable%20Logic%20Controllers%20Programming%20Methods.pdf
4. https://www.electrical4u.com/industrial-automation/

**MAPPING COURSE OUTCOMES WITH PROGRAMME OUTCOMES**

| PO, PSO CO | PO 01 | PO 02 | PO 03 | PO 04 | PO 05 | PO 06 | PO 07 | PO 08 | PO 09 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | | | | | 1 | | 1 | | | | | |
| **CO2** | 3 | 3 | 2 | | | | | 1 | | 1 | 2 | | | | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 1 | | | 1 | | 1 | | | | | |
| **CO4** | 3 | 3 | | 3 | 3 | | | 1 | | 1 | | | 3 | 3 | |
| **CO5** | 3 | 3 | 3 | 2 | 1 | | | 1 | | 1 | | | 3 | 3 | 3 |
| **Avg** | 3 | 2.9 | 2.25 | 2.6 | 1.6 | | | 1 | | 1 | | | 3 | 3 | 2.9 |

**OFD352 TRADITIONAL INDIAN FOODS L T P C**
**3 0 0 3**

**OBJECTIVE:**

- To help students acquire a sound knowledge on diversities of foods, food habits and patterns in India with focus on traditional foods.

**UNIT I HISTORICAL AND CULTURAL PERSPECTIVES 9**

Food production and accessibility - subsistence foraging, horticulture, agriculture and pastoralization, origin of agriculture, earliest crops grown. Food as source of physical sustenance, food as religious and cultural symbols; importance of food in understanding human culture - variability, diversity, from basic ingredients to food preparation; impact of customs and traditions on food habits, heterogeneity within cultures (social groups) and specific social contexts - festive occasions, specific religious festivals, mourning etc. Kosher, Halal foods; foods for religious and other fasts.

**UNIT II TRADITIONAL METHODS OF FOOD PROCESSING 9**

Traditional methods of milling grains – rice, wheat and corn – equipments and processes as compared to modern methods. Equipments and processes for edible oil extraction, paneer, butter and ghee manufacture – comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons. Traditional methods of food preservation – sundrying, osmotic drying, brining, pickling and smoking.

**UNIT III TRADITIONAL FOOD PATTERNS 9**

Typical breakfast, meal and snack foods of different regions of India.Regional foods that have gone Pan Indian / Global. Popular regional foods; Traditional fermented foods,pickles and preserves, beverages, snacks, desserts and sweets, street foods; IPR issues in traditional foods

**UNIT IV COMMERCIAL PRODUCTION OF TRADITIONAL FOODS 9**

Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods – types marketed, turnover; role of SHGs, SMES industries, national and multinational

companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods – ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters.

**UNIT V HEALTH ASPECTS OF TRADIONAL FOODS 9**

Comparison of traditional foods with typical fast foods / junk foods – cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments /illnesses.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

CO1To understand the historical and traditional perspective of foods and food habits

CO2 To understand the wide diversity and common features of traditional Indian foods and meal patterns.

**TEXT BOOKS:**

1. Sen, Colleen Taylor “Food Culture in India” Greenwood Press, 2005.
2. Davidar, Ruth N. “Indian Food Science: A Health and Nutrition Guide to Traditional Recipes: East West Books, 2001.

**OFD353 INTRODUCTION TO FOOD PROCESSING L T P C**
**3 0 0 3**

**OBJECTIVE:**

- The course aims to introduce the students to the area of Food Processing. This is necessary for effective understanding of a detailed study of food processing and technology subjects. This course will enable students to appreciate the importance of food processing with respect to the producer, manufacturer and consumer.

**UNIT I PROCESSING OF FOOD AND ITS IMPORTANCE 9**

Source of food - plant, animal and microbial origin; different foods and groups of foods as raw materials for processing – cereals, pulses, grains, vegetables and fruits, milk and animal foods, sea weeds, algae, oil seeds & fats, sugars, tea, coffee, cocoa, spices and condiments, additives; need and significance of processing these foods.

**UNIT II METHODS OF FOOD HANDLING AND STORAGE 9**

Nature of harvested crop, plant and animal; storage of raw materials and products using low temperature, refrigerated gas storage of foods, gas packed refrigerated foods, sub atmospheric storage, Gas atmospheric storage of meat, grains, seeds and flour, roots and tubers; freezing of raw and processed foods.

**UNIT III LARGE-SCALE FOOD PROCESSING 12**

Milling of grains and pulses; edible oil extraction; Pasteurisation of milk and yoghurt; canning and bottling of foods; drying – Traditional and modern methods of drying, Dehydration of fruits, vegetables, milk, animal products etc; preservation by use of acid, sugar and salt; Pickling and curing with microorganisms, use of salt, and microbial fermentation; frying, baking, extrusion cooking, snack foods.

**UNIT IV FOOD WASTES IN VARIOUS PROCESSES 6**

Waste disposal-solid and liquid waste; rodent and insect control; use of pesticides; ETP; selecting and installing necessary equipment.

**UNIT V FOOD HYGIENE 9**

Food related hazards – Biological hazards – physical hazards – microbiological considerations in foods. Food adulteration – definition, common food adulterants, contamination with toxic metals, pesticides and insecticides; Safety in food procurement, storage handling and preparation; Relationship of microbes to sanitation, Public health hazards due to contaminated water and food; Personnel hygiene; Training& Education for safe methods of handling and processing food; sterilization and disinfection of manufacturing plant; use of sanitizers, detergents, heat, chemicals, Cleaning of equipment and premises.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course the students are expected to

CO1 Be aware of the different methods applied to processing foods.

CO2 Be able to understand the significance of food processing and the role of foodand beverage industries in the supply of foods.

**TEXT BOOKS/REFERENCES:**

1. Karnal, Marcus and D.B. Lund “Physical Principles of Food Preservation”. Rutledge, 2003.
2. VanGarde, S.J. and Woodburn. M “Food Preservation and Safety Principles and Practice”.Surbhi Publications, 2001.
3. Sivasankar, B. “Food Processing & Preservation”, Prentice Hall of India, 2002.
4. Khetarpaul, Neelam, “Food Processing and Preservation”, Daya Publications, 2005.

**OPY352 IPR FOR PHARMA INDUSTRY L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- To provide the basic fundamental knowledge of different forms of Intellectual Property Rights in national and international level.
- To provide the significance of the Intellectual Property Rights about the patents, copyrights, industrial design, plant and geographical indications.
- This paper is to study significance of the amended patent act on pharma industry.

**UNIT I INTRODUCTION- INTELLECTUAL PROPERTY RIGHTS 9**

Introduction, Types of Intellectual Property Rights -patents, plant varieties protection, geographical indicators, copyright, trademark, trade secrets.

**UNIT II PATENTS 9**

Patents-Objective, Introduction, Requirement for patenting- Novelty, Inventive step (Non-obviousness) and industrial application (utility), Non-patentable inventions, rights of patent owner, assignment of patent rights, patent specification (provisional and complete), parts of complete specification, claims, procedure for obtaining patents, compulsory license.

**UNIT III PLANT VARIETY-TRADITIONAL KNOWLEDGE –GEOGRAPHICAL INDICATIONS 9**

Plant variety- Justification, criteria for protection of plant variety and protection in India. Traditional knowledge- Concept of traditional knowledge, protection of traditional knowledge under Intellectual Property frame works in national level and Traditional knowledge digital library (TKDL). Geographical Indications – Justification for protection, National and International position.

**UNIT IV ENFORCEMENT AND PRACTICAL ASPECTS OF IPR 9**

Introduction – civil remedies – injunction, damage, account of profit – criminal remedies – patent, trademark. Practical aspects – Introduction, benefits of licensing, licensing of basic types of IPR, licensing clauses of IPR. Case studies of patent infringement, compulsory licensing, simple patent license agreements.

**UNIT V INTERNATIONAL BACKGROUND OF INTELLECTUAL PROPERTY 9**

International Background of Intellectual Property- Paris Convention, Berne convention, World Trade Organization (WTO), World Intellectual Property Organization (WIPO), Trade Related Aspects of Intellectual Property Rights (TRIPS) and Patent Co-operation Treaty (PCT).

**TOTAL:45 PERIODS**

**TEXT BOOKS:**


1. N. Nagpal, M. Arora, M.R.D. Usman, S. Rahar, “Intellectual Property Rights” Edu creation Publishing, New Delhi, 2017.
2. The Patents Act, 1970 (Bare Act with Short Notes) (New Delhi: Universal Law Publishing Company Pvt. Ltd. 2012.
3. B.S. Rao, P.V. Appaji, “Intellectual Property Rights in Pharmaceutical Industry: Theory and Practice”, 2015.


**REFERENCES:**


1. Patents for Chemicals, Pharmaceuticals, & Biotechnology-Fundamentals of Global Law, Practice and Strategy. Philip W. Grubb, Oxford University Press, 2004.
2. Basic Principles of patent law – Basics principles and acquisition of IPR. Ramakrishna T. CIPRA, NLSIU, Bangalore, 2005
3. S. Lakshmana Prabu, TNK. Suriyaprakash, “Intellectual Property Rights”, 1st ed., In Tech open access, Croatia, 2017.


**COURSE OUTCOMES:**

The student will be able to

**C1** Understand and differentiate the categories of intellectual property rights.
**C2** Describe about patents and procedure for obtaining patents.
**C3** Distinguish plant variety, traditional knowledge and geographical indications under IPR.
**C4** Provide the information about the different enforcements and practical aspects involved in protection of IPR.
**C5** Provide different organizations role and responsibilities in the protection of IPR in the international level.
**C6** Understand the interrelationships between different Intellectual Property Rights on International Society

| **CO – PO MAPPING** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **IPR FOR PHARMA INDUSTRY** | | | | | | | | | | | | |
| | PO1 | PO2 | PO 3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO1 0 | PO11 | PO 12 |
| **C1** | 3 | 3 | | 2 | | | | | 2 | 2 | | |
| **C2** | | 3 | 3 | | | | 2 | 2 | | | | |
| **C3** | 3 | 3 | | | | | 2 | 2 | | | | 1 |
| **C4** | | | | | 2 | | 3 | 3 | | 2 | 2 | |
| **C5** | | 3 | | | | | 3 | | | 2 | | 1 |
| **C6** | 3 | 2 | | | | 2 | 2 | | | | | 2 |

**OTT351 BASICS OF TEXTILE FINISHING L T P C**
**3 0 0 3**

**OBJECTIVE:**

- To enable the students to understand the basics and different types of finishes required for textile materials and machines used for finishing.

**UNIT I RESIN FINISHING 9**

Importance of finishing and its classification. Resin finishing: Mechanism of creasing, Types of Resins .Anti crease, wash and wear, durable press resin finishing. Study about eco friendly method of anti crease finishing.

**UNIT II FLAME PROOF & WATERPROOF 9**

Concept of Flame proof & flame retardancy. Flame retardant finishes for cotton, Concept of waterproof and water repellent Finishes, Durable & Semi durable and Temporary finishes, Concept of Antimicrobial finish.

**UNIT III SOIL RELEASE AND ANTISTATIC FINISHES 9**

Soil Release Finishing: Mechanism of soil retention & soil release. Anti pilling Finishing: chemical and mechanical methods to produce anti pilling. Concept of UV Protection finishes- Concept of antistatic finishes.

**UNIT IV MECHANICAL FINISHES 9**

Mechanical finishing of textile materials - calendaring, compacting, Sanforising, Peach finishing. Object of Heat setting. Various methods of heat setting and mechanism of heat setting.

**UNIT V STIFFENING AND SOFTENING 9**

Concept of stiffening and softening of textile materials. Mechanism in the weight reduction of PET .Concept of Micro encapsulation techniques in finishing process, Nano finish, Plasma Treatment and Bio finishing.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of the course, the students will be able to Understand the

CO: 1 Basics of Resin Finishing Process.

CO: 2 Concept of Flame proof & flame retardancy, waterproof and water repellent, Antimicrobial finishes.

CO: 3 Concept of Soil Release, Anti Pilling, UV Protection and Antistatic finishes.

CO: 4 Concept of Mechanical finishing.

CO: 5 Basics of Micro encapsulation techniques, Nano finish, Plasma Treatment.

**TEXT BOOKS:**


1. V.A.Shennai, "Technology of Finishing", Vol X, Sevak Publications, Mumbai
2. Perkins, W.S., “Textile colouration and finishing”, Carolina Academic Press., U.K, ISBN: 0890898855.2004.


**REFERENCES:**


1. Microencapsulation in finishing, Review of progress of Colouration, SDC, 2001 62
2. Chakraborty, J.N, Fundamentals and Practices in colouration of Textiles, Woodhead Publishing India, 2009, ISBN-13:978-81-908001-4-3
3. W. D. Schindler and P. J. Hauser "Chemical finishing of textiles", Woodhead Publishing Cambridge England,2004.

**OTT352 INDUSTRIAL ENGINEERING FOR GARMENT INDUSTRY L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To enable the students to learn about basics of industrial engineering and different tools of industrial engineering and its application in apparel industry

**UNIT I INTRODUCTION 9**

Scope of industrial engineering in apparel Industry, role of industrial engineers.

**Productivity:** Definition - Productivity, Productivity measures .Reduction of work content due to the product and process, Reduction of ineffective time due to the management, due to the worker. Causes for low productivity in apparel industry and measures for improvement.

**UNIT II WORK STUDY 9**

Definition, Purpose, Basic procedure and techniques of work-study.

**Work environment** – Lighting, Ventilation, Climatic condition on productivity. Temperature control, humidity control, noise control measures. Safety and ergonomics on work station and work environment

**Material Handling** – Objectives, Classification and characteristics of material handling equipments, Specialized material handling equipments.

**UNIT III METHOD STUDY 9**

Definition, Objectives, Procedure, Process charts and symbols. Various charts – Charts indicating process sequence: Outline process chart, flow process chart (man type, material type and equipment type); Charts using time scale – multiple activity chart. Diagrams indicating movement – flow diagram, string diagram, cycle graph, chrono cycle graph, travel chart

**MOTION STUDY:** Principle of motion economy, Two handed process chart, micro motion analysis – therbligs, SIMO chart.

**UNIT IV WORK MEASUREMENT 9**

Definition, purpose, procedure, equipments, techniques. Time study - Definition, basics of time study- equipments. Time study forms, Stop watch procedure. Predetermined motion time standards (PMTS). Time Study rating, calculation of standard time, Performance rating – relaxation and other allowances. Calculation of SAM for different garments, GSD.

**UNIT V WORK STUDY APPLICATION 9**

Application of work study techniques in cutting, stitching and packing in garment industry. Workaids in sewing, Pitch diagram, Line balancing, Capacity planning, scientific method of training.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon the completion of the course the student shall be able to understand

CO1: Fundamental concepts of industrial Engineering and productivity
CO2: Method study
CO3: Motion analysis
CO4: Work measurement and SAM
CO5: Ergonomics and its application to garment industry

**TEXT BOOKS:**


1. George Kanwaty, “Introduction to Work Study “, ILO, Geneva, 1996, ISBN: 9221071081 |ISBN-13: 9789221071082
2. Enrick N. L., “Time study manual for Textile industry”, Wiley Eastern (P) Ltd., 1989, ISBN: 0898740444 | ISBN-13: 9780898740448
3. Khanna O. P., and Sarup A., “Industrial Engineering and Management”, Dhanpat Rai Publications, New Delhi, 2010, ISBN: 818992835X / ISBN: 978-8189928353

**REFERENCES**


1. Norberd Lloyd Enrick., “Industrial Engineering Manual for Textile Industry”, Wiley Eastern (P) Ltd., New Delhi, 1988, ISBN: 0882756311 | ISBN-13: 9780882756318
2. Chuter A. J., “Introduction to Clothing Production Management”, Wiley-Black well Science, U.S. A., 1995, ISBN: 0632039396 | ISBN-13: 9780632039395
3. GordanaColovic., “Ergonomics in the garment industry”, Wood publishing India Pvt. Ltd., India, 2014, ISBN: 0857098225 | ISBN-13: 9780857098221
4. Rajesh Bheda, “Managing Productivity in Apparel Industry “CBS Publishers & Distributors, 2008


**Course Articulation Matrix:**

| Course Outcomes | Statement | Program Outcome | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | Fundamental concepts of industrial Engineering and productivity | 2 | 2 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 1 | - |
| CO2 | Method study | 1 | 2 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 1 | - |
| CO3 | Motion analysis | 1 | 2 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 1 | - |
| CO4 | Work measurement and SAM | 1 | 2 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 1 | 3 | 2 | 1 | 1 | - |
| CO5 | Ergonomics and itsapplication to garment industry | 1 | 2 | 3 | 3 | 2 | 1 | 2 | 2 | 2 | 1 | 3 | 2 | 1 | 1 | - |
| Overall CO | | 1.2 | 2 | 3 | 3 | 2 | 1 | 1.2 | 2 | 2 | 1 | 2.4 | 2 | 1 | 1 | - |

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**OTT353 BASICS OF TEXTILE MANUFACTURE L T P C**
**3 0 0 3**

**OBJECTIVES:**

To enable the students to learn about the basics of fibre forming, yarn production, fabric formation, coloration of fabrics and garment manufacturing

**UNIT I NATURAL FIBRES 9**

Introduction: Definition of staple fibre, filament; Classification of natural and man-made fibres, essential and desirable properties of fibres. Production and cultivation of Natural Fibers: Cultivation of cotton, production of silk (sericulture), wool and jute – physical and chemical structure of these fibres..

**UNIT II REGENERATED AND SYNTHETIC FIBRES 9**

Production sequence of regenerated and modified cellulosic fibres: viscose rayon, Acetate Rayon, high wet modulus and high tenacity fibres; synthetic fibres – chemical structure, fibre forming polymers, production principles.

**UNIT III BASICS OF SPINNING 9**

Spinning – principle of yarn formation, sequence of machines for yarn production with short staple fibres and blends, principles of opening and cleaning machines; yarn numbering - calculations

**UNIT IV BASICS OF WEAVING 9**

Woven fabric – warp, weft, weaving, path of warp; looms – classification, handloom and its parts, powerloom, automatic looms, shuttleless looms, special type of looms; preparatory machines for weaving process and their objectives; basic weaving mechanism - primary, secondary and auxiliary mechanisms.

**UNIT V BASICS OF KNITTING AND NONWOVEN 9**

Knitting – classification, principle, types of fabrics; nonwoven process –classification, principle, types of fabrics.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

On completion of this course, the students shall have the basic knowledge on

CO1: Classification of fibres and production of natural fibres
CO2: Regenerated and synthetic fibres
CO3: Yarn spinning
CO4: Weaving
CO5: Knitting and nonwoven

**TEXTBOOKS**


1. Mishra S. P. , “A Text Book of Fibre Science and Technology”, New Age Publishers, 2000, ISBN: 8122412505
2. Marks R., and Robinson. T.C., “Principles of Weaving”, The Textile Institute, Manchester, 1989, ISBN: 0 900739 258.
3. Spencer D.J., “Knitting Technology”, III Ed., Textile Institute, Manchester, 2001, ISBN: 185573 333 1.


**REFERENCES:**


1. Hornberer M., Eberle H., Kilgus R., Ring W. and Hermeling H., “Clothing Technology: From Fibre to Fabric”, Europa LehrmittelVerlag, 2008, ISBN: 3808562250 / ISBN: 978-3808562253.
2. Wynne A., “Motivate Series-Textiles”, Maxmillan Publications, London, 1997.
3. Carr H. and Latham B., “The Technology of Clothing Manufacture” Backwell Science, U.K., 1994, ISBN: 0632037482 / ISBN:13: 9780632037483.Klein W., “The Rieter Manual of Spinning, Vol.1”, Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-1-4 / ISBN 13 978-3-9523173-1-0.
4. Klein W., “The Rieter Manual of Spinning, Vol.2”, Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-2-2 / ISBN 13 978-3-9523173-2-7.
5. Klein W., “The Rieter Manual of Spinning, Vol.1-3”, Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-3-0 / ISBN 13 978-3-9523173-3-4.
6. Talukdar. M.K., Sriramulu. P.K., and Ajgaonkar. D.B., “Weaving: Machines, Mechanisms, Management”, Mahajan Publishers, Ahmedabad, 1998, ISBN: 81-85401-16-0.
7. Morton W. E., and Hearle J. W. S., “Physical Properties of Textile Fibres”, The Textile Institute, Washington D.C., 2008, ISBN 978-1-84569-220-95
8. Gohl E. P. G., “Textile Science”, CBS Publishers and distributors, 1987, ISBN 0582685958

## COURSE ARTICULATION MATRIX:

| Course Outcomes | Statement | Program Outcome | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO3 |
| CO1. | Classification of fibres and production of natural fibres | - | - | - | - | - | - | - | 2 | 1 | - | 1 | 1 | - | 1 | - |
| CO2. | Regenerated and synthetic fibres | - | - | - | - | - | - | - | 2 | 1 | - | 1 | 1 | - | 1 | - |
| CO3. | Yarn spinning | - | - | - | - | - | - | - | 2 | 1 | - | 1 | 1 | - | 1 | - |
| CO4. | Weaving | - | - | - | - | - | - | - | 2 | 1 | - | 1 | 1 | - | 1 | - |
| CO5. | Knitting and nonwoven | - | - | - | - | - | - | - | 2 | 1 | - | 1 | 1 | - | 1 | - |
| **Overall CO** | | - | - | - | - | - | - | - | 2 | 1 | - | 1 | 1 | - | 1 | - |

**1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively**

**OPE351 INTRODUCTION TO PETROLEUM REFINING AND PETROCHEMICALS** **L T P C**
**3 0 0 3**

**OBJECTIVE:**
The course is aimed to
Gain knowledge about petroleum refining process and production of petrochemical products.

**UNIT I ORIGIN, FORMATION AND REFINING OF CRUDE OIL 9**
Origin, Formation and Evaluation of Crude Oil. Testing of Petroleum Products. Refining of Petroleum - Atmospheric and Vacuum Distillation.

**UNIT II CRACKING 9**
Cracking, Thermal Cracking, Vis-breaking, Catalytic Cracking (FCC), Hydro Cracking, Coking and Air Blowing of Bitumen

**UNIT III REFORMING AND HYDROTREATING 9**
Catalytic Reforming of Petroleum Feed Stocks. Lube oil processing- Solvent Treatment Processes, Dewaxing, Clay Treatment and Hydrofining. Treatment Techniques: Removal of Sulphur Compounds in all Petroleum Fractions to improve performance.

**UNIT IV INTRODUCTION TO PETROCHEMICALS 9**
Petrochemicals - Cracking of Naphtha and Feed stock gas for the production of Ethylene, Propylene, Isobutylene and Butadiene. Production of Acetylene from Methane, and Extraction of Aromatics.

**UNIT V PRODUCTION OF PETROCHEMICALS 9**

Production of Petrochemicals like Dimethyl Terephathalate(DMT), Ethylene Glycol, Synthetic glycerine, Linear Alkyl Benzene (LAB), Acrylonitrile, Methyl Methacrylate (MMA), Vinyl Acetate Monomer, Phthalic Anhydride, Maleic Anhydride, Phenol, Acetone, Methanol, Formaldehyde, Acetaldehyde, Pentaerythritol and production of Carbon Black.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

On the completion of the course students are expected to

**CO1:** Understand the classification, composition and testing methods of crude petroleum and its products. Learn the mechanism of refining process.

**CO2:** Understand the insights of primary treatment processes to produce the precursors.

**CO3:** Study the secondary treatment processes cracking, vis-breaking and coking to produce more petroleum products.

**CO4:** Appreciate the need of treatment techniques for the removal of sulphur and other impurities from petroleum products.

**CO5:** Understand the societal impact of petrochemicals and learn their manufacturing processes.

**CO6:** Learn the importance of optimization of process parameters for the high yield of petroleum products.

**TEXT BOOKS**

1. Nelson, W. L., “Petroleum Refinery Engineering”, 4th Edition., McGraw Hill, New York,1985.
2. Wiseman. P., "Petrochemicals", UMIST Series in Science and Technology, John Wiley & Sons,1986.

**REFERENCES**

1. Bhaskara Rao, B. K., “Modern Petroleum Refining Processes”, 2nd Edition, Oxford and IBH Publishing Company, New Delhi, 1990.
2. Bhaskara Rao, B. K. “A Text on Petrochemicals”, 1st Edition, Khanna Publishers

**CPE334 ENERGY CONSERVATION AND MANAGEMENT L T P C**
**3 0 0 3**

**OBJECTIVES:**

At the end of the course, the student is expected to

- understand and analyse the energy data of industries
- carryout energy accounting and balancing
- conduct energy audit and suggest methodologies for energy savings and
- utilise the available resources in optimal ways

**UNIT I INTRODUCTION 9**

Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization – Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.

**UNIT II ELECTRICAL SYSTEMS 9**

Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.

**UNIT III THERMAL SYSTEMS 9**

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Steam: Distribution &U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories

**UNIT IV ENERGY CONSERVATION IN MAJOR UTILITIES 9**

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – D.G. sets

**UNIT V ECONOMICS 9**

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of this course, the students can able to analyze the energy data of industries.

CO1: Remember the knowledge for Basic combustion and furnace design and selection of thermal and mechanical energy equipment.

CO2: Study the Importance of Stoichiometry relations, Theoretical air required for complete combustion.

CO3: Skills on combustion thermodynamics and kinetics.

CO4: Apply calculation and design tube still heaters.

CO5: Studied different heat treatment furnace.

CO6: Practical and theoretical knowledge burner design.

**TEXT BOOKS:**

1. Energy Manager Training Manual (4 Volumes) available at www.energymanagertraining.com. a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004.

**REFERENCES:**


1. Witte. L.C., P.S. Schmidt, D.R. Brown, “Industrial Energy Management and Utilisation” Hemisphere Publ, Washington, 1988.
2. Callaghn, P.W. “Design and Management for Energy Conservation”, Pergamon Press, Oxford, 1981.
3. Dryden. I.G.C., “The Efficient Use of Energy” Butterworths, London, 1982
4. Turner. W.C., “Energy Management Hand book”, Wiley, New York, 1982.
5. Murphy. W.R. and G. Mc KAY, “Energy Management”, Butterworths, London 1987


**OCH351 NANO TECHNOLOGY L T P C**

**3 0 0 3**

**UNIT I INTRODUCTION 8**

General definition and size effects–important nano structured materials and nano particles-importance of nano materials- Size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties of nanomaterials- surface area - band gap energy and applications. Photochemistry and Electrochemistry of nanomaterials –Ionic properties of nanomaterials- Nano catalysis.

**UNIT II SYNTHESIS OF NANOMATERIALS 8**

Bottom up and Top-down approach for obtaining nano materials - Precipitation methods – sol gel technique – high energy ball milling, CVD and PVD methods, gas phase condensation, magnetron sputtering and laser deposition methods – laser ablation, sputtering.

**UNIT III NANO COMPOSITES 10**

Definition- importance of nanocomposites- nano composite materials-classification of composites-metal/metal oxides, metal-polymer- thermoplastic based, thermoset based and elastomer based-influence of size, shape and role of interface in composites applications.

**UNIT IV NANO STRUCTURES AND CHARACTERIZATION TECHNIQUES 10**

Classifications of nanomaterials - Zero dimensional, one-dimensional and two-dimensional nanostructures- Kinetics in nanostructured materials- multilayer thin films and superlattice-clusters of metals, semiconductors and nanocomposites. Spectroscopic techniques, Diffraction methods, thermal analysis method, BET analysis method.

**UNIT V APPLICATIONS OF NANO MATERIALS 9**

Overview of nanomaterials properties and their applications, nano painting, nano coating, nanomaterials for renewable energy, Molecular Electronics and Nanoelectronics – Nanobots-Biological Applications. Emerging technologies for environmental applications- Practice of nanoparticles for environmental remediation and water treatment.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

CO1 - understand the basic properties such as structural, physical, chemical properties of nanomaterials and their applications.

CO2 – able to acquire knowledge about the different types of nano material synthesis

CO3 – describes about the shape, size,structure of composite nano materials and their interference

CO4 – understand the different characterization techniques for nanomaterials

CO5 - develop a deeper knowledge in the application of nanomaterials in different fields.

**TEXT BOOKS**

1. Mick Wilson, Kamali Kannangara,Geoff Smith, Michelle Simmom, Burkhard Raguse, " Nano Technology: Basic Science & Engineering Technology", 2005, Overseas Press
2. G. Cao, "Nanostructures & Nanomaterials: Synthesis, Properties &Applications" Imperial College Press, 2004
3. William A Goddard "Handbook of Nanoscience, Engineering and Technology", 3rd Edition, CRC Taylor and Francis group 2012.

**REFERENCES**

1. R.H.J.Hannink & A.J.Hill, Nanostructure Control, Wood Head Publishing Ltd.,Cambridge, 2006.
2. C.N.R.Rao, A.Muller, A.K.Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications Vol. I & II, 2nd edition, 2005, Wiley VCH Verlag Gibtl & Co
3. Ivor Brodie and Julius J.Muray,'The physics of Micro/Nano – Fabrication',Springer International Edition,2010

**COURSE ARTICULATION MATRIX**

| Course Outcomes | Statement | Program Outcome | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 |
| CO1 | Understand the basic properties such as structural, physical, chemical properties of nanomaterials and their applications | 2 | 3 | 2 | 3 | 3 | - | - | - | 1 | 1 | - | 3 | 1 | 1 | 3 |
| CO2 | Acquire knowledge about the different types of nano material synthesis | 2 | 3 | 1 | 3 | 3 | - | - | - | 1 | 1 | - | 3 | 2 | 1 | 3 |
| CO3 | Describes about the shape, size,structure of composite nano materials and their interference | 2 | 2 | 2 | 3 | 3 | 1 | 1 | - | 1 | 1 | - | 3 | 2 | 1 | 3 |
| CO4 | Understand the different characterization techniques for nanomaterials | 2 | 2 | 1 | 3 | 3 | 1 | 1 | 1 | 1 | - | 1 | 3 | 1 | 1 | 3 |
| CO5 | Develop a deeper knowledge in the application of nanomaterials in different fields | 2 | 2 | 1 | 3 | 3 | 1 | 1 | 1 | 1 | - | 1 | 3 | 2 | 1 | 3 |
| | Overall CO | 3 | 2 | 2 | 1 | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 1 |

**OCH352 FUNCTIONAL MATERIALS L T P C**
**3 0 0 3**

**OBJECTIVE:**

- The course emphasis on the molecular safe assembly and materials for polymer electronics

**UNIT I INTRODUCTION 9**

Historical Perspectives, Lessons from the Nature, Engineering the Functions, Tuning the functions, Multiscale Modeling and Computation, Classification of Functional Materials, Functional Diversity of Materials, Hybrid Materials, Technological Relevance, Societal Impact.

**UNIT II MOLECULAR SELF ASSEMBLY 9**

Molecular Organization, Self-Assembly in Biology, Energetics of Self-Organization, A Few Case Studies, Synthetic Protocols and Challenges, Solvent-assisted Self-Assembly, Directed Assembly-Langmuir-Blodgett and Langmuir-Schaefer techniques, Technological Applications of SAMs.

**UNIT III BIO-INSPIRED MATERIALS 9**

Bio-inspired materials, Classification, Biomimicry, Spider Silk, Lotus Leaf, Gecko feet, Synovial fluid, 'Bionics'-Bio-inspired Information Technologies, Artificial Sensory Organs, Biomineralization-En route to Nanotechnology.

**UNIT IV SMART OR INTELLIGENT MATERIALS 9**

Criteria for Smartness, Significance of Smart Materials, Representative Examples like Smart Gels and Polymers, Electro/Magneto Rheological Fluids, Smart Electroceramics, Technical Limitations and Challenges, Functional Nanocomposites, Polymer-carbon nanotube composities.

**UNIT V MATERIALS FOR POLYMER ELECTRONICS 9**

Polymers for Electronics, Organic Light Emitting Diodes, Working Principle of OLEDs, Illustrated Examples, Organic Field-Effect Transistors Operating Principle, Design Considerations, Polymer FETs vs Inorganic FETs, Liquid Crystal Displays, Engineering Aspects of Flat Panel Displays,

Intelligent Polymers for Data Storage, Polymer-based Data Storage-Principle, Magnetic Vs. Polymer-based Data Storage.

**TOTAL: 45 PERIODS**

**OUTCOME:**

- Students will be able to differentiate among various functional properties and select appropriate material for certain functional applications, analyze the nature and potential of functional material.

**TEXT BOOK:**

1. Vijayamohanan K. Pillai and MeeraParthasarathy, "Functional Materials: A chemist's perpective", Universities Press Hyderabad (2012).

**REFERENCE:**

1. Stephen Manne "Biomimetic Materials Chemistry" Wiley-VCH Newyork, 1966.

**OEC351 SIGNALS AND SYSTEMS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To understand the basic properties of signal & systems
- To know the methods of characterization of LTI systems in time domain
- To analyze continuous time signals and system in the Fourier and Laplace domain
- To analyze discrete time signals and system in the Fourier and Z transform domain

**UNIT I CLASSIFICATION OF SIGNALS AND SYSTEMS 9**

Standard signals- Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids_Classification of signals – Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals - Classification of systems- CT systems and DT systems- – Linear & Nonlinear, Time-variant& Time-invariant,Causal & Non-causal, Stable & Unstable.

**UNIT II ANALYSIS OF CONTINUOUS TIME SIGNALS 9**

Fourier series for periodic signals - Fourier Transform – properties- Laplace Transforms and Properties

**UNIT III LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS 9**

Impulse response - convolution integrals- Differential Equation- Fourier and Laplace transforms in Analysis of CT systems - Systems connected in series / parallel.

**UNIT IV ANALYSIS OF DISCRETE TIME SIGNALS 9**

Baseband signal Sampling–Fourier Transform of discrete time signals (DTFT)– Properties of DTFT - Z Transform & Properties

**UNIT V LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS 9**

Impulse response–Difference equations-Convolution sum- Discrete Fourier Transform and Z Transform Analysis of Recursive & Non-Recursive systems-DT systems connected in series and parallel.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**At the end of the course, the student will be able to:**

CO1:Determine if a given system is linear/causal/stable
CO2: Determine the frequency components present in a deterministic signal
CO3:Characterize continuous LTI systems in the time domain and frequency domain
CO4:Characterize discrete LTI systems in the time domain and frequency domain

CO5:Compute the output of an LTI system in the time and frequency domains

**TEXT BOOKS:**

1. Oppenheim, Willsky and Hamid, “Signals and Systems”, 2nd Edition, Pearson Education, New Delhi, 2015.(Units I - V)
2. Simon Haykin, Barry Van Veen, “Signals and Systems”, 2nd Edition, Wiley, 2002

**REFERENCES :**

1. B. P. Lathi, “Principles of Linear Systems and Signals”, 2nd Edition, Oxford, 2009.
2. M. J. Roberts, “Signals and Systems Analysis using Transform methods and MATLAB”, McGraw- Hill Education, 2018.
3. John Alan Stuller, “An Introduction to Signals and Systems”, Thomson, 2007.

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | - | 3 | - | 3 | 2 | - | - | - | - | | 3 | - | - | 1 |
| 2 | 3 | - | 3 | - | - | 2 | - | - | - | - | | 3 | - | 3 | - |
| 3 | 3 | 3 | - | - | 3 | 2 | - | - | - | - | | 3 | 2 | - | - |
| 4 | 3 | 3 | - | - | 3 | 2 | - | - | - | - | | 3 | - | 3 | 1 |
| 5 | 3 | 3 | - | 3 | 3 | 2 | - | - | - | - | | 3 | - | 3 | 1 |
| **C** | **3** | **3** | **3** | **3** | **3** | **2** | **-** | **-** | **-** | **-** | **-** | **3** | **2** | **3** | **1** |

**OEC352 FUNDAMENTALS Of ELECTRONIC DEVICES AND CIRCUITS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES :**

- To give a comprehensive exposure to all types of devices and circuits constructed with discrete components. This helps to develop a strong basis for building linear and digital integrated circuits
- To analyze the frequency response of small signal amplifiers
- To design and analyze single stage and multistage amplifier circuits
- To study about feedback amplifiers and oscillators principles
- To understand the analysis and design of multi vibrators

**UNIT I SEMICONDUCTOR DEVICES 9**

PN junction diode, Zener diode, BJT, MOSFET, UJT –structure, operation and V-I characteristics, Rectifiers – Half Wave and Full Wave Rectifier, Zener as regulator

**UNIT II AMPLIFIERS 9**

Load line, operating point, biasing methods for BJT and MOSFET**,** BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response –Analysis of CS and Source follower – Gain and frequency response- High frequency analysis.

**UNIT III MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER 9**

Cascode amplifier, Differential amplifier – Common mode and Difference mode analysis – Tuned amplifiers – Gain and frequency response – Neutralization methods.

**UNIT IV FEEDBACK AMPLIFIERS AND OSCILLATORS 9**

Advantages of negative feedback – Analysis of Voltage / Current, Series , Shunt feedback Amplifiers – positive feedback–Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators.

**UNIT V POWER AMPLIFIERS AND DC/DC CONVERTERS 9**

Power amplifiers- class A-Class B-Class AB-Class C-Temperature Effect- Class AB Power amplifier using MOSFET –DC/DC convertors – Buck, Boost, Buck-Boost analysis and design

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES :**

At the end of the course the students will be able to

CO1: Explain the structure and working operation of basic electronic devices.
CO2: Design and analyze amplifiers.
CO3: Analyze frequency response of BJT and MOSFET amplifiers
CO4: Design and analyze feedback amplifiers and oscillator principles.
CO5: Design and analyze power amplifiers and supply circuits

**TEXT BOOKS :**


1. David A. Bell, "Electronic Devices and Circuits", Oxford Higher Education press, 5 th Edition, 2010.
2. Robert L. Boylestad and Louis Nasheresky, “Electronic Devices and Circuit Theory”, 10th Edition, Pearson Education / PHI, 2008.
3. Adel .S. Sedra, Kenneth C. Smith, "Micro Electronic Circuits", Oxford University Press, 7 th Edition, 2014.


**REFERENCES :**


1. Donald.A. Neamen, "Electronic Circuit Analysis and Design", Tata McGraw Hill, 3 rd Edition, 2010.
2. D.Schilling and C.Belove, "Electronic Circuits", McGraw Hill, 3 rd Edition, 1989
3. Muhammad H.Rashid, "Power Electronics", Pearson Education / PHI , 2004.


| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 3 | 3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 2 | 1 | 1 |
| 2 | 3 | 2 | 2 | 3 | 2 | 2 | - | - | - | - | - | 1 | 2 | 1 | 1 |
| 3 | 3 | 3 | 3 | 2 | 1 | 2 | - | - | - | - | - | 1 | 2 | 1 | 1 |
| 4 | 3 | 3 | 2 | 3 | 2 | 2 | - | - | - | - | - | 1 | 2 | 1 | 1 |
| 5 | 3 | 2 | 3 | 2 | 2 | 1 | - | - | - | - | - | 1 | 2 | 1 | 1 |
| CO | **3** | **3** | **3** | **3** | **2** | **2** | - | - | - | - | - | **1** | **2** | **1** | **1** |

**CBM348 FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To understand the global trends and development methodologies of various types of products and services
- To conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems
- To understand requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them in to design specification

- To understand system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics
- To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL (End of Life) support activities for engineering customer

**UNIT I BASICS OF PRODUCT DEVELOPMENT 9**

Global Trends Analysis and Product decision - Social Trends - Technical Trends- Economical Trends - Environmental Trends - Political/Policy Trends - Introduction to Product Development Methodologies and Management - Overview of Products and Services - Types of Product Development - Overview of Product Development methodologies - Product Life Cycle – Product Development Planning and Management.

**UNIT II REQUIREMENTS AND SYSTEM DESIGN 9**

Requirement Engineering - Types of Requirements - Requirement Engineering - traceability Matrix and Analysis - Requirement Management - System Design & Modeling - Introduction to System Modeling - System Optimization - System Specification - Sub-System Design - Interface Design.

**UNIT III DESIGN AND TESTING 9**

Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – Challenges in Integration of Engineering Disciplines - Concept Screening & Evaluation - Detailed Design - Component Design and Verification – Mechanical, Electronics and Software Subsystems - High Level Design/Low Level Design of S/W Program - Types of Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – Prototyping - Introduction to Rapid Prototyping and Rapid Manufacturing - System Integration, Testing, Certification and Documentation

**UNIT IV SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT 9**

Introduction to Product verification processes and stages - Introduction to Product Validation processes and stages - Product Testing Standards and Certification - Product Documentation - Sustenance -Maintenance and Repair – Enhancements - Product EoL - Obsolescence Management – Configuration Management - EoL Disposal

**UNIT V BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY 9**

The Industry - Engineering Services Industry - Product Development in Industry versus Academia –The IPD Essentials - Introduction to Vertical Specific Product Development processes - Manufacturing/Purchase and Assembly of Systems - Integration of Mechanical, Embedded and Software Systems – Product Development Trade-offs - Intellectual Property Rights and Confidentiality – Security and Configuration Management.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of the course, the students will be able to:

- Define, formulate, and analyze a problem
- Solve specific problems independently or as part of a team
- Gain knowledge of the Innovation & Product Development process in the Business Context
- Work independently as well as in teams
- Manage a project from start to finish

**TEXT BOOKS**:


1. Book specially prepared by NASSCOM as per the MoU.
2. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, Fifth Edition, 2011.
3. John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill, Eleventh Edition, 2005.


**REFERENCES**:


1. Hiriyappa B, “Corporate Strategy – Managing the Business”, Author House, 2013.

2. Peter F Drucker, “People and Performance”, Butterworth – Heinemann [Elsevier], Oxford, 2004.
3. Vinod Kumar Garg and Venkita Krishnan N K, “Enterprise Resource Planning – Concepts”, Second Edition, Prentice Hall, 2003.
4. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, Seventh Edition, 2013

**CO’s- PO’s & PSO’s MAPPING**

| CO’s | PO’s | | | | | | | | | | | | PSO’s | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 2 | 3 | 1 | | | | | | 1 | | 1 | | | |
| 2 | 3 | 2 | 3 | 1 | | | | | | 1 | | 1 | | | |
| 3 | 3 | 2 | 3 | 1 | 1 | | | 1 | 1 | 1 | | 1 | | | |
| 4 | 3 | 2 | 3 | 1 | 1 | | | 1 | 1 | 1 | | 1 | | | |
| 5 | 3 | 2 | 3 | 1 | 1 | | | 1 | 1 | 1 | | 1 | | | |
| AVg. | | | | | | | | | | | | | | | |

**CBM333 ASSISTIVE TECHNOLOGY L T P C**
**3 0 0 3**

**OBJECTIVES:**
**The student should be made to:**
- To know the hardware requirement various assistive devices
- To understand the prosthetic and orthotic devices
- To know the developments in assistive technology

**UNIT I CARDIAC ASSIST DEVICES 9**
Cardiac functions and parameters, principle of External counter pulsation techniques, intra aortic balloon pump, Auxillary ventricle and schematic for temporary bypass of left ventricle, prosthetic heart valves, cardiac pacemaker.

**UNIT II HEMODIALYSERS 9**
Physiology of kidney, Artificial kidney, Dialysis action, hemodialyser unit, membrane dialysis, portable dialyser monitoring and functional parameters.

**UNIT III HEARING AIDS 9**
Anatomy of ear, Common tests – audiograms, air conduction, bone conduction, masking techniques, SISI, Hearing aids – principles, drawbacks in the conventional unit, DSP based hearing aids.

**UNIT IV PROSTHETIC AND ORTHODIC DEVICES 9**
Hand and arm replacement – different types of models, externally powered limb prosthesis, feedback in orthotic system, functional electrical stimulation, sensory assist devices.

**UNIT V RECENT TRENDS 9**
Transcutaneous electrical nerve stimulator, bio-feedback, assistive devices in drug delivery

**TOTAL :45 PERIODS**

**OUTCOMES:**
**On successful completion of this course, the student will be able to**
CO1: Interpret the various mechanical techniques that will help in assisting the heart functions.
CO2: Describe the underlying principles of hemodialyzer machine.
CO3: Indicate the methodologies to assess the hearing loss.
CO4: Evaluate the types of assistive devices for mobilization.

CO5: Explain about TENS and biofeedback system.

**TEXT BOOKS**


1. Joseph D. Bronzino, The Biomedical Engineering Handbook, Third Edition: Three Volume Set, CRC Press,2006
2. Marion. A. Hersh, Michael A. Johnson,Assistive Technology for visually impaired and blind,Springer Science & Business Media, 1st edition, 12-May-2010
3. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino, Clinical Engineering, CRC Press, 1st edition,2010.


**REFERENCES**


1. Kenneth J. Turner Advances in Home Care Technologies: Results of the match Project, Springer, 1stedition, 2011.
2. Gerr M. Craddock Assistive Technology-Shaping the future, IOS Press, 1st edition, 2003.
3. 3D Printing in Orthopaedic Surgery, Matthew Dipaola , Elsevier 2019 ISBN 978 -0-323-662116
4. Cardiac Assist Devices, Daniel Goldstein (Editor), Mehmet Oz (Editor), Wiley-Blackwell April 2000 ISBN: 978-0-879-93449-1


| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 1 | 1 | 1 | 1 | | | | | | | | | | |
| 2 | 3 | 1 | 1 | 1 | 1 | | | | | | | | | | |
| 3 | 3 | 1 | 1 | 1 | 1 | | | | | | | | | | |
| 4 | 3 | 1 | 1 | 1 | 1 | | | | | | | | | | |
| 5 | 3 | 1 | 1 | 1 | 1 | | | | | | | | | | |
| AVg. | | | | | | | | | | | | | | | |

**OMA352 OPERATIONS RESEARCH L T P C**
**3 0 0 3**

**OBJECTIVES:**

This course will help the students to

- determine the optimum solution for Linear programming problems.
- study the Transportation and assignment models and various techniques to solve them.
- acquire the knowledge of optimality, formulation and computation of integer programming problems.
- acquire the knowledge of optimality, formulation and computation of dynamic programming problems.
- determine the optimum solution for non-linear programming problems.

**UNIT I LINEAR PROGRAMMING 9**

Formulation of linear programming models – Graphical solution – Simplex method - Big M Method – Two phase simplex method - Duality - Dual simplex method.

**UNIT II TRANSPORTATION AND ASSIGNMENT PROBLEMS 9**

Matrix form of Transportation problems – Loops in T.P – Initial basic feasible solution – Transportation algorithm – Assignment problem – Unbalanced assignment problems .

**UNIT III INTEGER PROGRAMMING 9**

Introduction – All and mixed I.P.P – Gomory's method – Cutting plane algorithm – Branch and bound algorithm – Zero – one programming.

**UNIT IV DYNAMIC PROGRAMMING PROBLEMS 9**

Recursive nature of computation – Forward and backward recursion – Resource Allocation model – Cargo – loading model – Work – force size model - Investment model – Solution of L.P.P by dynamic programming .

**UNIT V NON - LINEAR PROGRAMMING PROBLEMS 9**

Lagrange multipliers – Equality constraints – Inequality constraints – Kuhn – Tucker Conditions – Quadratic programming.

**TOTAL:45 PERIODS**

**OUTCOMES :**

At the end of the course, students will be able to

- Could develop a fundamental understanding of linear programming models, able to develop a linear programming model from problem description, apply the simplex method for solving linear programming problems.
- analyze the concept of developing, formulating, modeling and solving transportation and assignment problems.
- solve the integer programming problems using various methods.
- conceptualize the principle of optimality and sub-optimization, formulation and computational procedure of dynamic programming.
- determine the optimum solution for non linear programming problems.

**TEXT BOOKS:**


1. Kanti Swarup, P.K.Gupta and Man Mohan, " Operations Research " , Sultan Chand & Sons, New Delhi, Fifth Edition , 1990.
2. Taha. H.A, " Operations Research – An Introduction , Pearson Education, Ninth Edition , New Delhi, 2012.


**REFERENCES :**


1. J.K.Sharma , " Operations Research - Theory and Applications " Mac Millan India Ltd , Second Edition , New Delhi , 2003.
2. Richard Bronson & Govindasami Naadimuthu , " Operations Research " ( Schaum's Outlines – TMH Edition) Tata McGraw Hill, Second Edition, New Delhi, 2004.
3. Pradeep Prabhakar Pai , " Operations Research and Practice", Oxford University Press, New Delhi , 2012.
4. J.P.Singh and N.P.Singh , " Operations Research , Ane Books Pvt.L.td, New Delhi , 2014.
5. F.S.Hillier and G.J. Lieberman, " Introduction to Operations Research " , Tata McGraw Hill, Eighth Edition , New Delhi, 2005.


| | PO 01 | PO 02 | PO 03 | PO 04 | PO 05 | PO 06 | PO 07 | PO 08 | PO 09 | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | - | - | - |
| **CO2** | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | - | - | - |
| **CO3** | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | - | - | - |
| **CO4** | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | - | - | - |
| **CO5** | 3 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | - | - | - |
| **Avg** | 3 | 3 | 1 | 0.8 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | - | - | - |

**OMA353 ALGEBRA AND NUMBER THEORY L T P C**
**3 0 0 3**

**OBJECTIVES :**

- To introduce the basic notions of groups, rings, fields which will then be used to solve related problems.
- To examine the key questions in the Theory of Numbers.
- To give an integrated approach to number theory and abstract algebra, and provide a firm basis for further reading and study in the subject.

**UNIT I GROUPS AND RINGS 9**

Groups: Definition - Properties - Homomorphism - Isomorphism - Cyclic groups - Cosets - Lagrange's theorem.
Rings: Definition - Sub rings - Integral domain - Field - Integer modulo n - Ring homomorphism.

**UNIT II FINITE FIELDS AND POLYNOMIALS 9**

Rings - Polynomial rings - Irreducible polynomials over finite fields - Factorization of polynomials over finite fields.

**UNIT III DIVISIBILITY THEORY AND CANONICAL DECOMPOSITIONS 9**

Division algorithm- Base-b representations – Number patterns – Prime and composite numbers – GCD – Euclidean algorithm – Fundamental theorem of arithmetic – LCM.

**UNIT IV DIOPHANTINE EQUATIONS AND CONGRUENCES 9**

Linear Diophantine equations – Congruence's – Linear Congruence's - Applications : Divisibility tests - Modular exponentiation - Chinese remainder theorem – 2x2 linear systems.

**UNIT V CLASSICAL THEOREMS AND MULTIPLICATIVE FUNCTIONS 9**

Wilson's theorem – Fermat's Little theorem – Euler's theorem – Euler's Phi functions – Tau and Sigma functions.

**TOTAL: 45 PERIODS**

**OUTCOMES :**

- Explain the fundamental concepts of advanced algebra and their role in modern mathematics and applied contexts.
- Demonstrate accurate and efficient use of advanced algebraic techniques.
- The students should be able to demonstrate their mastery by solving non-trivial problems related to the concepts, and by proving simple theorems about the, statements proven by the text

**TEXT BOOKS :**


1. Grimaldi, R.P and Ramana, B.V., "Discrete and Combinatorial Mathematics", Pearson Education, 5th Edition, New Delhi, 2007.
2. Thomas Koshy, "Elementary Number Theory with Applications", Elsevier Publications , New Delhi , 2002.


**REFERENCES:**


1. San Ling and Chaoping Xing, "Coding Theory – A first Course", Cambridge Publications, Cambridge, 2004.
2. Niven.I, Zuckerman.H.S., and Montgomery, H.L., "An Introduction to Theory of Numbers" , John Wiley and Sons , Singapore, 2004.
3. Lidl.R., and Pitz. G, "Applied Abstract Algebra", Springer Verlag, New Delhi, 2nd Edition , 2006.

| | PO 01 | PO 02 | PO 03 | PO 04 | PO 05 | PO 06 | PO 07 | PO 08 | PO 09 | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 1 | 2 | - | - | - | 2 | 1 | - | 1 | 2 | 2 | - | - | - |
| **CO2** | 3 | 3 | 1 | 1 | 3 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | - | - | - |
| **CO3** | 3 | 3 | 2 | 1 | 3 | 1 | 3 | 1 | 1 | 1 | 2 | 3 | - | - | - |
| **CO4** | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 3 | - | - | - |
| **CO5** | 2 | 2 | 1 | - | 3 | 1 | 2 | 1 | 1 | 1 | 3 | 3 | - | - | - |
| **Avg** | 2.8 | 2.4 | 1.6 | 0.8 | 2.4 | 1 | 2.2 | 1 | 0.8 | 1 | 2.2 | 2.6 | - | - | - |

**OMA354** **LINEAR ALGEBRA** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To test the consistency and solve system of linear equations.
- To find the basis and dimension of vector space.
- To obtain the matrix of linear transformation and its eigenvalues and eigenvectors.
- To find orthonormal basis of inner product space and find least square approximation.
- To find eigenvalues of a matrix using numerical techniques and perform matrix decomposition.

**UNIT I MATRICES AND SYSTEM OF LINEAR EQUATIONS 9**

Matrices - Row echelon form - Rank - System of linear equations - Consistency - Gauss elimination method - Gauss Jordan method.

**UNIT II VECTOR SPACES 9**

Vector spaces over Real and Complex fields - Subspace – Linear space - Linear independence and dependence - Basis and dimension.

**UNIT III LINEAR TRANSFORMATION 9**

Linear transformation - Rank space and null space - Rank and nullity - Dimension theorem– Matrix representation of linear transformation - Eigenvalues and eigenvectors of linear transformation – Diagonalization.

**UNIT IV INNER PRODUCT SPACES 9**

Inner product and norms - Properties - Orthogonal, Orthonormal vectors - Gram Schmidt orthonormalization process - Least square approximation.

**UNIT V EIGEN VALUE PROBLEMS AND MATRIX DECOMPOSITION 9**

Eigen value Problems : Power method, Jacobi rotation method - Singular value decomposition – QR decomposition.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

After the completion of the course the student will be able to

1. Test the consistency and solve system of linear equations.
2. Find the basis and dimension of vector space.
3. Obtain the matrix of linear transformation and its eigenvalues and eigenvectors.
4. Find orthonormal basis of inner product space and find least square approximation.
5. Find eigenvalues of a matrix using numerical techniques and perform matrix decomposition.

**TEXT BOOKS**


1. Faires J.D. and Burden R., Numerical Methods, Brooks/Cole (Thomson Publications), New Delhi, 2002.
2. Friedberg A.H, Insel A.J. and Spence L, Linear Algebra, Pearson Education, 5th Edition,2019.

**REFERENCES**


1. Bernard Kolman, David R. Hill, Introductory Linear Algebra, Pearson Educations, New Delhi, 8th Edition, 2009.
2. Gerald C.F. and Wheatley P.O, Applied Numerical Analysis, Pearson Educations, New Delhi, 7th Edition, 2007.
3. Kumaresan S, Linear Algebra - A geometric approach, Prentice Hall of India, New Delhi, Reprint, 2010.
4. Richard Branson, Matrix Operations, Schaum's outline series, 1989.
5. Strang G, Linear Algebra and its applications, Thomson (Brooks / Cole) New Delhi, 4th Edition, 2005.
6. Sundarapandian V, Numerical Linear Algebra, Prentice Hall of India, New Delhi, 2014.


| | PO 01 | PO 02 | PO 03 | PO 04 | PO 05 | PO 06 | PO 07 | PO 08 | PO 09 | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | - | - | - |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | - | - | - |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | - | - | - |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | - | - | - |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | - | - | - |
| **Avg** | 3 | 3 | 3 | 3 | 2.8 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | - | - | - |

**OBT352 BASICS OF MICROBIAL TECHNOLOGY L T P C**
**3 0 0 3**

**COURSE OBJECTIVE:**

- Enable the Non-biological student's to understand about the basics of life science and their pro and cons for living organisms.

**UNIT I BASICS OF MICROBES AND ITS TYPES 9**

Introduction to microbes, existence of microbes, inventions of great scientist and history, types of microorganisms – Bacteria, Virus, Fungi.

**UNIT II MICROBIAL TECHNIQUES 9**

Sterilization – types – physical and chemical sterilization, Decontamination, Preservation methods, fermentation, Cultivation and growth of microbes, Diagnostic methods.

**UNIT III PATHOGENIC MICROBES 9**

Infectious Disease – Awareness, Causative agent, Prevention and control - Cholera, Dengu, Malaria, Diarrhea, Tuberculosis, Typhoid, Covid, HIV.

**UNIT IV BENEFICIAL MICROBES 9**

Applications of microbes – Clinical microbiology, agricultural microbiology, Food Microbiology, Environmental Microbiology, Animal Microbiology, Marine Microbiology.

**UNIT V PRODUCTS FROM MICROBES 9**

Fermentedproducts – Fermented Beverages, Curd, Cheese, Mushroom, Agricultural products – Biopesticide, Biofertilizers, Vermi compost, Pharmaceutical products - Antibiotics, Vaccines

**OTAL: 45 PERIODS**

**COURSE OUTCOME:**

At the end of the course the students will be able to

1. Microbes and their types
2. Cultivation of microbes

3. Pathogens and control measures for safety
4. Microbes in different industry for economy.

**TEXT BOOKS**

1. Talaron K, Talaron A, Casita, Pelczar and Reid. Foundations in Microbiology, W.C. Brown Publishers, 1993.
2. Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.
3. Prescott L.M., Harley J.P., Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 1996.

**OBT353 BASICS OF BIOMOLECULES L T P C**
**3 0 0 3**

**OBJECTIVES:**

- The objective is to offer basic concepts of biochemistry to students with diverse background in life sciences including but not limited to the structure and function of various biomolecules and their metabolism.

**UNIT I CARBOHYDRATES 9**

Introduction to carbohydrate, classification, properties of monosaccharide, structural aspects of monosaccharides. Introduction to disaccharide (lactose, maltose, sucrose) and polysaccharide (Heparin, starch, and glycogen) biological function of carbohydrate.

**UNIT II LIPID AND FATTY ACIDS 9**

Introduction to lipid, occurrence, properties, classification of lipid. Importance of phospholipids, sphingolipid and glycerolipid. Biological function of lipid. Fatty acid, Introduction, Nomenclature and classification of fatty acid Essential and non essential fatty acids.

**UNIT III AMINO ACIDS AND PROTEIN. 9**

Introduction to amino acid, structure, classification of protein based on polarity. Introduction to protein, classification of protein based on solubility, shape, composition and Function. Peptide bond– Structure of peptide bond. Denauration – renaturation of protein, properties of protein. Introduction to lipoprotein, glycoprotein and nucleoprotein.Biological function of protein.

**UNIT IV NUCLEIC ACIDS 9**

Introduction to nucleic acid, Difference between nucleotide and nucleoside, composition of DNA & amp; RNA Structure of Nitrogen bases in DNA and RNA along with the nomenclature· DNA double helix (Watson and crick) model, types of DNA, RNA.

**UNIT V VITAMINS AND HORMONES 9**

Different types of vitamins, their diverse biochemical functions and deficiency related diseases. Overview of hormones. Hormone mediated signaling. Mechanism of action of steroid hormones, epinephrine, glucagons and insulin.Role of vitamins and hormones in metabolism; Hormonal disorders; Therapeutic uses ofvitamins and hormones.

**OUTCOMES:**

 Students will learn about various kinds of biomolecules and their physiological role.
 Students will gain knowledge about various metabolic disorders and will help them to know the importance of various biomolecules in terms of disease correlation.

**TOTAL: 45 PERIODS**

**TEXT BOOKS**


1. Lehninger Principles of Biochemistry 6th Edition by David L. Nelson, Michael M. Cox W.H.Freeman and Company 2017
2. Satyanarayana, U. and U. Chakerapani, “Biochemistry” 3rd Rev. Edition, Books & Allied (P) Ltd., 2006. 3. Rastogi, S.C. “Biochemistry” 2nd Edition, Tata McGraw-Hill, 2003.
4. Conn, E.E., etal., “Outlines of Biochemistry” 5th Edition, John Wiley & Sons, 1987.
5. Outlines of Biochemistry, 5th Edition: By E E Conn, P K Stumpf, G Bruening and R Y Doi.pp 693. John Wiley and Sons, New York. 1987.


**REFERENCES**


1. Berg, Jeremy M. et al. “Biochemsitry”, 6th Edition, W.H. Freeman & Co., 2006.
2. Murray, R.K., etal “Harper’s Illustrated Biochemistry”, 31st Edition, McGraw-Hill, 2018.
3. Voet, D. and Voet, J.G., “Biochemistry”, 4th Edition, John Wiley & Sons Inc., 2010.


**OBT354 FUNDAMENTALS OF CELL AND MOLECULAR BIOLOGY L T P C**
**3 0 0 3**

**OBJECTIVES**:

- To provide knowledge on the fundamentals of cell biology.
- To understand the signalling mechanisms.
- Understand basic principles of molecular biology at intracellular level to regulate growth,
- division and development.

**UNIT-I INTRODUCTION TO CELL 9**

Cell, cell wall and Extracellular Matrix (ECM), composition, cellular dimensions, Evolution, Organisation, differentiation of prokaryotic and Eukaryotic cells, Virus, bacteria,cyanobacteria, mycoplasma and prions.

**UNIT II CELL ORGANELLES 9**

Molecular organisation, biogenesis and functin Mitochondria, endoplasmic reticulam, golgi apparatus, plastids, chloroplast, leucoplast, centrosome, lysosome, ribosome, peroxisome, Nucleus and nucleolus. Endo membrane system, concept of compartmentalisation.

**UNIT III BIO-MEMBRANE TRANSPORT 9**

Physiochemical properties of cell membranes. Molecular constitute of membranes, asymmetrical organisation of lipids and proteins. Solute transport across membrane’s-fick’s law, simple diffusion, passive-facilitated diffusion, active transport- primary and secondary, group translocation, transport ATPases, membrane transport in bacteria and animals. Transportmechanism- mobile carriers and pores mechanisms. Transport by vesicle formation, endocytosis, exocytosis, cell respiration.

**UNIT IV CELL CYCLE 9**

Cell cycle- Cell division by mitosis and meosis, Comparision of meosis and mitosis, regulation of cell cycle, cell lysis, Cytokinesis, Cell signaling, Cell communication, Cell adhesion and Cell junction, cell cycle checkpoints.

**UNIT V CENTRAL DOGMA 9**

Overview of Central dogma DNA replication: Meselson & Stahl experiment, bi–directional DNA replication, Okazaki fragments. Structure and function of mRNA, rRNA and tRNA. RNA synthesis: Initiation, elongation and termination of RNA synthesis Introduction to Genetic code-Steps in translation: Initiation, Elongation and termination of protein synthesis.

**TOTAL: 45 PERIODS**

**OUTCOMES**:

- Understanding of cell at structural and functional level.
- Understand the central dogma of life and its significance.
- Comprehend the basic mechanisms of cell division.

**TEXTBOOKS:**

1. Cooper, G.M. and R.E. Hansman “The Cell: A Molecular Approach”, 8th Edition, Oxford University Press, 2018
2. Friefelder, David. “Molecular Biology.” Narosa Publications, 1999
3. Weaver, Robert F. “Molecular Biology” IInd Edition, Tata McGraw-Hill, 2003.

**REFERENCES:**

1. Lodish H, Berk A, MatsudairaP,Kaiser CA, Krieger M, Schot MP, Zipursky L, Darnell J. Molecular Cell Biology, 6th Edition, 2007.
2. Becker, W.M. etal., “The World of the Cell”, 9th Edition, Pearson Education, 2003.
3. Campbell, N.A., J.B. Recee and E.J. Simon “Essential Biology”, VIIrd Edition, Pearson International, 2007.
4. Alberts, Bruce etal., “Essential Cell Biology”, 4th Edition, W.W. Norton, 2013.

## OPEN ELECTIVE IV

| OHS352 | PROJECT REPORT WRITING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVE**

The Course will enable Learners to,

- Understand the essentials of project writing.
- Perceive the difference between general writing and technical writing
- Assimilate the fundamental features of report writing.
- Understand the essential differences that exist between general and technical writing.
- Learn the structure of a technical and project report.

**UNIT I** **9**

Writing Skills – Essential Grammar and Vocabulary – Passive Voice, Reported Speech, Concord, Signpost words, Cohesive Devices – Paragraph writing - Technical Writing vs. General Writing.

**UNIT II** **9**

Project Report – Definition, Structure, Types of Reports, Purpose – Intended Audience – Plagiarism – Report Writing in STEM fields – Experiment – Statistical Analysis.

**UNIT III** **9**

Structure of the Project Report: (Part 1) Framing a Title – Content – Acknowledgement – Funding Details -Abstract – Introduction – Aim of the Study – Background - Writing the research question - Need of the Study/Project Significance, Relevance – Determining the feasibility – Theoretical Framework.

**UNIT IV** **9**

Structure of the Project Report: (Part 2) – Literature Review, Research Design, Methods of Data Collection - Tools and Procedures - Data Analysis - Interpretation - Findings –Limitations - Recommendations – Conclusion – Bibliography.

**UNIT V** **9**

Proof reading a report – Avoiding Typographical Errors – Bibliography in required Format – Font – Spacing – Checking Tables and Illustrations – Presenting a Report Orally – Techniques.

**TOTAL:45 PERIODS**

**OUTCOMES**

By the end of the course, learners will be able to

- Write effective project reports.
- Use statistical tools with confidence.
- Explain the purpose and intension of the proposed project coherently and with clarity.
- Create writing texts to suit achieve the intended purpose.
- Master the art of writing winning proposals and projects.

**CO-PO & PSO MAPPING**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 2 | 1 | 1 | 1 | 1 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | - | - | - |
| 2 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 3 | 2 | 3 | - | - | - |
| 3 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 3 | - | - | - |
| 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| 5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| AVg. | 2.4 | 2.2 | 2.4 | 2.2 | 2 | 2.6 | 2.4 | 2.2 | 2.6 | 3 | 2.6 | 3 | - | - | - |

- 1-low, 2-medium, 3-high, '-"- no correlation
- **Note:** The average value of this course to be used for program articulation matrix.

**REFERENCES:**


1. Gerson and Gerson - Technical Communication: Process and Product, 7th Edition, Prentice Hall(2012)
2. Virendra K. Pamecha - Guide to Project Reports, Project Appraisals and Project Finance (2012)
3. Daniel Riordan - Technical Report Writing Today (1998)
   Darla-Jean Weatherford - Technical Writing for Engineering Professionals (2016) Penwell Publishers.


**OCE354 BASICS OF INTEGRATED WATER RESOURCES MANAGEMENT L T P C**
**3 0 0 3**

**OBJECTIVES**

- To introduce the interdisciplinary approach of water management.
- To develop knowledge base and capacity building on IWRM.

**UNIT I OVERVIEW OF IWRM 9**

Facts about water - Definition – Key challenges - Paradigm shift - Water management Principles - Social equity - Ecological sustainability – Economic efficiency - SDGs - World Water Forums.

**UNIT II WATER USE SECTORS: IMPACTS AND SOLUTION 9**

Water users: People, Agriculture, ecosystem and others - Impacts of the water use sectors on water resources - Securing water for people, food production, ecosystems and other uses - IWRM relevance in water resources management.

**UNIT III WATER ECONOMICS 9**

Economic characteristics of water good and services – Economic instruments – Private sector involvement in water resources management - PPP experiences through case studies.

**UNIT IV RECENT TREANDS IN WATER MANAGEMENT 9**

River basin management - Ecosystem Regeneration – 5 Rs - WASH - Sustainable livelihood - Water management in the context of climate change.

**UNIT V IMPLEMENTATION OF IWRM 9**

Barriers to implementing IWRM - Policy and legal framework - Bureaucratic reforms and inclusive development - Institutional Transformation - Capacity building - Case studies on conceptual framework of IWRM.

**TOTAL: 45 PERIODS**

**OUTCOMES**

- On completion of the course, the student will be able to apply appropriate management techniques towards managing the water resources.

**OUTCOMES:**

**CO1** Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management.
**CO2** Discuss on the different water uses; how it is impacted and ways to tackle these impacts.
**CO3** Explain the economic aspects of water and choose the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies.
**CO4** Illustrate the recent trends in water management.
**CO5** Understand the implementation hitches and the institutional frameworks.

**TEXT BOOKS:**

1. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.
2. Mollinga P. *et al.* " Integrated Water Resources Management", Water in South Asia Volume I, Sage Publications, 2006.

**REFERENCES**

1. Technical Advisory Committee, Background Papers No: 1, 4 and 7, Stockholm, Sweden. 2002.
2. IWRM Guidelines at River Basin Level (UNESCO, 2008).
3. Tutorial on Basic Principles of Integrated Water Resources Management ,CAP-NET. http://www.pacificwater.org/userfiles/file/IWRM/Toolboxes/introduction%20to%20iwrm/Tutorial_text.pdf
4. Pramod R. Bhave, 2011, Water Resources Systems, Narosa Publishers.
5. The 17 Goals, United Nations, https://sdgs.un.org/goals.

**OMA355 ADVANCED NUMERICAL METHODS L T P C**
**3 0 0 3**

**OBJECTIVE:**

- To impart knowledge on numerical methods that will come in handy to solve numerically the problems that arise in engineering and technology. This will also serve as a precursor for future research.

**UNIT I ALGEBRAIC EQUATIONS AND EIGENVALUE PROBLEM 9**

System of nonlinear equations : Fixed point iteration method - Newton's method; System of linear equations: Thomas algorithm for tri diagonal system - SOR iteration methods ; Eigen value problems: Given's method - Householder's method.

**UNIT II INTERPOLATION 9**

Central difference: Stirling and Bessel's interpolation formulae ; Piecewise spline interpolation: Piecewise linear, piecewise quadratic and cubic spline ; Least square approximation for continuous data (upto 3rd degree).

**UNIT III NUMERICAL METHODS FOR ORDINARY DIFFERENTIAL EQUATIONS 9**

Explicit Adams - Bashforth Techniques - Implicit Adams - Moulton Techniques, Predictor - Corrector Techniques - Finite difference methods for solving two - point linear boundary value problems - Orthogonal Collocation method.

**UNIT IV FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS 9**

Laplace and Poisson's equations in a rectangular region : Five point finite difference schemes - Leibmann's iterative methods - Dirichlet's and Neumann conditions – Laplace equation in polar coordinates : Finite difference schemes .

**UNIT V FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATIONS 9**

Parabolic equations : Explicit and implicit finite difference methods – Weighted average approximation - Dirichlet's and Neumann conditions – First order hyperbolic equations - Method of characteristics - Different explicit and implicit methods; Wave equation : Explicit scheme – Stability of above schemes.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

Upon completion of this course, the students will be able to:

CO1: demonstrate the understandings of common numerical methods for nonlinear equations, system of linear equations and eigenvalue problems;

CO2: understand the interpolation theory;

CO3: understand the concepts of numerical methods for ordinary differential equations;

CO4: demonstrate the understandings of common numerical methods for elliptic equations;

CO5: understand the concepts of numerical methods for time dependent partial differential equations

**TEXT BOOKS :**


1. Grewal, B.S., "Numerical Methods in Engineering & Science ", Khanna Publications, Delhi, 2013.
2. Gupta, S.K., "Numerical Methods for Engineers", (Third Edition), New Age Publishers, 2015.
3. Jain, M.K., Iyengar, S.R.K. and Jain, R.K., "Computational Methods for Partial Differential Equations", New Age Publishers, 1994.


**REFERENCES:**


1. Saumyen Guha and Rajesh Srivastava, "Numerical methods for Engineering and Science", Oxford Higher Education, New Delhi, 2010.
2. Burden, R.L., and Faires, J.D., "Numerical Analysis – Theory and Applications", 9 th Edition, Cengage Learning, New Delhi, 2016.
3. Gupta S.K., "Numerical Methods for Engineers",4th Edition, New Age Publishers, 2019.
4. Sastry, S.S., "Introductory Methods of Numerical Analysis", 5th Edition, PHI Learning, 2015.
5. Morton, K.W. and Mayers D.F., "Numerical solution of Partial Differential equations", Cambridge University press, Cambridge, 2002.


| | PO 01 | PO 02 | PO 03 | PO 04 | PO 05 | PO 06 | PO 07 | PO 08 | PO 09 | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | - | - | - |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | - | - | - |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | - | - | - |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | - | - | - |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | - | - | - |
| **Avg** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | - | - | - |

**OMA356 RANDOM PROCESSES L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To introduce the basic concepts of probability, one and two dimensional random variables with applications to engineering which can describe real life phenomenon.
- To understand the basic concepts of random processes which are widely used in communication networks.
- To acquaint with specialized random processes which are apt for modelling the real time scenario.
- To understand the concept of correlation and spectral densities.
- To understand the significance of linear systems with random inputs.

**UNIT I RANDOM VARIABLES 9**

Discrete and continuous random variables – Moments – Moment generating functions – Joint Distribution- Covariance and Correlation – Transformation of a random variable.

**UNIT II RANDOM PROCESSES 9**

Classification – Characterization – Cross correlation and Cross covariance functions - Stationary Random Processes – Markov process - Markov chain.

**UNIT III SPECIAL RANDOM PROCESSES 9**

Bernoulli Process – Gaussian Process - Poisson process – Random telegraph process.

**UNIT IV CORRELATION AND SPECTRAL DENSITIES 9**

Auto correlation functions – Cross correlation functions – Properties – Power spectral density – Cross spectral density – Properties.

**UNIT V LINEAR SYSTEMS WITH RANDOM INPUTS 9**

Linear time invariant system – System transfer function – Linear systems with random inputs – Auto correlation and cross correlation functions of input and output.

**TOTAL: 45 PERIODS**

**OUTCOMES**

Upon successful completion of the course, students should be able to:

- Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.
- Apply the concept random processes in engineering disciplines.
- Understand and apply the concept of correlation and spectral densities.
- Get an exposure of various distribution functions and help in acquiring skills in handling situations involving more than one variable.
- Analyze the response of random inputs to linear time invariant systems.

**TEXT BOOKS**


1. Ibe, O.C.," Fundamentals of Applied Probability and Random Processes ", 1st Indian Reprint, Elsevier, 2007.
2. Peebles, P.Z., "Probability, Random Variables and Random Signal Principles ", Tata McGraw Hill, 4th Edition, New Delhi, 2002.


**REFERENCES**


1. Cooper. G.R., McGillem. C.D., "Probabilistic Methods of Signal and System Analysis", Oxford University Press, New Delhi, 3rd Indian Edition, 2012.
2. Hwei Hsu, "Schaum's Outline of Theory and Problems of Probability, Random Variables and Random Processes ", Tata McGraw Hill Edition, New Delhi, 2004.
3. Miller. S.L. and Childers. D.G., "Probability and Random Processes with Applications to Signal Processing and Communications ", Academic Press, 2004.

4. Stark. H. and Woods. J.W., “Probability and Random Processes with Applications to Signal Processing ", Pearson Education, Asia, 3rd Edition, 2002.
5. Yates. R.D. and Goodman. D.J., “Probability and Stochastic Processes", Wiley India Pvt. Ltd., Bangalore, 2nd Edition, 2012.

| | PO 01 | PO 02 | PO 03 | PO 04 | PO 05 | PO 06 | PO 07 | PO 08 | PO 09 | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | - | - | - |
| **CO2** | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | - | - | - |
| **CO3** | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | - | - | - |
| **CO4** | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | - | - | - |
| **CO5** | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | - | - | - |
| **Avg** | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | - | - | - |

**OMA357 QUEUEING AND RELIABILITY MODELLING L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To provide necessary basic concepts in probability and random processes for applications such as random signals, linear systems in communication engineering.
- To understand the concept of queueing models and apply in engineering.
- To provide the required mathematical support in real life problems and develop probabilistic models which can be used in several areas of science and engineering.
- To study the system reliability and hazard function for series and parallel systems.
- To implement Markovian Techniques for availability and maintainability which opens up new avenues for research.

**UNIT I RANDOM PROCESSES 9**

Classification – Stationary process – Markov process - Poisson process – Discrete parameter Markov chain – Chapman Kolmogorov equations – Limiting distributions.

**UNIT II MARKOVIAN QUEUEING MODELS 9**

Markovian queues – Birth and death processes – Single and multiple server queueing models – Little’s formula - Queues with finite waiting rooms.

**UNIT III ADVANCED QUEUEING MODELS 9**

M/G/1 queue – Pollaczek Khinchin formula - M/D/1 and $M/E_K/1$ as special cases – Series queues – Open Jackson networks.

**UNIT IV SYSTEM RELIABILITY 9**

Reliability and hazard functions- Exponential, Normal, Weibull and Gamma failure distribution – Time - dependent hazard models – Reliability of Series and Parallel Systems.

**UNIT V MAINTAINABILITY AND AVAILABILITY 9**

Maintainability and Availability functions – Frequency of failures – Two Unit parallel system with repair – k out of m systems.

**TOTAL: 45 PERIODS**

**OUTCOMES**

Upon successful completion of the course, students should be able to:

- Enable the students to apply the concept of random processes in engineering disciplines.

- Students acquire skills in analyzing various queueing models.
- Students can understand and characterize phenomenon which evolve with respect to time in a probabilistic manner.
- Students can analyze reliability of the systems for various probability distributions.
- Students can be able to formulate problems using the maintainability and availability analyses by using theoretical approach.

**TEXT BOOKS**


1. Shortle J.F, Gross D, Thompson J.M,Harris C.M., “Fundamentals of Queueing Theory”, John Wiley and Sons, New York,2018.
2. Balagurusamy E., “Reliability Engineering”, Tata McGraw Hill Publishing Company Ltd., New Delhi,2010.


**REFERENCES**


1. Medhi J, ”Stochastic models of Queueing Theory”, Academic Press, Elsevier, Amsterdam, 2003.
2. Taha, H.A., "Operations Research", 9th Edition, Pearson India Education Services, Delhi, 2016.
3. Trivedi, K.S., "Probability and Statistics with Reliability, Queueing and Computer Science Applications", 2nd Edition, John Wiley and Sons, 2002.
4. Govil A.K., “Reliability Engineering”, Tata-McGraw Hill Publishing Company Ltd., New Delhi,1983.


| | PO 01 | PO 02 | PO 03 | PO 04 | PO 05 | PO 06 | PO 07 | PO 08 | PO 09 | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| **CO2** | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | - | - | - |
| **CO3** | 3 | 3 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | - | - | - |
| **CO4** | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | - | - | - |
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**OMG354 PRODUCTION AND OPERATIONS MANAGEMENT FOR ENTREPRENEURS**

| L | T | P | C |
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| 3 | 0 | 0 | 3 |

**OBJECTIVES**:

- To know the basic concept and function of Production and Operation Management for entrepreneurship.
- To understand the Production process and planning.
- To understand the Production and Operations Management Control for business owners.

**UNIT I INTRODUCTION TO PRODUCTION AND OPERATIONS MANGEMENT 9**

Functions of Production Management - Relationship between production and other functions – Production management and operations management, Characteristics of modern production and operation management, organisation of production function, recent trends in production /operations management - production as an organisational function, decision making in production Operations research

**UNIT II PRODUCTION & OPERATION SYSTEMS 9**

Production Systems- principles – Models - CAD and CAM- Automation in Production - Functions and significance- Capacity and Facility Planning: Importance of capacity planning- Capacity measurement – Capacity Requirement Planning (CRP) process for manufacturing and service industry

**UNIT III PRODUCTION & OPERATIONS PLANNING 9**

Facility Planning – Location of facilities – Location flexibility – Facility design process and techniques – Location break even analysis-Production Process Planning: Characteristic of production process systems – Steps for production process- Production Planning Control Functions – Planning phase- Action phase- Control phase - Aggregate production planning

**UNIT IV PRODUCTION & OPERATIONS MANAGEMENT PROCESS 9**

Process selection with PLC phases- Process simulation tools- Work Study – Significance – Methods, evolution of normal/ standard time – Job design and rating - Value Analysis - Plant Layout: meaning – characters –- Plant location techniques - Types- MRP and Layout Design - Optimisation and Theory of Constraints (TOC)– Critical Chain Project Management (CCPM)- REL (Relationship) Chart – Assembly line balancing- – Plant design optimisation -Forecasting methods.

**UNIT V CONTROLING PRODUCTION & OPERATIONS MANAGEMENT 9**

Material requirement planning (MRP)- Concept- Process and control - Inventory control systems and techniques – JIT and Lean manufacturing - Network techniques - Quality Management: Preventive Vs Breakdown maintenance for Quality – Techniques for measuring quality - Control Chart (X , R , p , np and C chart ) - Cost of Quality, Continuous improvement (Kaizen) - Quality awards - Supply Chain Management - Total Quality Management - 6 Sigma approach and Zero Defect Manufacturing.

**TOTAL 45: PERIODS**

**OUTCOMES:**

Upon completion of this course the learners will be able :

CO 1 To understand the basics and functions of Production and Operation Management for business owners.

CO 2 To learn about the Production & Operation Systems.

CO 3 To acquaint on the Production & Operations Planning Techniques followed by entrepreneurs in Industries.

CO 4 To known about the Production & Operations Management Processes in organisations.

CO 5 To comprehend the techniques of controlling , Production and Operations in industries.

**REFERENCES**


1. Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, Pearson, 2007.
2. Amitabh Raturi, Production and Inventory Management, , 2008.
3. Adam Jr. Ebert, Production and Operations Management, PHI Publication, 1992.
4.Muhlemann, Okland and Lockyer, Production and Operation Management, Macmillan India,1992.
6. Chary S.N, Production and Operations Management, TMH Publications, 2010.
7. Terry Hill ,Operation Management. Pal Grave McMillan (Case Study).2005.


**OMG355 MULTIVARIATE DATA ANALYSIS L T P C**
**3 0 0 3**

**OBJECTIVE:**

- To know various multivariate data analysis techniques for business research.

**UNIT I INTRODUCTION 9**

Uni-variate, Bi-variate and Multi-variate techniques – Classification of multivariate techniques – Guidelines for multivariate analysis and interpretation.

**UNIT II PREPARING FOR MULTIVARIATE ANALYSIS 9**

Conceptualization of research model with variables, collection of data –-Approaches for dealing with missing data – Testing the assumptions of multivariate analysis.

**UNIT III MULTIPLE LINEAR REGRESSION ANALYSIS, FACTOR ANALYSIS 9**

Multiple Linear Regression Analysis – Inferences from the estimated regression function – Validation of the model. -Approaches to factor analysis – interpretation of results.

**UNIT IV LATENT VARIABLE TECHNIQUES 9**

Confirmatory Factor Analysis, Structural equation modelling, Mediation models, Moderation models, Longitudinal studies.

**UNIT V ADVANCED MULTIVARIATE TECHNIQUES 9**

Multiple Discriminant Analysis, Logistic Regression, Cluster Analysis, Conjoint Analysis, multidimensional scaling.

**TOTAL: 45 PERIODS**

**OUTCOMES :**

- Demonstrate a sophisticated understanding of the concepts and methods; know the exact scopes and possible limitations of each method; and show capability of using multivariate techniques to provide constructive guidance in decision making.
- Use advanced techniques to conduct thorough and insightful analysis, and interpret the results correctly with detailed and useful information.
- Show substantial understanding of the real problems; conduct deep analysis using correct methods; and draw reasonable conclusions with sufficient explanation and elaboration.
- Write an insightful and well-organized report for a real-world case study, including thoughtful and convincing details.
- Make better business decisions by using advanced techniques in data analytics. ‘

**REFERENCES :**


1. Joseph F Hair, Rolph E Anderson, Ronald L. Tatham & William C. Black, Multivariate Data Analysis, Pearson Education, New Delhi, 2005.
2. Barbara G. Tabachnick, Linda S.Fidell, Using Multivariate Statistics, 6th Edition, Pearson, 2012.
3. Richard A Johnson and Dean W.Wichern, Applied Multivariate Statistical Analysis, Prentice Hall, New Delhi, 2005.
4. David R Anderson, Dennis J Seveency, and Thomas A Williams, Statistics for Business and Economics, Thompson, Singapore, 2002.


**CME343 NEW PRODUCT DEVELOPMENT**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES**

1 To introduce the fundamental concepts of the new product development
2 To develop material specifications, analysis and process.
3 To Learn the Feasibility Studies & reporting of new product development.
4 To study the New product qualification and Market Survey on similar products of new product development
To learn Reverse Engineering. Cloud points generation, converting cloud data to 3D model

**UNIT – I FUNDAMENTALS OF NPD 9**

Introduction – Reading of Drawing – Grid reading, Revisions, ECN (Engg. Change Note), Component material grade, Specifications, customer specific requirements – Basics of monitoring of NPD applying Gantt chart, Critical path analysis – Fundamentals of BOM (Bill of Materials), Engg. BOM & Manufacturing BOM. Basics of MIS software and their application in industries like SAP, MS Dynamics, Oracle ERP Cloud – QFD.

**UNIT – II MATERIAL SPECIFICATIONS, ANALYSIS & PROCESS 9**

Material specification standards – ISO, DIN, JIS, ASTM, EN, etc. – Awareness on various manufacturing process like Metal castings & Forming, Machining (Conventional, 3 Axis, 4 Axis, 5 Axis, ), Fabrications, Welding process. Qualifications of parts mechanical, physical & Chemical properties and their test report preparation and submission. Fundamentals of DFMEA & PFMEA, Fundamentals of FEA, Bend Analysis, Hot Distortion, Metal and Material Flow, Fill and Solidification analysis.

**UNIT – III ESSENTIALS OF NPD 9**

RFQ (Request of Quotation) Processing – Feasibility Studies & reporting – CFT (Cross Function Team) discussion on new product and reporting – Concept design, Machine selection for tool making, Machining – Manufacturing Process selection, Machining Planning, cutting tool selection – Various Inspection methods – Manual measuring, CMM – GOM (Geometric Optical Measuring), Lay out marking and Cut section analysis. Tool Design and Detail drawings preparation, release of details to machine shop and CAM programing. Tool assembly and shop floor trials. Initial sample submission with PPAP documents.

**UNIT – IV CRITERIONS OF NPD 9**

New product qualification for Dimensions, Mechanical & Physical Properties, Internal Soundness proving through X-Ray, Radiography, Ultrasonic Testing, MPT, etc. Agreement with customer for testing frequencies. Market Survey on similar products, Risk analysis, validating samples with simulation results, Lesson Learned & Horizontal deployment in NPD.

**UNIT – V REPORTING & FORWARD-THINKING OF NPD 9**

Detailed study on PPAP with 18 elements reporting, APQP and its 5 Sections, APQP vs PPAP, Importance of SOP (Standard Operating Procedure) – Purpose & documents, deployment in shop floor. Prototyping & RPT - Concepts, Application and its advantages, 3D Printing – resin models, Sand cores for foundries; Reverse Engineering. Cloud points generation, converting cloud data to 3D model – Advantages & Limitation of RE, CE (Concurrent Engineering) – Basics, Application and its advantages in NPD (to reduce development lead time, time to Market, Improve productivity and product cost.)

**TOTAL :45 PERIODS**

**OUTCOMES:** At the end of the course the students would be able to

1. Discuss fundamental concepts and customer specific requirements of the New Product development
2. Discuss the Material specification standards, analysis and fabrication, manufacturing process.
3. Develop Feasibility Studies & reporting of New Product development
4. Analyzing the New product qualification and Market Survey on similar products of new product development
5. Develop Reverse Engineering. Cloud points generation, converting cloud data to 3D model

**TEXT BOOKS:**

1. Product Development – Sten Jonsson
2. Product Design & Development – Karl T. Ulrich, Maria C. Young, Steven D. Eppinger

**REFERENCES:**

1. Revolutionizing Product Development – Steven C Wheelwright & Kim B. Clark
2. Change by Design
3. Toyota Product Development System – James Morgan & Jeffrey K. Liker
4. Winning at New Products – Robert Brands 3rd Edition
5. Product Design & Value Engineering – Dr. M.A. Bulsara &Dr. H.R. Thakkar

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| 3 | 1 | 1 | 3 | 1 | | | | 1 | 1 | | | 1 | 1 | 3 | 2 |
| 4 | 1 | 1 | 3 | 1 | | | | 1 | 1 | | | 1 | 1 | 3 | 2 |
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**OME355 INDUSTRIAL DESIGN & RAPID PROTOTYPING TECHNIQUES L T P C**
**3 0 0 3**

**OBJECTIVES:**

The course aims to

- Outline Fundamental concepts in UI & UX
- Introduce the principles of Design and Building an mobile app
- Illustrate the use of CAD in product design
- Outline the choice and use of prototyping tools
- Understanding design of electronic circuits and fabrication of electronic devices

**UNIT I UI/UX 9**

Fundamental concepts in UI & UX - Tools - Fundamentals of design principles - Psychology and Human Factors for User Interface Design - Layout and composition for Web, Mobile and Devices - Typography - Information architecture - Color theory - Design process flow, wireframes, best practices in the industry -User engagement ethics - Design alternatives

**UNIT II APP DEVELOPMENT 9**

SDLC - Introduction to App Development - Types of Apps - web Development - understanding Stack - Frontend - backend - Working with Databases - Introduction to API - Introduction to Cloud services - Cloud environment Setup- Reading and writing data to cloud - Embedding ML models to Apps - Deploying application.

**UNIT III INDUSTRIAL DESIGN 9**

Introduction to Industrial Design - Points, lines, and planes - Sketching and concept generation - Sketch to CAD - Introduction to CAD tools - Types of 3D modeling - Basic 3D Modeling Tools - Part creation – Assembly - Product design and rendering basics - Dimensioning & Tolerancing

**UNIT IV MECHANICAL RAPID PROTOTYPING 9**

Need for prototyping - Domains in prototyping - Difference between actual manufacturing and prototyping - Rapid prototyping methods - Tools used in different domains - Mechanical Prototyping; 3D Printing and classification - Laser Cutting and engraving - RD Works - Additive manufacturing

**UNIT V ELECTRONIC RAPID PROTOTYPING 9**

Basics of electronic circuit design - lumped circuits - Electronic Prototyping - Working with simulation tool - simple PCB design with EDA

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

**At the end of the course, learners will be able to:**

- Create quick UI/UX prototypes for customer needs
- Develop web application to test product traction / product feature
- Develop 3D models for prototyping various product ideas
- Built prototypes using Tools and Techniques in a quick iterative methodology

**TEXT BOOKS**


1. Peter Fiell, Charlotte Fiell, Industrial Design A-Z, TASCHEN America Llc(2003)
2. Samar Malik, Autodesk Fusion 360 - The Master Guide.
3. Steve Krug, Don't Make Me Think, Revisited: A Common Sense Approach to Web Usability, Pearson,3rd edition(2014)


**REFERENCES:**


1. https://www.adobe.com/products/xd/learn/get-star ted.html
2. https://developer.android.com/guide
3. https://help.autodesk.com/view/fusion360/ENU/courses/

4. https://help.prusa3d.com/en/categor y/prusaslicer_204

**MF3010 MICRO AND PRECISION ENGINEERING LT P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

At the end of this course the student should be able to

- Learn about the precision machine tools
- Learn about the macro and micro components.
- Understand handling and operating of the precision machine tools.
- Learn to work with miniature models of existing machine tools/robots and other instruments.
- Learn metrology for micro system

**UNIT I INTRODUCTION TO MICROSYSTEMS 9**

Design, and material selection, micro-actuators: hydraulic, pneumatic, electrostatic/ magnetic etc. for medical to general purpose applications. Micro-sensors based on Thermal, mechanical, electrical properties; micro-sensors for measurement of pressure, flow, temperature, inertia, force, acceleration, torque, vibration, and monitoring of manufacturing systems.

**UNIT II FABRICATION PROCESSES FOR MICRO-SYSTEMS: 9**

Additive, subtractive, forming process, microsystems-Micro-pumps, micro- turbines, micro engines, micro-robot, and miniature biomedical devices

**UNIT III INTRODUCTION TO PRECISION ENGINEERING 9**

Machine tools, holding and handling devices, positioning fixtures for fabrication/ assembly of microsystems. Precision drives: inch worm motors, ultrasonic motors, stick- slip mechanism and other piezo-based devices.

**UNIT IV PRECISION MACHINING PROCESSES 9**

Precision machining processes for macro components - Diamond turning, fixed and free abrasive processes, finishing processes.

**UNIT V METROLOGY FOR MICRO SYSTEMS 9**

Metrology for micro systems - Surface integrity and its characterization.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon the completion of this course the students will be able to

- Select suitable precision machine tools and operate
- Apply the macro and micro components for fabrication of micro systems.
- Apply suitable machining process
- Able to work with miniature models of existing machine tools/robots and other instruments.
- Apply metrology for micro system

**TEXT BOOKS:**

1. Davim, J. Paulo, ed. Microfabrication and Precision Engineering: Research and Development. Woodhead Publishing, 2017
2. Gupta K, editor. Micro and Precision Manufacturing. Springer; 2017

**REFERENCES:**

1. Dornfeld, D., and Lee, D. E., Precision Manufacturing, 2008, Springer.

2. H. Nakazawa, Principles of Precision Engineering, 1994, Oxford University Press.
3. Whitehouse, D. J., Handbook of Surface Metrology, Institute of Physics Publishing, Philadelphia PA, 1994.
4. Murthy.R.L, —Precision Engineering in Manufacturing‖, New Age International, New Delhi, 2005

**OMF354 COST MANAGEMENT OF ENGINEERING PROJECTS LT P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

Summarize the costing concepts and their role in decision making
Infer the project management concepts and their various aspects in selection
Interpret costing concepts with project execution
Develop knowledge of costing techniques in service sector and various budgetary control techniques
Illustrate with quantitative techniques in cost management

**UNIT – I INTRODUCTION TO COSTING CONCEPTS 9**

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.'

**UNIT – II INTRODUCTION TO PROJECT MANAGEMENT 9**

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts

**UNIT – III PROJECT EXECUTION AND COSTING CONCEPTS 9**

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing

**UNIT – IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9**

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

**UNIT – V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9**

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:
CO1: Understand the costing concepts and their role in decision making.
CO2: Understand the project management concepts and their various aspects in selection.
CO3: Interpret costing concepts with project execution.
CO4:Gain knowledge of costing techniques in service sector and various budgetary control techniques.
CO5: Become familiar with quantitative techniques in cost management.

**TEXT BOOKS:**

1. John M. Nicholas, Herman Steyn Project Management for Engineering, Business and Technology, Taylor & Francis, 2 August 2020, ISBN: 9781000092561.

2. Albert Lester ,Project Management, Planning and Control, Elsevier/Butterworth-Heinemann, 2007, ISBN: 9780750669566, 075066956X.

**REFERENCES:**

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991.
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988.
3. Charles T. Horngren et al Cost Accounting a Managerial Emphasis, Prentice Hall of India, New Delhi, 2011.
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003.
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007.

**AU3002 BATTERIES AND MANAGEMENT SYSTEM L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- The objective of this course is to make the students to understand the working and characteristics of different types of batteries and their management.

**UNIT I ADVANCED BATTERIES 9**

Li-ion Batteries-different formats, chemistry, safe operating area, efficiency, aging. Characteristics-SOC,DOD, SOH. Balancing-Passive Balancing Vs Active Balancing. Other Batteries-NCM and NCA Batteries. *NCR18650B* specifications.

**UNIT II BATTERY PACK 9**

Battery Pack- design, sizing, calculations, flow chart, real and simulation Model.Peak power – definition, testing methods-relationships with Power, Temperature and ohmic Internal Resistance. Cloud based and Local Smart charging.

**UNITIII BATTERY MODELLING 9**

Battery Modelling Methods-Equivalent Circuit Models, Electrochemical Model, Neural Network Model. ECM Comparisons- Rint model, Thevenin model, PNGV model. State space Models-Introduction. Battery Modelling software/simulation frameworks

**UNIT IV BATTERY STATE ESTIMATION 9**

SOC Estimation- Definition, importance, single cell Vs series batteries SOC. Estimation Methods-Load voltage, Electromotive force, AC impedance, Ah counting, Neural networks, Neuro-fuzzy forecast method, Kalman filter. Estimation Algorithms.

**UNIT V BMS ARCHITECTURE AND REAL TIME COMPONENTS 9**

Battery Management System- need, operation, classification. BMS ASIC-bq76PL536A-Q1 Battery Monitor IC- CC2662R-Q1 Wireless BMS MCU. Communication Modules- CAN Open-Flex Ray-CANedge1 package.ARBIN Battery Tester. BMS Development with Modeling software and Model-Based Design.

**TOTAL =45 PERIODS**

**COURSE OUTCOMES:**

At the end of this course, students will be able to

1. Acquire knowledge of different Li-ion Batteries performance.
2. Design a Battery Pack and make related calculations.
3. Demonstrate a BatteryModel or Simulation.
4. Estimate State-of-Charges in a Battery Pack.

5. Approach different BMS architectures during real world usage.

**TEXT BOOKS**

1. Jiuchun Jiang and Caiping Zhang, “Fundamentals and applications of Lithium-Ion batteriesin Electric Drive Vehicles’’, Wiley, 2015.
2. Davide Andrea ,“Battery Management Systems for Large Lithium-Ion Battery Packs” ARTECH House, 2010.

**REFERENCE BOOKS**

1. Developing Battery Management Systems with Simulink and Model-Based Design-whitepaper
2. Panasonic *NCR18650B- DataSheet*
3. bq76PL536A-Q1- IC DataSheet
4. CC2662R-Q1- IC DataSheet

**AU3008 SENSORS AND ACTUATORS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- The objective of this course is to make the students to list common types of sensor and actuators used in automotive vehicles.

**UNIT I INTRODUCTION TO MEASUREMENTS AND SENSORS 9**

Sensors: Functions- Classifications- Main technical requirement and trends Units and standards- Calibration methods- Classification of errors- Error analysis- Limiting error- Probable error- Propagation of error- Odds and uncertainty- principle of transduction-Classification. Static characteristics- mathematical model of transducers- Zero, First and Second order transducers- Dynamic characteristics of first and second order transducers for standard test inputs.

**UNIT II VARIABLE RESISTANCE AND INDUTANCE SENSORS 9**

Principle of operation- Construction details- Characteristics and applications of resistive potentiometer- Strain gauges- Resistive thermometers- Thermistors- Piezoresistive sensors Inductive potentiometer- Variable reluctance transducers:- EI pick up and LVDT

**UNIT III VARIABLE AND OTHER SPECIAL SENSORS 9**

Variable air gap type, variable area type and variable permittivity type- capacitor microphone Piezoelectric, Magnetostrictive, Hall Effect, semiconductor sensor- digital transducers-Humidity Sensor. Rain sensor, climatic condition sensor, solar, light sensor, antiglare sensor.

**UNIT IV AUTOMOTIVE ACTUATORS 9**

Electromechanical actuators- Fluid-mechanical actuators- Electrical machines- Direct-current machines- Three-phase machines- Single-phase alternating-current Machines - Duty-type ratings for electrical machines. Working principles, construction and location of actuators viz. Solenoid, relay, stepper motor etc.

**UNIT V AUTOMATIC TEMPERATURE CONTROL ACTUATORS 9**

Different types of actuators used in automatic temperature control- Fixed and variable displacement temperature control- Semi Automatic- Controller design for Fixed and variable displacement type air conditioning system.

**TOTAL =45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, the student will be able to

1. List common types of sensor and actuators used in vehicles.
2. Design measuring equipment's for the measurement of pressure force, temperature and flow.
3. Generate new ideas in designing the sensors and actuators for automotive application
4. Understand the operation of thesensors, actuators and electronic control.
5. Design temperature control actuators for vehicles.

**TEXT BOOKS:**


1. Doebelin's Measurement Systems: 7th Edition (SIE),Ernest O. Doebelin DhaneshN.Manik McGraw Hill Publishers, 2019.
2. Robert Brandy, " Automotive Electronics and Computer System", Prentice Hall,2001
3. William Kimberley," Bosch Automotive Handbook", 6th Edition, Robert Bosch GmbH, 2004.
4. Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th Edition, 2007, ISBN No: 978-3-658-01783-5.


**REFERENCES:**


1. James D Halderman, " Automotive Electrical and Electronics" , Prentice Hall, USA, 2013
2. Tom Denton, "Automotive Electrical and Electronics Systems," Third Edition, 2004, SAE International.
3. Patranabis.D, " Sensors and Transducers", 2nd Edition, Prentice Hall India Ltd,2003
4. William Ribbens, "Understanding Automotive Electronics -An Engineering Perspective," 7th Edition, Elsevier Butterworth-Heinemann Publishers, 2012.


**OAS353 SPACE VEHICLES**

| L | T | P | C |
|---|---|---|---|
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**OBJECTIVES:**

- To interpret the missile space stations, space vs earth environment.
- To explain the life support systems, mission logistics and planning.
- To deploy the skills effectively in the understanding of space vehicle configuration design.
- To explain Engine system and support of space vehicle
- To interpret nose cone configuration of space vehicle

**UNIT I FUNDAMENTAL ASPECTS 9**

Energy and Efficiencies of power plants for space vehicles – Typical Performance Values – Mission design – Structural design aspects during launch - role of launch environment on launch vehicle integrity.

**UNIT II SELECTION OF ROCKET PROPULSION SYSTEMS 9**

Ascent flight mechanics – Launch vehicle selection process – Criteria for Selection for different missions – selection of subsystems – types of staging – Interfaces – selection and criteria for stages and their role in launch vehicle configuration design.

**UNIT III ENGINE SYSTEMS, CONTROLS, AND INTEGRATION 9**

Propellant Budget – Performance of Complete or Multiple Rocket Propulsion Systems – Engine Design – Engine Controls – Engine System Calibration – System Integration and Engine Optimization.

**UNIT IV THRUST VECTOR CONTROL 9**

TVC Mechanisms with a Single Nozzle – TVC with Multiple Thrust Chambers or Nozzles – Testing – Integration with Vehicle – SITVC method – other jet control methods - exhaust plume problems in space environment

**UNIT V NOSE CONE CONFIGURATION 9**

Aerodynamic aspects on the selection of nose shape of a launch vehicle - design factors in the finalization of nose configuration with respect to payload - nose cone thermal protection system - separation of fairings - payload injection mechanism

**TOTAL: 45 PERIODS**

**OUTCOMES:**

On successful completion of this course, the student will be able to

- Explain exotic space propulsion concepts, such as nuclear, solar sail, and antimatter.
- Apply knowledge in selecting the appropriate rocket propulsion systems.
- Interpret the air-breathing propulsion suitable for initial stages and fly-back boosters.
- Analyze aerodynamics aspect, including boost-phase lift and drag, hypersonic, and re-entry.
- Adapt from aircraft engineers moving into launch vehicle, spacecraft, and hypersonic vehicle design.

**OIM352 MANAGEMENT SCIENCE L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

Of this course are

1. To introduce fundamental concepts of management and organization to students.
2. Toi mpart knowledge to students on various aspects of marketing, quality control and marketing strategies.
3. To make students familiarize with the concepts of human resources management.
4. To acquaint students with the concepts of project management and cost analysis.
5. To make students familiarize with the concepts of planning process and business strategies.

**UNITI INTRODUCTION TO MANAGEMENT AND ORGANISATION 9**

Concepts of Management and organization- nature, importance and Functions of Management, Systems Approach to Management - Taylor's Scientific Management Theory- Fayal's Principles of Management- Maslow's theory of Hierarchy of Human Needs- Douglas McGregor's TheoryXandTheoryY-HertzbergTwoFactorTheoryofMotivation-
LeadershipStyles,Socialresponsibilities of Management, Designing Organisational Structures: Basic concepts related to Organisation -Departmentation and Decentralisation.

**UNITII OPERATIONS AND MARKETING MANAGEMENT 9**

Principles and Types of Plant Layout-Methods of Production(Job, batch and Mass Production),Work Study - Basic procedure involved in Method Study and Work Measurement - BusinessProcessReengineering(BPR)-
StatisticalQualityControl:controlchartsforVariablesandAttributes (simple Problems) and Acceptance Sampling, Objectives of Inventory control, EOQ,ABC Analysis, Purchase Procedure, Stores Management and Store Records - JIT System,Supply Chain Management, Functions of Marketing, Marketing Mix, and Marketing Strategies based on ProductLifeCycle.

**UNITIII HUMAN RESOURCES MANAGEMENT 9**

Concepts of HRM, HRD and Personnel Management and Industrial Relations (PMIR), HRM vs PMIR, Basic functions of HR Manager:Manpower planning, Recruitment, Selection, TrainingandDevelopment,WageandSalaryAdministration,Promotion,Transfer,PerformanceApprais al, Grievance Handling and Welfare Administration, Job Evaluation and Merit Rating –Capability Maturity Model (CMM)Levels.

**UNITIV PROJECT MANAGEMENT 9**

Network Analysis, Programme Evaluation and Review Technique (PERT), Critical Path Method(CPM), identifying critical path, Probability of Completing the project within given time, Project Cost Analysis,Project Crashing (simple problems).

**UNITV STRATEGIC MANAGEMENT AND CONTEMPORARY STRATEGIC ISSUES 9**

Mission, Goals, Objectives, Policy, Strategy, Programmes, Elements of Corporate Planning Process, Environmental Scanning, Value Chain Analysis, SWOT Analysis, Steps in Strategy Formulation and Implementation, Generic Strategy alternatives. Bench Marking and Balanced Score Cardas Contemporary Business Strategies.

**TOTAL: 45 PERIODS**

**COURSEOUTCOMES:**

Upon completion of the course, Students will be able to

CO1:Plananorganizationalstructureforagivencontextintheorganisationtocarryoutproductionoperations throughWork-study.

CO2:Surveythemarkets,customersandcompetitionbetterandpricethegivenproductsappropriatey

CO3:Ensurequalityforagivenproduct or service.

CO4:Plan, schedule and control projects through PERTandCPM.

CO5:Evaluate strategyforabusiness orserviceorganisation.

| CO's | PO's | | | | | | | | | | | | PSO's | | |
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| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | | | 3 | 3 | 3 | | 3 | 3 | 2 | | | 2 | 3 | |
| 2 | 3 | | | 2 | 3 | 3 | | 2 | 3 | 2 | | | | 2 | |
| 3 | 3 | | | 3 | 2 | 2 | | 3 | 2 | 2 | | | | | 2 |
| 4 | 3 | | | 3 | 3 | 2 | | 3 | 2 | 3 | | | | | 3 |
| 5 | 3 | | | 2 | 3 | 3 | | 2 | 3 | 3 | | | 2 | 1 | |
| AVg. | 3 | | | 2.6 | 2.8 | 2.6 | | 2.6 | 2.6 | 2.4 | | | 2 | 2 | 2.5 |

**TEXTBOOKS:**


1. KanishkaBedi, Production and Operations Management, Oxford University Press, 2007.
2. Stoner,Freeman,Gilbert, Management,6th Ed, PearsonEducation,NewDelhi,2004.
3. ThomasN.Duening & John M.Ivancevich Management Principles and Guidelines, Biztantra, 2007.
4. P.VijayKumar,N.Appa Rao and Ashnab, Chnalill, CengageLearning India,2012.


**REFERECES:**


1. KotlerPhilip and KellerKevinLane: Marketing Management, Pearson, 2012.
2. KoontzandWeihrich: Essentials of Management, McGrawHill, 2012.
3. Lawrence RJauch,R.Guptaand William F. Glueck: Business Policy and Strategic Management Science,McGrawHill,2012.
4. SamuelC.Certo:Modern Management,2012.


**OIM353 PRODUCTION PLANNING AND CONTROL**

**L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To understand the concept of production planning and control act work study,
- To apply the concept of product planning,
- To analyze the production scheduling,
- To apply the Inventory Control concepts.
- To prepare the manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

**UNIT I INTRODUCTION 9**

Objectives and benefits of planning and control-Functions of production control-Types of production- job- batch and continuous-Product development and design-Marketing aspect - Functional aspects- Operational aspect-Durability and dependability aspect aesthetic aspect. Profit consideration- Standardization, Simplification & specialization- Break even analysis-Economics of a new design.

**UNITII WORK STUDY 9**

Method study, basic procedure-Selection-Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards.

**UNITIII PRODUCT PLANNING AND PROCESS PLANNING 9**

Product planning-Extending the original product information-Value analysis-Problems in lack of product planning-Process planning and routing-Pre requisite information needed for process planning- Steps in process planning-Quantity determination in batch production-Machine capacity, balancing- Analysis of process capabilities in a multi product system.

**UNITIV PRODUCTION SCHEDULING 9**

Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules-Gantt charts-Perpetual loading-Basic scheduling problems - Line of balance – Flow production scheduling- Batch production scheduling-Product sequencing – Production Control systems-Periodic batch control-Material requirement planning kanban – Dispatching-Progress reporting and expediting- Manufacturing lead time-Techniques for aligning completion times and due dates.

**UNIT V INVENTORY CONTROL AND RECENT TRENDS IN PPC 9**

Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures. Two bin system - Ordering cycle system-Determination of Economic order quantity and economic lot size- ABC analysis - Recorder procedure-Introduction to computer integrated production planning systems- elements of JUST IN TIME SYSTEMS-Fundamentals of MRP II and ERP.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course,

CO1:The students can able to prepare production planning and control act work study,
CO2:The students can able to prepare product planning,
CO3:The students can able to prepare production scheduling,
CO4:The students can able to prepare Inventory Control.
CO5:They can plan manufacturing requirements manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

**TEXT BOOKS:**


1. James. B. Dilworth, ”Operations management – Design, Planning and Control for manufacturing and services” Mcgraw Hill International edition 1992.
2. Martand Telsang, “Industrial Engineering and Production Management”, First edition, S. Chand and Company, 2000.


**REFERENCES**


1. Chary. S.N., “Theory and Problems in Production & Operations Management”, Tata McGraw Hill, 1995.
2. Elwood S.Buffa, and Rakesh K.Sarin, “Modern Production / Operations Management”, 8th Edition John Wiley and Sons, 2000
3. 3. Jain. K.C. & Aggarwal. L.N., “Production Planning Control and Industrial Management”, Khanna Publishers, 1990

4. 4. Kanishka Bedi, “Production and Operations management”, 2nd Edition, Oxford university press, 2007
5. Melynk, Denzler, “ Operations management – A value driven approach” Irwin Mcgraw hill.
6. Norman Gaither, G. Frazier, “Operations Management” 9th Edition, Thomson learning IE, 2007
7. Samson Eilon, “Elements of Production Planning and Control”, Universal Book Corpn.1984
8. Upendra Kachru, “ Production and Operations Management – Text and cases” 1st Edition, Excel books 2007

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 3 | | | 3 | | 1 | | | | 1 | | 3 | | |
| 2 | 3 | 2 | | | 3 | | | | | | | | | 2 | |
| 3 | | 2 | | | 3 | | | | | | | | | 2 | |
| 4 | | 2 | 2 | | | | | | | | | | | | |
| 5 | 3 | 3 | 2 | | | | | | | | | | | 1 | |
| AVg. | 3 | 2.6 | 2 | | 3 | | 1 | | | | 1 | | 3 | 1.8 | |

**OIE353 OPERATIONS MANAGEMENT L T P C**
**3 0 0 3**

**COURSE OBJECTIVE:**

- Recognize and appreciate the concept of Production and Operations Management in creating and enhancing a firm’s competitive advantages.
- Describe the concept and contribution of various constituents of Production and Operations Management (both manufacturing and service).
- Relate the interdependence of the operations function with the other key functional areas of a firm.
- Teach analytical skills and problem-solving tools to the analysis of the operations problems.
- Apply scheduling and Lean Concepts for improving System Performance.

**UNIT I INTRODUCTION TO OPERATIONS MANAGEMENT 9**

Operations Management – Nature, Importance, historical development, transformation processes, differences between services and goods, a system perspective, functions, challenges, current priorities, recent trends; Operations Strategy – Strategic fit , framework; Supply Chain Management

**UNIT II FORECASTING, CAPACITY AND FACILITY DESIGN 9**

Demand Forecasting – Need, Types, COURSE OBJECTIVES and Steps. Overview of Qualitative and Quantitative methods. Capacity Planning - Long range, Types, Developing capacity alternatives. Overview of sales and operations planning. Overview of MRP, MRP II and ERP. Facility Location – Theories, Steps in Selection, Location Models. Facility Layout – Principles, Types, Planning tools and techniques.

**UNIT III DESIGN OF PRODUCT, PROCESS AND WORK SYSTEMS 9**

Product Design – Influencing factors, Approaches, Legal, Ethical and Environmental issues. Process – Planning, Selection, Strategy, Major Decisions. Work Study – COURSE OBJECTIVES, Procedure. Method Study and Motion Study. Work Measurement and Productivity – Measuring Productivityand Methods to improve productivity.

**UNIT IV MATERIALS MANAGEMENT 9**

Materials Management – COURSE OBJECTIVES, Planning, Budgeting and Control. Purchasing – COURSE OBJECTIVES, Functions, Policies, Vendor rating and Value Analysis. Stores Management – Nature, Layout, Classification and Coding. Inventory – COURSE OBJECTIVES, Costs and control techniques. Overview of JIT.

**UNIT V SCHEDULING AND PROJECT MANAGEMENT 9**

Project Management – Scheduling Techniques, PERT, CPM; Scheduling - work centers – nature, importance; Priority rules and techniques, shopfloor control; Flow shop scheduling – Johnson"sAlgorithm – Gantt charts; personnel scheduling in services.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1:** The students will appreciate the role of Production and Operations management in enabling and enhancing a firm's competitive advantages in the dynamic business environment.

**CO2:** The students will obtain sufficient knowledge and skills to forecast demand for Production and Service Systems.

**CO3:** The students will able to Formulate and Assess Aggregate Planning strategies and Material Requirement Plan.

**CO4:** The students will be able to develop analytical skills to calculate capacity requirements and developing capacity alternatives.

**CO5:** The students will be able to apply scheduling and Lean Concepts for improving System Performance.

**CO's- PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | | | | | | | | | | | 2 | | | |
| 2 | | 3 | 3 | | | | | | | | | | | 3 | 3 |
| 3 | | 2 | 3 | 3 | | | | | | | | | 2 | 3 | |
| 4 | | 3 | 3 | 3 | | | | | | | | | 2 | 3 | |
| 5 | | | 3 | 2 | | | | | | | | | | | |
| AVg. | 3 | 2.6 | 3 | 2.6 | | | | | | | | 2 | 2 | 3 | 3 |

**TEXT BOOKS**


1. Richard B. Chase, Ravi Shankar, F. Robert Jacobs, Nicholas J. Aquilano, Operations andSupply Management, Tata McGraw Hill, 12th Edition, 2010.
2. Norman Gaither and Gregory Frazier, Operations Management, South Western CengageLearning, 2002.


**REFERENCES**


1. William J Stevenson, Operations Management, Tata McGraw Hill, 9th Edition, 2009.
2. Russel and Taylor, Operations Management, Wiley, Fifth Edition, 2006.
3. Kanishka Bedi, Production and Operations Management, Oxford University Press, 2004.
4. Chary S. N, Production and Operations Management, Tata McGraw Hill, Third Edition, 2008.
5. Aswathappa K and Shridhara Bhat K, Production and Operations Management, HimalayaPublishing House, Revised Second Edition, 2008.
6. Mahadevan B, Operations Management Theory and practice, Pearson Education, 2007.
7. Pannerselvam R, Production and Operations Management, Prentice Hall India, Second Edition, 2008.

**OSF352** **INDUSTRIAL HYGIENE** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

1. Demonstrate an understanding of how occupational hygiene standards are set and used in work health and safety.
2. Compare and contrast the roles of environmental and biological monitoring in work health and safety
3. Outline strategies for identifying, assessing and controlling risks associated with airborne gases, vapours and particulates
4. Discuss how personal protective equipment can be used to reduce risks associated with workplace exposures
5. Provide high-level advice on managing and controlling noise and noise-related hazards

**UNIT I INTRODUCTION AND SCOPE 9**

Occupational Health and Environmental Safety Management - Principles practices. Comm on Occupational diseases: Occupational Health Management Services at the work place. Pre-employment, periodic medical examination of workers, medical surveillance for control of occupational diseases and health records.

**UNIT II MONITORING FOR SAFETY, HEALTH & ENVIRONMENT 9**

Occupational Health and Environment Safety Management System, ILO and EPA Standards Industrial Hygiene: Definition of Industrial Hygiene, Industrial Hygiene: Control Methods, Substitution, Changing the process, Local Exhaust Ventilation, Isolation, Wet method, Personal hygiene, housekeeping and maintenance, waste disposal, special control measures.

**UNIT III OCCUPATIONAL HEALTH AND ENVIRONMENTAL SAFETY EDUCATION 9**

Element of training cycle, Assessment of needs.Techniques of training, design and development of training programs.Training methods and strategies types of training.Evaluation and review of training programs. Occupational Health Hazards, Promoting Safety, Safety and Health training, Stress and Safety, Exposure Limit .

**UNIT IV OCCUPATIONAL SAFETY, HEALTH AND ENVIRONMENT MANAGEMENT 9**

Bureau of Indian standards on safety and health 14489 - 1998 and 15001 – 2000, OSHA, Process Safety Management (PSM) as per OSHA, PSM principles, OHSAS – 18001, EPA Standards, Performance measurements to determine effectiveness of PSM. Importance of Industrial safety, role of safety department,

**UNIT-V INDUSTRIAL HAZARDS 9**

i. Radiation: Types and effects of radiation on human body, Measurement and detection of radiation intensity. Effects of radiation on human body, Measurement – disposal of radioactive waste, Control of radiation ii. Noise and Vibration: Sources, and its control, Effects of noise on the auditory system and health, Measurement of noise , Different air pollutants in industries, Effect of different gases and particulate matter ,acid fumes ,smoke, fog on human health, Vibration: effects.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Students able to

CO1: Explain and apply human factors engineering concepts in both evaluation of existing systems and design of new systems

CO2: Specify designs that avoid occupation related injuries

CO3: Define and apply the principles of work design, motion economy, and work environment design.

CO4: Identify the basic human sensory, cognitive, and physical capabilities and limitations with respect to human-machine system performance.

CO5: Acknowledge the impact of workplace design and environment on productivity

**TEXT BOOKS:**

1. R. K. Jain and Sunil S. Rao , Industrial Safety , Health and Environment Management Systems, Khanna publishers, New Delhi (2006)
2. Slote. L, Handbook of Occupational Safety and Health, John Willey and Sons, New York .

**REFERENCES:**

1. Jeanne MagerStellman, Encyclopedia of Occupational Health and Safety (ILO) Ms. Irma Jourdan publication
2. Frank P Lees - Loss of prevention in Process Industries, Vol. 1 and 2,
3. ButterworthHeinemann Ltd., London (1991). 2. Industrial Safety - National Safety Council of India
4. Frank P Lees – Loss of prevention in Process Industries , Vol. 1 and 2, Butterworth- Heinemann Ltd., London
5. R. K. Jain and Sunil S. Rao, Industrial Safety , Health and Environment Management Systems, Khanna publishers, New Delhi (2006).

**CO's- PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 2 | | 2 | | 2 | - | - | - | - | - | 2 | - | - | - | - |
| 2 | - | | 2 | | - | - | 1 | - | - | - | 1 | - | - | - | - |
| 3 | - | | - | | 2 | - | - | - | - | - | 2 | - | - | - | - |
| 4 | - | | - | | - | - | - | - | 2 | - | 3 | - | - | - | - |
| 5 | - | | - | | - | - | - | 1 | - | - | - | - | - | - | - |
| AVg. | 2 | - | 2 | - | - | - | 1 | 1 | 2 | - | 2 | | - | - | - |

**OSF353 CHEMICAL PROCESS SAFETY L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- Teach the principles of safety applicable to the design, and operation of chemical process plants.
- Ensure that potential hazards are identified and mitigation measures are in place to prevent unwanted release of energy.
- Learn about the hazardous chemicals into locations that could expose employees and others to serious harm.
- Focuses on preventing incidents and accidents during large scale manufacturing of chemicals and pharmaceuticals.
- Ensure that the general design of the plant is capable of complying with the dose limits in force and with the radioactive releases.

**UNIT I SAFETY IN THE STORAGE AND HANDLING OF CHEMICALS AND GASES 9**

Types of storage-general considerations for storage layouts- atmospheric venting, pressure and temperature relief - relief valve sizing calculations - storage and handling of hazardous chemicals and industrial gases, safe disposal methods, reaction with other chemicals, hazards during transportation - pipe line transport - safety in chemical laboratories.

**UNIT II CHEMICAL REACTION HAZARDS 9**

Hazardous inorganic and organic reactions and processes, Reactivity as a process hazard, Detonations, Deflagrations, and Runaways, Assessment and Testing strategies, Self - heating hazards of solids, Explosive potential of chemicals, Structural groups and instability of chemicals, Thermochemical screening,

**UNIT III SAFETY IN THE DESIGN OF CHEMICAL PROCESS PLANTS 9**

Design principles -Process design development -types of designs, feasibility survey, preliminary design, Flow diagrams, piping and instrumentation diagram, batch versus continuous operation, factors in equipment scale up and design, equipment specifications - reliability and safety in designing - inherent safety - engineered safety - safety during startup and shutdown - non destructive testing methods - pressure and leak testing - emergency safety devices - scrubbers and flares- new concepts in safety design and operation- Pressure vessel testing standards- Inspection techniques for boilers and reaction vessels.

**UNIT IV SAFETY IN THE OPERATION OF CHEMICAL PROCESS PLANTS 9**

Properties of chemicals - Material Safety Data Sheets - the various properties and formats used - methods available for property determination. Operational activities and hazards -standards operating procedures - safe operation of pumps, compressors, heaters, column, reactors, pressure vessels, storage vessels, piping systems - effects of pressure, temperature, Flow rate and humidity on operations - corrosion and control measures- condition monitoring - control valves - safety valves - pressure reducing valves, drains, bypass valves, inert gases. Chemical splashes, eye irrigation and automatic showers.

**UNIT V SAFETY AND ANALYSIS 9**

Safety vs reliability- quantification of basic events, system safety quantification, Human error analysis, Accident investigation and analysis, OSHAS 18001 and OSHMS.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**Students able to**

**CO1** Differentiate between inherent safety and engineered safety and recognize the importance of safety in the design of chemical process plants.

**CO2** Develop thorough knowledge about safety in the operation of chemical plants.

**CO3** Apply the principles of safety in the storage and handling of gases.

**CO4** Identify the conditions that lead to reaction hazards and adopt measures to prevent them.

**CO5** Develop thorough knowledge about

**TEXT BOOKS:**


1. David A Crowl& Joseph F Louvar,"Chemical Process safety", Pearson publication, 3rd Edition,2014
2. Maurice Jones .A,"Fire Protection Systems,2nd edition, Jones & Bartlett Publishers,2015


**REFERENCES:**


1. Ralph King and Ron Hirst,"King´s safety in the process industries", Arnold, London, 1998.
2. Industrial Environment and its Evolution and Control, NIOSH Publication, 1973.
3. National Safety Council," Accident prevention manual for industrial operations". Chicago, 1982.
4. Lewis, Richard. J., Sr,"Sax´s dangerous properties of materials". (Ninth edition). Van Nostrand Reinhold, New York, 1996.
5. Roy E Sanders, "Chemical Process Safety",3rd Edition, Gulf professional publishing, 2006


**CO's- PO's & PSO's MAPPING**

| | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO's** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** |
| **1** | 2 | 3 | - | - | - | 1 | - | - | 1 | - | - | - | 2 | - | - |
| **2** | - | | | 2 | - | - | - | - | 1 | - | | - | - | 2 | - |
| **3** | - | 3 | | 1 | - | - | - | 2 | - | - | 1 | - | - | - | - |
| **4** | - | 2 | - | | - | 1 | - | - | 1 | - | | - | - | - | 2 |
| **5** | -3333 3 | 2 | 3 | | - | - | - | 1 | - | - | 1 | - | - | - | - |
| **AVg.** | 2 | 2.5 | 3 | 1.5 | - | 1 | - | 1.5 | 1 | - | 1 | | 2 | 2 | 2 |

**OML352 ELECTRICAL, ELECTRONIC AND MAGNETIC MATERIALS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

1. Understanding the importance of various materials used in electrical, electronics and magnetic applications
2. Acquiring knowledge on the properties of electrical, electronics and magnetic materials.
3. Gaining knowledge on the selection of suitable materials for the given application
4. Knowing the fundamental concepts in Semiconducting materials
5. Getting equipped with the materials used in optical and optoelectronic applications.

**UNIT- I DIELECTRIC MATERIALS 9**

Dielectric as Electric Field Medium, leakage currents, dielectric loss, dielectric strength, breakdown voltage, breakdown in solid dielectrics, flashover, liquid dielectrics, electric conductivity in solid, liquid and gaseous dielectrics, Ferromagnetic materials, properties of ferromagnetic materials in static fields, spontaneous, polarization, curie point, anti-ferromagnetic materials, piezoelectric materials, pyroelectric materials.

**UNIT – II MAGNETIC MATERIALS 9**

Classification of magnetic materials, spontaneous magnetization in ferromagnetic materials, magnetic Anisotropy, Magnetostriction, diamagnetism, magnetically soft and hard materials, special purpose materials, feebly magnetic materials, Ferrites, cast and cermet permanent magnets, ageing of magnets. Factors effecting permeability and Hysteresis

**UNIT – III SEMICONDUCTOR MATERIALS 9**

Properties of semiconductors, Silicon wafers, integration techniques, Large and very large scale Integration techniques. Concept of superconductivity; theories and examples for high temperature superconductivity; discussion on specific superconducting materials; comments on fabrication and engineering applications.

**UNIT – IV MATERIALS FOR ELECTRICAL APPLICATIONS 9**

Materials used for Resistors, rheostats, heaters, transmission line structures, stranded conductors, bimetals fuses, soft and hard solders, electric contact materials, electric carbon materials, thermocouple materials. Solid, Liquid and Gaseous insulating materials, Effect of moisture on insulation.

**UNIT – V OPTICAL AND OPTOELECTRONIC MATERIALS 9**

Principles of photoconductivity - effect of impurities - principles of luminescence-laser principles - He-Ne, injection lasers, LED materials - binary, ternary photoelectronic materials - LCD materials - photo detectors - applications of optoelectronic materials - optical fibres and materials - electro optic modulators - Kerr effect - Pockels effect.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

After completion of this course, the students will be able to

1. Understand various types of dielectric materials, their properties in various conditions.
2. Evaluate magnetic materials and their behavior.
3. Evaluate semiconductor materials and technologies.
4. Select suitable materials for electrical engineering applications.
5. Identify right material for optical and optoelectronic applications

**TEXT BOOKS:**


1. Pradeep Fulay, “Electronic, Magnetic and Optical materials”, CRC Press, taylor and Francis, 2 nd illustrated edition, 2017.
2. “R K Rajput”, “A course in Electrical Engineering Materials”, Laxmi Publications, 2009.

**REFERENCE BOOKS:**


1. T K Basak, “A course in Electrical Engineering Materials”, New Age Science Publications, 2009
2. TTTI Madras, “Electrical Engineering Materials”, McGraw Hill Education, 2004.
3. Adrianus J. Dekker, “Electrical Engineering Materials”, PHI Publication, 2006.
4. S. P. Seth, P. V. Gupta “A course in Electrical Engineering Materials”, Dhanpat Rai & Sons, 2011.
5. C. Kittel, “Introduction to Solid State Physics”, 7th Edition, John Wiley & Sons,Singapore, (2006).


| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **C01** | 3 | 2 | 2 | 3 | | | | | | | | 2 | 2 | 2 | 1 |
| **C02** | 3 | 1 | 2 | 2 | | | | | | | | 2 | 2 | 2 | 1 |
| **C03** | 3 | 2 | 1 | 2 | | | | | | | | 2 | 2 | 2 | 1 |
| **CO4** | 3 | 2 | 1 | 2 | | | | | | | | 2 | 2 | 2 | 2 |
| **CO5** | 3 | 2 | 2 | 2 | | | | | | | | 2 | 2 | 2 | 1 |
| **Avg** | 3 | 1.8 | 1.6 | 2.2 | | | | | | | | 2 | 2 | 2 | 1.2 |

**OML353 NANOMATERIALS AND APPLICATIONS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

1. Understanding the evolution of nanomaterials in the scientific era and make them to understand different types of nanomaterials for the future engineering applications
2. Gaining knowledge on dimensionality effects on different properties of nanomaterials
3. Getting acquainted with the different processing techniques employed for fabricating nanomaterials
4. Having knowledge on the different characterisation techniques employed to characterise the nanomaterials
5. Acquiring knowledge on different applications of nanomaterials in different disciplines of engineering.

**UNIT I NANOMATERIALS 9**

Introduction, Classification: 0D, 1D, 2D, 3D nanomaterials and nano-composites, their mechanical, electrical, optical, magnetic properties; Nanomaterials versus bulk materials.

**UNIT II THERMODYNAMICS & KINETICS OF NANOSTRUCTURED MATERIALS 9**

Size and interface/interphase effects, interfacial thermodynamics, phase diagrams, diffusivity, grain growth, and thermal stability of nanomaterials.

**UNIT III PROCESSING 9**

Bottom-up and top-down approaches for the synthesis of nanomaterials, mechanical alloying, chemical routes, severe plastic deformation, and electrical wire explosion technique.

**UNIT IV STRUCTURAL CHARACTERISTICS 9**

Principles of emerging nanoscale X-ray techniques such as small angle X-ray scattering and X-ray absorption fine structure (XAFS), electron and neutron diffraction techniques and their application to nanomaterials; SPM, Nanoindentation, Grain size, phase formation, texture, stress analysis

**UNIT V APPLICATIONS 9**

Applications of nanoparticles, quantum dots, nanotubes, nanowires, nanocoatings; applications in electronic, electrical and medical industries

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

After completion of this course, the students will be able to

1. Evaluate nanomaterials and understand the different types of nanomaterials
2. Recognise the effects of dimensionality of materials on the properties
3. Process different nanomaterials and use them in engineering applications
4. Use appropriate techniques for characterising nanomaterials
5. Identify and use different nanomaterials for applications in different engineering fields.

**TEXT BOOKS:**


1. Bhusan, Bharat (Ed), “Springer Handbook of Nanotechnology”, 2nd edition, 2007.
2. Carl C. Koch (ed.), NANOSTRUCTURED MATERIALS, Processing, Properties and Potential Applications, NOYES PUBLICATIONS, Norwich, New York, U.S.A.


**REFERENCES:**


1. Poole C.P, and Owens F.J., Introduction to Nanotechnology, John Wiley 2003
2. Nalwa H.S., Encyclopedia of Nanoscience and Nanotechnology, American Scientific Publishers 2004
3. Zehetbauer M.J. and Zhu Y.T., Bulk Nanostructured Materials, Wiley 2008
4. Wang Z.L., Characterization of Nanophase Materials, Wiley 2000
5. Gutkin Y., Ovid’ko I.A. and Gutkin M., Plastic Deformation in Nanocrystalline Materials, Springer 2004


| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **C01** | 2 | 2 | 2 | 3 | | | | | | | | 2 | 1 | 2 | |
| **C02** | 3 | 1 | 2 | 2 | | | | | | | | 2 | 2 | 2 | 1 |
| **C03** | 3 | 2 | 1 | 2 | | | | | | | | 2 | 2 | 2 | |
| **CO4** | 3 | 1 | | 2 | | | | | | | | 2 | 2 | 2 | 2 |
| **CO5** | 3 | 2 | 2 | 2 | | | | | | | | 2 | 2 | 2 | 1 |
| **Avg** | 2.8 | 1.6 | 1.7 | 2.2 | | | | | | | | 2 | 1.8 | 2 | 1.3 |

**OMR352 HYDRAULICS AND PNEUMATICS**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

1. To knowledge on fluid power principles and working of hydraulic pumps
2. To obtain the knowledge in hydraulic actuators and control components
3. To understand the basics in hydraulic circuits and systems
4. To obtain the knowledge in pneumatic and electro pneumatic systems
5. To apply the concepts to solve the trouble shooting

**UNIT – I FLUID POWER PRINICIPLES AND HYDRAULIC PUMPS 9**

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps – Problems.

**UNIT – II HYDRAULIC ACTUATORS AND CONTROL COMPONENTS 9**

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components : Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories : Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols – Problems.

**UNIT – III HYDRAULIC CIRCUITS AND SYSTEMS 9**

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

**UNIT – IV PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS 9**

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits

**UNIT – V TROUBLE SHOOTING AND APPLICATIONS 9**

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

CO 1: Analyze the methods in fluid power principles and working of hydraulic pumps
CO 2: Recognize the concepts in hydraulic actuators and control components
CO 3: Obtain the knowledge in basics of hydraulic circuits and systems
CO 4: Know about the basics concept in pneumatic and electro pneumatic systems
CO 5: Apply the concepts to solve the trouble shooting hydraulic and pneumatics

| Mapping of COs with POs and PSOs | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs & PSOs** | **POs** | | | | | | | | | | | | **PSOs** | | |
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** |
| CO1 | 3 | 2 | 1 | | 2 | 2 | | | | | | 1 | 2 | 2 | 1 |
| CO2 | 3 | 2 | 1 | | 2 | 2 | | | | | | 1 | 2 | 2 | 1 |
| CO3 | 3 | 2 | 1 | | 2 | 2 | | | | | | 1 | 2 | 2 | 1 |
| CO4 | 3 | 2 | 1 | | 2 | 2 | | | | | | 1 | 2 | 2 | 1 |
| CO5 | 3 | 2 | 1 | | 2 | 2 | | | | | | 1 | 2 | 2 | 1 |
| CO/PO & PSO Average | 3 | 2 | 1 | | 2 | 2 | | | | | | 1 | 2 | 2 | 1 |
| 1 – Slight, 2 – Moderate, 3 – Substantial | | | | | | | | | | | | | | | |

**TEXT BOOKS**

1. Anthony Esposito, “Fluid Power with Applications”, Prentice Hall, 2009.
2. James A. Sullivan, “Fluid Power Theory and Applications”, Fourth Edition, Prentice Hall, 1997.

**REFERENCES**


1. Shanmugasundaram.K, “Hydraulic and Pneumatic Controls”. Chand & Co, 2006.
2. Majumdar, S.R., “Oil Hydraulics Systems – Principles and Maintenance”, Tata McG Raw Hill, 2001.
3. Majumdar, S.R., “Pneumatic Systems – Principles and Maintenance”, Tata McGRaw Hill, 2007.
4. Dudley, A. Pease and John J Pippenger, “Basic Fluid Power”, Prentice Hall, 1987
5. Srinivasan. R, “Hydraulic and Pneumatic Controls”, Vijay Nicole Imprints, 2008
6. Joshi.P, Pneumatic Control”, Wiley India, 2008.
7. Jagadeesha T, “Pneumatics Concepts, Design and Applications “, Universities Press, 2015.


**OMR353 SENSORS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

1. To learn the various types of sensors, transducers, sensor output signal types, calibration techniques, formulation of system equation and its characteristics.
2. To understand basic working principle, construction, Application and characteristics of displacement, speed and ranging sensors.
3. To understand and analyze the working principle, construction, application and characteristics of force, magnetic and heading sensors.
4. To learn and analyze the working principle, construction, application and characteristics of optical, pressure, temperature and other sensors.
5. To familiarize students with different signal conditioning circuits design and data acquisition system.

**UNIT – I SENSOR CLASSIFICATION, CHARACTERISTICS AND SIGNAL TYPES 9**

Basics of Measurement – Classification of Errors – Error Analysis – Static and Dynamic Characteristics of Transducers – Performance Measures of Sensors – Classification of Sensors – Sensor Calibration Techniques – Sensor Outputs - Signal Types - Analog and Digital Signals, PWM and PPM.

**UNIT – II DISPLACEMENT, PROXIMITY AND RANGING SENSORS 9**

Displacement Sensors – Brush Encoders - Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – Range Sensors - Ultrasonic Ranging - Reflective Beacons - Laser Range Sensor (LIDAR) – GPS - RF Beacons.

**UNIT – III FORCE, MAGNETIC AND HEADING SENSORS 9**

Strain Gage – Types, Working, Advantage, Limitation, and Applications: Load Measurement – Force and Torque Measurement - Magnetic Sensors – Types, Principle, Advantage, Limitation, and Applications - Magneto Resistive – Hall Effect, Eddy Current Sensor - Heading Sensors – Compass, Gyroscope and Inclinometers.

**UNIT – IV OPTICAL, PRESSURE, TEMPERATURE AND OTHER SENSORS 9**

Photo Conductive Cell, Photo Voltaic, Photo Resistive, LDR – Fiber Optic Sensors – Pressure – Diaphragm – Bellows - Piezoelectric - Piezo-resistive - Acoustic, Temperature – IC, Thermistor, RTD, Thermocouple – Non Contact Sensor - Chemical Sensors - MEMS Sensors - Smart Sensors.

**UNIT – V SIGNAL CONDITIONING 9**

Need for Signal Conditioning – Resistive, Inductive and Capacitive Bridges for Measurement - DC and AC Signal Conditioning - Voltage, Current, Power and Instrumentation Amplifiers – Filter and Isolation Circuits – Fundamentals of Data Acquisition System

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

CO1:Understand various sensor effects, sensor characteristics, signal types, calibration methods and obtain transfer function and empirical relation of sensors. They can also analyze the densor response.

CO2: Analyze and select suitable sensor for displacement, proximity and range measurement.

CO3: Analyze and select suitable sensor for force, magnetic field, speed, position and direction measurement.

CO4:Analyze and Select suitable sensor for light detection, pressure and temperature measurement and also familiar with other miniaturized smart sensors.

CO5:Select and design suitable signal conditioning circuit with proper compensation and linearizing element based on sensor output signal.

| **Mapping of COs with POs and PSOs** | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/POs & PSOs** | **POs** | | | | | | | | | | | | **PSOs** | | |
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** |
| CO1 | 3 | 3 | 2 | | | | | | | | 1 | 2 | 3 | 2 | 1 |
| CO2 | 3 | 3 | 2 | 1 | 1 | 1 | | | | | 1 | 2 | 3 | 2 | 1 |
| CO3 | 3 | 3 | 2 | 1 | 1 | 1 | | | | | 1 | 2 | 3 | 2 | 1 |
| CO4 | 3 | 3 | 2 | 1 | 1 | 1 | | | | | 1 | 2 | 3 | 2 | 1 |
| CO5 | 3 | 3 | 2 | 1 | 1 | 1 | | | | | 1 | 2 | 3 | 2 | 1 |
| CO/PO & PSO Average | 3 | 3 | 2 | 0.8 | 0.8 | 0.8 | | | | | 0.8 | 2 | 3 | 2 | 1 |
| 1 – Slight, 2 – Moderate, 3 – Substantial | | | | | | | | | | | | | | | |

**TEXT BOOKS:**


1. Bolton W., “Mechatronics”, Pearson Education, 6th Edition, 2015.
2. Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, Penram International Publishing Private Limited, 6th Edition, 2013.


**REFERENCES:**


1. Bradley D.A., Dawson D., Buru N.C. and Loader A.J., “Mechatronics”, Chapman and Hall, 1993.
2. Davis G. Alciatore and Michael B. Histand, “Introduction to Mechatronics and Measurement systems”, McGraw Hill Education, 2011.
3. Devadas Shetty and Richard A. Kolk, “Mechatronics Systems Design”, Cengage Learning, 2010.
4. Nitaigour Premchand Mahalik, “Mechatronics Principles, Concepts and Applications”, McGraw Hill Education, 2015.
5. Smaili. A and Mrad. F, “Mechatronics Integrated Technologies for Intelligent Machines”, Oxford University Press, 2007.

| ORA352 | CONCEPTS IN MOBILE ROBOTS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES**

1. To introduce mobile robotic technology and its types in detail.
2. To learn the kinematics of wheeled and legged robot.
3. To familiarize the intelligence into the mobile robots using various sensors.
4. To acquaint the localization strategies and mapping technique for mobile robot.
5. To aware the collaborative mobile robotics in task planning, navigation and intelligence.

**UNIT – I INTRODUCTION TO MOBILE ROBOTICS 9**

Introduction – Locomotion of the Robots – Key Issues on Locomotion – Legged Mobile Roots – Configurations and Stability – Wheeled Mobile Robots – Design Space and Mobility Issues – Unmanned Aerial and Underwater Vehicles

**UNIT – II KINEMATICS 9**

Kinematic Models – Representation of Robot – Forward Kinematics – Wheel and Robot Constraints – Degree of Mobility and Steerability – **Manoeuvrability** – Workspace – Degrees of Freedom – Path and Trajectory Considerations – Motion Controls - Holonomic Robots

**UNIT – III PERCEPTION 9**

Sensor for Mobile Robots – Classification and Performance Characterization – Wheel/Motor Sensors – Heading Sensors - Ground-Based Beacons - Active Ranging - Motion/Speed Sensors – Camera - Visual Appearance based Feature Extraction.

**UNIT – IV LOCALIZATION 9**

Localization Based Navigation Versus Programmed Solutions - Map Representation - Continuous Representations - Decomposition Strategies - Probabilistic Map-Based Localization - Landmark-Based Navigation - Globally Unique Localization - Positioning Beacon Systems - Route-Based Localization - Autonomous Map Building - Simultaneous Localization and Mapping (SLAM).

**UNIT – V PLANNING, NAVIGATION AND COLLABORATIVE ROBOTS 9**

Introduction - Competences for Navigation: Planning and Reacting - Path Planning - Obstacle Avoidance - Navigation Architectures - Control Localization - Techniques for Decomposition - Case Studies – Collaborative Robots – Swarm Robots.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

**CO1:** Evaluate the appropriate mobile robots for the desired application.
**CO2:** Create the kinematics for given wheeled and legged robot.
**CO3:** Analyse the sensors for the intelligence of mobile robotics.
**CO4:** Create the localization strategies and mapping technique for mobile robot.
**CO5:** Create the collaborative mobile robotics for planning, navigation and intelligence for desired applications.

**TEXTBOOK**

1. Roland Siegwart and IllahR.Nourbakish, “Introduction to Autonomous Mobile Robots” MIT Press, Cambridge, 2004.

**REFERENCES:**

1. Dragomir N. Nenchev, Atsushi Konno, TeppeiTsujita, “Humanoid Robots: Modelling and Control”, Butterworth-Heinemann, 2018

2. MohantaJagadish Chandra, “Introduction to Mobile Robots Navigation”, LAP Lambert Academic Publishing, 2015.
3. Peter Corke, “Robotics, Vision and Control”, Springer, 2017.
4. Ulrich Nehmzow, “Mobile Robotics: A Practical Introduction”, Springer, 2003.
5. Xiao Qi Chen, Y.Q. Chen and J.G. Chase, “Mobile Robots - State of the Art in Land, Sea, Air, and Collaborative Missions”, Intec Press, 2009.
6. Alonzo Kelly, Mobile Robotics: Mathematics, Models, and Methods, Cambridge University Press, 2013, ISBN: 978-1107031159.

**MV3501 MARINE PROPULSION L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

1. To impart knowledge on basics of propulsion system and ship dynamic movements
2. To educate them on basic layout and propulsion equipment’s
3. To impart basic knowledge on performance of the ship
4. To impart basic knowledge on Ship propeller and its types
5. To impart knowledge on ship rudder and its types

**UNIT I BASICS SHIP PROPULSION SYSTEM AND EQUIPMENTS 9**

law of floatation - Basics principle of propulsion- Earlier methods of propulsion- ship propulsion machinery- boiler, Marine steam engine, diesel engine, ship power transmission system, ship dynamic structure, Marine propulsion equipment - shaft tunnel, Intermediate shaft and bearing, stern tube, stern tube sealing etc. degree of freedom, Modern propelling methods- water jet propulsion , screw propulsion.

**UNIT II SHIPS MOVEMENTS AND SHIP STABILIZATION 9**

Thrust augmented devices, Ship hull, modern ship propulsion design, bow thruster – Advantages, various methods to stabilize the ship- passive and active stabilizer, fin stabilizer, bilge keel - stabilizing and securing ship in port- effect of tides on ship – effect of river water and sea water sailing vessel, Load line and load line of marking- draught markings.

**UNIT III SHIPS SPEED AND ITS PERFORMANCE 9**

Ship propulsion factors, factors affecting ships speed, various velocities of ship, hull drag, effects of fouling on ships hull, ship wake, relation between powers, Fuel consumption of ship, cavitations - effects of cavitation’s, ship turning radius.

**UNIT IV BASICS OF PROPELLER 9**

Propeller dimension, Propeller and its types – fixed propeller, control pitch propeller, kort nozzle, ducted propeller, voith schneider, Parts of propeller, 3 blade - 5 blade - 6 blade propellers and its advantages, propeller boss hub, crown nut, propeller skew, pitch of propeller - Thrust creation by propeller. Propeller Material – Propeller balancing- static and dynamic.

**UNIT V BASICS OF RUDDER 9**

Rudder dimension, Area of rudder and its design, Rudder arrangements, Rudder fittings- Rudder pintle – Rudder types- Balanced rudder, semi balanced rudder, Spade rudder, merits and demerits of various types of rudders, Propeller and rudder interaction, Rudder stopper, movement of rudders, Basic construction of Rudder

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to:
CO1: Explain the basics of propulsion system and ship dynamic movements

CO2: Familiarize with various components assisting ship stabilization.
CO3: Demonstrate the performance of the ship.
CO4: Classify the Propeller and its types, Materials etc.
CO5: Categories the Rudder and its types, design criteria of rudder.

**TEXT BOOKS:**

1. GP. Ghose, “Basic Ship propulsion”,2015
2. E.A. Stokoe “Reeds Ship construction for marine engineers”, Vol. 5,2010
3. E.A. Stokoe, “Reeds Naval architecture for the marine engineers”,4th Edition,2009

**REFERENCES BOOKS:**

1. DJ Eyers and GJ Bruse, “Ship Construction”, 7th Edition, 2006.
2. KJ Rawson and EC Tupper, “Basic Ship theory I” Vol. 1,5th Edition,2001.

**MAPPING OF COS AND POS:**

| CO | PO | | | | | | | | | | | | PSO | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO6 | PO7 | PO8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO2 | PSO3 | PSO4 |
| 1 | 1 | 1 | 1 | 1 | 1 | | | | | | 1 | 1 | | 1 | | 1 |
| 2 | 1 | 1 | 1 | | | | | | | | | | | 1 | | 1 |
| 3 | 1 | | | 1 | 1 | | | | 1 | 1 | 1 | | 1 | 1 | | 1 |
| 4 | 1 | | 1 | 1 | | | | | | | | | | 1 | | 1 |
| 5 | 1 | | 1 | 1 | | | | | | | | | | 1 | | 1 |
| Avg | 5/5 =1 | 2/2 =1 | 4/4 =1 | 4/4 =1 | 2/2 =1 | | | | 1/1 =1 | 1/1 =1 | 2/2 =1 | 1/1 =1 | 1/1= 1 | 5/5 =1 | | 5/5 =1 |

**OMV351 MARINE MERCHANT VESSELS L T P C**
**3 0 0 3**

**OBJECTIVES:**

**At the end of the course, students are expected to acquire**

1. Knowledge on basics of Hydrostatics
2. Familiarization on types of merchant ships
3. Knowledge on Shipbuilding Materials
4. Knowledge on marine propeller and rudder
5. Awareness on governing bodies in shipping industry

**UNIT I INTRODUCTION TO HYDROSTATICS 9**

Archimedes Principle- Laws of floatation– Meta centre – stability of floating and submerged bodies- Density, relative density – Displacement –Pressure –centre of pressure.

**UNIT II TYPES OF SHIP 10**

General cargo ship – Refrigerated cargo ships – Container ships – Roll-on Roll-off ships – Oil tankers- Bulk carriers – Liquefied Natural Gas carriers – Liquefied Petroleum Gas carriers – Chemical tankers – Passenger ships

**UNIT III SHIPBUILDING MATERIALS 9**

Types of Steels used in Shipbuilding – High tensile steels, Corrosion resistant steels, Steel sandwich panels, Steel castings, Steel forgings – Other shipbuilding materials, Aluminium alloys, Aluminium alloy sandwich panels, Fire protection especially for Aluminium Alloys, Fiber Reinforced Composites

**UNIT IV MARINE PROPELLER AND RUDDER 8**

Types of rudder, construction of Rudder-Types of Propeller, Propeller material-Cavitations and its effects on propeller

**UNIT V GOVERNING BODIES FOR SHIPPING INDUSTRY 9**

Role of **IMO** (International Maritime Organization), **SOLAS** (International Convention for the Safety of Life at Sea), **MARPOL** (International Convention for the Prevention of Pollution from Ships ) , **MLC** (Maritime Labour Convention), **STCW 2010** (International Convention on Standards of Training, Certification and Watch keeping for Seafarers), Classification societies Administration authorities

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of this course, students would

1. Acquire Knowledge on floatation of ships
2. Acquire Knowledge on features of various ships
3. Acquire Knowledge of Shipbuilding Materials
4. Acquire Knowledge to identify the different types of marine propeller and rudder
5. Understand the Roles and responsibilities of governing bodies

**TEXT BOOKS:**


1. D.J.Eyres, “Ship Constructions”, Seventh Edition, Butter Worth Heinemann Publishing, USA, 2015
2. Dr.DA Taylor, “Merchant Ship Naval Architecture” I. Mar EST publications, 2006
3. EA Stokoe, E.A, “Naval Architecture for Marine Engineers”, Vol.4, Reeds Publications,2000


**REFERENCES:**


1. Kemp & Young “Ship Construction Sketches & Notes”, Butter Worth Heinemann Publishing,USA, 2011
2. MARPOL Consolidated Edition , Bhandakar Publications, 2018
3. SOLAS Consolidated Edition , Bhandakar Publications, 2016


**OMV352 ELEMENTS OF MARINE ENGINEERING L T P C**
**3 0 0 3**

**OBJECTIVES**:

**At the end of the course, students are expected to**

1. Understand the role of Marine machinery systems
2. Be familiar with Marine propulsion machinery system
3. Acquaint with Marine Auxiliary machinery system
4. Have acquired basics of Marine Auxiliary boiler system
5. Be aware of ship propellers and steering system

**UNIT I ELEMENTARY KNOWLEDGE ON MARINE MACHINERY SYSTEMS 9**

Marine Engineering Terminologies, Parts of Ship, Introduction to Machinery systems on board ships – Propulsion Machinery system, Electricity Generator system, Steering gear system, Air compressors & Air reservoirs, Fuel oil and Lubricating Oil Purifiers, Marine Boiler systems

**UNIT II MARINE PROPULSION MACHINERY SYSTEM 9**

Two stroke Large Marine slow speed Diesel Engine – General Construction, Basic knowledge of Air starting and reversing mechanism, Cylinder lubrication oil system, Main lubricating oil system and cooling water system

**UNIT III MARINE AUXILIARY MACHINERY SYSTEM 9**

Four stroke medium speed Diesel engine – General Construction, Inline, V-type arrangement of engine, Difference between slow speed and medium speed engines – advantages, limitations and applications

**UNIT IV MARINE BOILER SYSTEM 9**

Types of Boiler – Difference between Water tube boiler and Fire tube boiler, Need for boiler on board ships, Uses of steam, Advantages of using steam as working medium, Boiler mountings and accessories – importance of mountings, need for accessories

**UNIT V SHIP PROPELLERS AND STEERING MECHANISM 9**

Importance of Propellor and Steering gear, Types of propellers - Fixed pitch propellers, Controllable pitch propellers, Water jet propellers, Steering gear systems - 2-Ram and 4 Ram steering gear, Electric steering gear

**TOTAL: 45 PERIODS**

**OUTCOMES:**

**At the end of the course, students should able to,**

1. Distinguish the role of various marine machinery systems
2. Relate the components of marine propulsion machinery system
3. Explain the importance of marine auxiliary machinery system
4. Acquire knowledge of marine boiler system
5. Understand the importance of ship propellors and steering system

**TEXT BOOKS:**


1. Taylor, “Introduction to Marine engineering”, Revised Second Edition, Butterworth Heinemann, London, 2011
2. J.K.Dhar, “Basic Marine Engineering”, Tenth Edition, G-Maritime Publications, Mumbai, 2011
3. K.Ramaraj, “ Text book on Marine Engineering”, Eswar Press, Chennai, 2018


**REFERENCES:**


1. Alan L.Rowen, “Introduction to Practical Marine Engineering, Volume 1&2, The Institute of Marine Engineers (India), Mumbai, 2006
2. A.S.Tambwekar, “Naval Architecture and Ship Construction”, The Institute of Marine Engineers (India), Mumbai, 2015


| CRA332 | DRONE TECHNOLOGIES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

1. To understand the basics of drone concepts
2. To learn and understand the fundaments of design, fabrication and programming of drone
3. To impart the knowledge of an flying and operation of drone
4. To know about the various applications of drone
5. To understand the safety risks and guidelines of fly safely

**UNIT – I INTRODUCTION TO DRONE TECHNOLOGY 9**

Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability

**UNIT – II DRONE DESIGN, FABRICATION AND PROGRAMMING 9**

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts -Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations -The methods of programming drone- Download program - Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

**UNIT – III DRONE FLYING AND OPERATION 9**

Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment- Drone controls Flight operations –management tool –Sensors-Onboard storage capacity -Removable storage devices- Linked mobile devices and applications

**UNIT – IV DRONE COMMERCIAL APPLICATIONS 9**

Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

**UNIT – V FUTURE DRONES AND SAFETY 9**

The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

CO1: Know about a various type of drone technology, drone fabrication and programming.
CO2: Execute the suitable operating procedures for functioning a drone
CO3: Select appropriate sensors and actuators for Drones
CO4: Develop a drone mechanism for specific applications
CO5: Createthe programs for various drones

**CO-PO MAPPING:**

| Mapping of COs with POs and PSOs | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs/Pos&PSOs** | **POs** | | | | | | | | | | | | **PSOs** | | |
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** |
| CO1 | 1 | 2 | 3 | 1 | 3 | 2 | | | | | | 1 | 2 | 1 | 3 |
| CO2 | 1 | 2 | 3 | 1 | 3 | 2 | | | | | | 1 | 2 | 1 | 3 |
| CO3 | 1 | 2 | 3 | 1 | 3 | 2 | | | | | | 1 | 2 | 1 | 3 |
| CO4 | 1 | 2 | 3 | 1 | 3 | 2 | | | | | | 1 | 2 | 1 | 3 |
| CO5 | 1 | 2 | 3 | 1 | 3 | 2 | | | | | | 1 | 2 | 1 | 3 |
| CO/PO & PSO Average | 1 | 2 | 3 | 1 | 3 | 2 | | | | | | 1 | 2 | 1 | 3 |
| 1 – Slight, 2 – Moderate, 3 – Substantial | | | | | | | | | | | | | | | |

**TEXT BOOKS**


1. Daniel Tal and John Altschuld, “Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation”, 2021 John Wiley & Sons, Inc.
2. Terry Kilby and Belinda Kilby, “Make:Getting Started with Drones “,Maker Media, Inc, 2016

**REFERENCES:**


1. John Baichtal, “Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs”, Que Publishing, 2016
2. Zavrsnik, “Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance”, Springer, 2018.


**OGI352 GEOGRAPHICAL INFORMATION SYSTEM L T P C**
**3 0 0 3**

**OBJECTIVES:**

To impart the knowledge on basic components, data preparation and implementation of Geographical Information System.

**UNIT I FUNDAMENTALS OF GIS 9**

Introduction to GIS - Basic spatial concepts - Coordinate Systems - GIS and Information Systems – Definitions – History of GIS - Components of a GIS – Hardware, Software, Data, People, Methods – Proprietary and open source Software - Types of data – Spatial, Attribute data- types of attributes – scales/ levels of measurements.

**UNIT II SPATIAL DATA MODELS 9**

Database Structures – Relational, Object Oriented – Entities – ER diagram - data models - conceptual, logical and physical models - spatial data models – Raster Data Structures – Raster Data Compression - Vector Data Structures - Raster vs Vector Models- TIN and GRID data models.

**UNIT III DATA INPUT AND TOPOLOGY 9**

Scanner - Raster Data Input – Raster Data File Formats – Georeferencing – Vector Data Input – Digitizer – Datum Projection and reprojection -Coordinate Transformation – Topology - Adjacency, connectivity and containment – Topological Consistency – Non topological file formats - Attribute Data linking – Linking External Databases – GPS Data Integration

**UNIT IV DATA QUALITY AND STANDARDS 9**

Data quality - Basic aspects - completeness, logical consistency, positional accuracy, temporal accuracy, thematic accuracy and lineage – Metadata – GIS Standards –Interoperability - OGC - Spatial Data Infrastructure

**UNIT V DATA MANAGEMENT AND OUTPUT 9**

Import/Export – Data Management functions- Raster to Vector and Vector to Raster Conversion - Data Output - Map Compilation – Chart/Graphs – Multimedia – Enterprise Vs. Desktop GIS-distributed GIS.

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

•On completion of the course, the student is expected to

**CO1** Have basic idea about the fundamentals of GIS.
**CO2** Understand the types of data models.
**CO3** Get knowledge about data input and topology
**CO4** Gain knowledge on data quality and standards
**CO5** Understand data management functions and data output

**TEXTBOOKS:**


1. Kang - Tsung Chang, Introduction to Geographic Information Systems, McGraw Hill Publishing, 2nd Edition, 2011.
2. Ian Heywood, Sarah Cornelius, Steve Carver, Srinivasa Raju, “An Introduction Geographical Information Systems, Pearson Education, 2nd Edition,2007.

**REFERENCES:**

1. Lo. C. P., Albert K.W. Yeung, Concepts and Techniques of Geographic Information Systems, Prentice-Hall India Publishers, 2006

**CO – PO – PSO MAPPING: GEOGRAPHIC INFORMATION SYSTEM**

| PO | GRADUATE ATTRIBUTE | COURSE OUTCOME | | | | | Average |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| PO1 | Engineering Knowledge | 3 | 3 | 3 | 3 | 3 | 3 |
| PO2 | Problem Analysis | | | | 3 | 3 | 3 |
| PO3 | Design/Development of Solutions | | | 3 | 3 | 3 | 3 |
| PO4 | Conduct Investigations of Complex Problems | | | 3 | 3 | 3 | 3 |
| PO5 | Modern Tool Usage | | 3 | | 3 | 3 | 3 |
| PO6 | The Engineer and Society | | | | | | |
| PO 7 | Environment and Sustainability | | | | | | |
| PO 8 | Ethics | | | | | | |
| PO 9 | Individual and Team Work | | | | | | |
| PO 10 | Communication | | | | | | |
| PO 11 | Project Management and Finance | | | | | | |
| PO 12 | Life-long Learning | | | | | | |
| PSO 1 | Knowledge of Geoinformatics discipline | 3 | 3 | 3 | 3 | 3 | 3 |
| PSO 2 | Critical analysis of Geoinformatics Engineering problems and innovations | 3 | 3 | 3 | 3 | 3 | 3 |
| PSO 3 | Conceptualization and evaluation of Design solutions | 3 | 3 | 3 | 3 | 3 | 3 |

**OAI352 AGRICULTURE ENTREPRENEURSHIP DEVELOPMENT L T P C**
**3 0 0 3**

**OBJECTIVES**

- To introduce the importance of Agri-business management, its characteristics and principles
- To impart knowledge on the functional areas of Agri-business like Marketing management, Product pricing methods and Market potential assessment.

**UNIT I ENTREPRENEURIAL ENVIRONMENT IN INDIAN CONTEXT 9**

Entrepreneur Development(ED): Concept of entrepreneur and entrepreneurship assessing overall business environment in Indian economy- Entrepreneurial and managerial characteristics- Entrepreneurship development programmers (EDP)-Generation incubation and commercialization of ideas and innovations- Motivation and entrepreneurship development- Globalization and the emerging business entrepreneurial environment.

**UNIT II AGRIPRNEURSHIP IN GLOBAL ARENA: LEGAL PERSPECTIVE 9**

Importance of agribusiness in Indian economy - International trade-WTO agreements- Provisions related to agreements in agricultural and food commodities - Agreements on Agriculture (AOA)- Domestic supply, market access, export subsidies agreements on sanitary and phyto-sanitary (SPS) measures, Trade related intellectual property rights (TRIPS).

**UNIT III ENTREPRENEURSHIP MANAGEMENT: FINANCIAL PERSPECTIVE 9**

Entrepreneurship - Essence of managerial Knowledge -Management functions- Planning-organizing-Directing-Motivation-ordering-leading-supervision- communication and control-Understanding Financial Aspects of Business - Importance of financial statements-liquidity ratios-leverage ratios, coverage ratios-turnover ratios-Profitability ratios. Agro-based industries-Project-Project cycle-Project appraisal and evaluation techniques-undiscounted measures-Payback period-proceeds per rupee of outlay, Discounted measures-Net Present Value (NPV)-Benefit-Cost Ratio(BCR)-Internal Rate of Return(IRR)-Net benefit investment ratio(N/K ratio)-sensitivity analysis.

**UNIT IV ENTREPRENEURIAL OPPORTUNITIES: ECONOMIC GROWTH PERSPECTIVE 9**

Managing an enterprise: Importance of planning, budgeting, monitoring evaluation and follow-up managing competition. Role of ED in economic development of a country- Overview of Indian social, political system and their implications for decision making by individual entrepreneurs-Economic system and its implication for decision making by individual entrepreneurs.

**UNITV ENTREPRENEURIAL PROMOTION MEASURES AND GOVERNMENT SUPPORT 9**

Social responsibility of business. Morals and ethics in enterprise management- SWOT analysis-Government schemes and incentives for promotions of entrepreneurship. Government policy on small and medium enterprises (SMEs)/SSIs/MSME sectors- Venture capital (VC), contract framing (CF) and Joint Venture (JV), public-private
partnerships (PPP) - overview of agricultural engineering industry, characteristics of Indian farm machinery industry.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

1. Judge about agricultural finance, banking and cooperation
2. Evaluate basic concepts, principles and functions of financial management
3. Improve the skills on basic banking and insurance schemes available to customers
4. Analyze various financial data for efficient farm management
5. Identify the financial institutions

**TEXT BOOKS**


1. Joseph L. Massie, 1995, “Essentials of Management”, prentice Hall of India Pvt limited, New Delhi
2. Khanka S, 1999, Entrepreneurial Development, S, Chand and Co, New Delhi
3. Mohanty S K, 2007, Fundamentals of Entrepreneurship, Prentice Hall India, New Delhi.


**REFERENCES**


1. Harih S B, Conner U J and Schwab G D, 1981, Management of the Farm Business, Prentice Hall Inc, New Jersey
2. Omri Ralins, N.1980, Introduction to Agricultural: Prentice Hall Inc, New Jersey
3. Gittenger Price, 1989, Economic Analysis of Agricultural project, John Hopkins University, Press, London.
4. Thomas W Zimmer and Norman M Scarborough, 1996, Entrepreneurship, Prentice Hall, New Jersey.
5. Mar J Dollinger, 1999, Entrepreneurship strategies and resources, Prentice –Hall, Upper Saddal Rover, New Jersey.

**CO-PO MAPPING**

| PO/PSO | | CO1 | CO2 | CO3 | CO4 | CO5 | Overall correlation of COs with POs |
|---|---|---|---|---|---|---|---|
| PO1 | Engineering Knowledge | 1 | 2 | 1 | 1 | 1 | 2 |
| PO2 | Problem Analysis | 2 | 1 | 1 | 1 | 2 | 1 |
| PO3 | Design/ Development of Solutions | 1 | 1 | 1 | 2 | 1 | 2 |
| PO4 | Conduct Investigations of Complex Problems | 1 | 1 | 2 | 1 | 1 | 1 |
| PO5 | Modern Tool Usage | 2 | 1 | 1 | 1 | 1 | 2 |
| PO6 | The Engineer and Society | 1 | 2 | 1 | 2 | 1 | 1 |
| PO7 | Environment and sustainability | 1 | 1 | 2 | 1 | 1 | 1 |
| PO8 | Ethics | 1 | 2 | 1 | 1 | 1 | 1 |
| PO9 | Individual and team work: | 1 | 1 | 1 | 2 | 1 | 1 |
| PO10 | Communication | 1 | 1 | 1 | 1 | 2 | 1 |
| PO11 | Project management and finance | 1 | 1 | 2 | 1 | 1 | 1 |
| PO12 | Life-long learning: | 1 | 2 | 1 | 1 | 1 | 2 |
| PSO1 | To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill | 1 | 2 | 1 | 1 | 1 | 1 |
| PSO2 | To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies. | 1 | 1 | 2 | 1 | 1 | 1 |
| PSO3 | To inculcate entrepreneurial skills through strong Industry-Institution linkage. | 1 | 2 | 1 | 1 | 2 | 1 |

**OEN352 BIODIVERSITY CONSERVATION L T P C**
**3 0 0 3**

**OBJECTIVE:**
The identification of different aspects of biological diversity and conservation techniques.

**UNIT I INTRODUCTION 9**
Concept of Species, Variation; Introduction to Major Plant Groups; Evolutionary relationships between Plant Groups; Nomenclature and History of plant taxonomy; Systems of Classification and their Application; Study of Plant Groups; Study of Identification Characters; Study of important families of Angiosperms; Plant Diversity Application.

**UNIT II INTRODUCTION TO ANIMAL DIVERSITY AND TAXONOMY 9**
Principles and Rules of Taxonomy; ICZN Rules, Animal Study Techniques; Concepts of Taxon, Categories, Holotype, Paratype, Topotype etc; Classification of Animal kingdom, Invertebrates, Vertebrates, Evolutionary relationships between Animal Groups.

**UNIT III MICROBIAL DIVERSITY 9**
Microbes and Earth History, Magnitude, Occurrence and Distribution. Concept of Species, Criteria for Classification, Outline Classification of Microorganisms (Bacteria, Viruses and Protozoa); Criteria for Classification and Identification of Fungi; Chemical and Biochemical Methods of Microbial Diversity Analysis

**UNIT IV MEGA DIVERSITY 9**

Biodiversity Hot-spots, Floristic and Faunal Regions in India and World; IUCN Red List; Factors affecting Diversity, Impact of Exotic Species and Human Disturbance on Diversity, Dispersal, Diversity-Stability Relationship; Socio- economic Issues of Biodiversity; Sustainable Utilization of Bioresources; National Movements and International Convention/Treaties on Biodiversity.

**UNIT V CONSERVATIONS OF BIODIVERSITY 9**

In-Situ Conservation- National parks, Wildlife sanctuaries, Biosphere reserves; Ex-situ conservation- Gene bank, Cryopreservation, Tissue culture bank; Long term captive breeding, Botanical gardens, Animal Translocation, Zoological Gardens; Concept of Keystone Species, Endangered Species, Threatened Species, Rare Species, Extinct Species

**TOTAL: 45 PERIODS**

**TEXT BOOKS:**


1. A textbook of Botany: Angiosperms- Taxonomy, Anatomy, Economic Botany & Embryology. S. Chand, Limited, Pandey, B. P. January 2001
2. Principles of Systematic Zoology, Mcgraw-Hill College, Ashlock, P.D., Latest Edition.
3. Microbiology, MacGraw Hill Companies Inc, Prescott, L.M., Harley, J.P., and Klein D.A. (2022).
4. Microbiology, Pearson Publisher, Gerard J. Tortora, Berdell R. Funke, Christine L.Case, 13th Edition 2019


**REFERENCES:**


1. Ecological Census Technique: A Handbook, Cambridge University Press, Sutherland, W.
2. Encyclopedia of Biodiversity, Academic Press, Simonson Asher Levin.


OUTCOMES

Upon successful completion of this course, students will:

CO1: An insight into the structure and function of diversity for ecosystem stability.

CO2: Understand the concept of animal diversity and taxonomy

CO3: Understand socio-economic issues pertaining to biodiversity

CO4: An understanding of biodiversity in community resource management.

CO5: Student can apply fundamental knowledge of biodiversity conservation to solve problems associated with infrastructure development.

**CO's- PO's & PSO's MAPPING**

| | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO's | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | | 2 | | | | | | 2 | | 2 | | | 2 | 2 | |
| 2 | | 2 | | 2 | 2 | 2 | | | | | | | 3 | 2 | |
| 3 | | | | 2 | | 2 | | | | | | | 3 | 2 | 3 |
| 4 | 3 | 2 | | | 2 | | | 2 | 2 | 2 | 2 | | 3 | 2 | 3 |
| 5 | | 2 | 3 | 2 | | | 1 | | | | | 1 | | 2 | |
| Avg. | 3 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 1 | 3 | 2 | 3 |

1.low, 2-medium, 3-high, '-"- no correlation

Note: The average value of this course to be used for program articulation matrix.

**OEE353 INTRODUCTION TO CONTROL SYSTEMS L T P C**
**3 0 0 3**

**OBJECTIVES**

- To impart knowledge on various representations of systems.
- To familiarize time response analysis of LTI systems and steady state error.
- To analyze the frequency responses and stability of the systems
- To analyze the stability of linear systems in frequency domain and time domain
- To develop linear models mainly state variable model and transfer function model

**UNIT I MATHEMATICAL MODELS OF PHYSICALSYSTEMS 9**

Definition & classification of system – terminology & structure of feedback control theory – Analogous systems - Physical system representation by Differential equations – Block diagram reduction–Signal flow graphs.

**UNIT II TIME RESPONSE ANALYSIS & ROOTLOCUSTECHNIQUE 9**

Standard test signals – Steady state error & error constants – Time Response of I and II order system–Root locus–Rules for sketching root loci.

**UNIT III FREQUENCY RESPONSE ANALYSIS 9**

Correlation between Time & Frequency response – Polar plots – Bode Plots – Determination of Transfer Function from Bode plot.

**UNIT IV STABILITY CONCEPTS & ANALYSIS 9**

Concept of stability – Necessary condition – RH criterion – Relative stability – Nyquist stability criterion — Stability from Bode plot — Relative stability from Nyquist & Bode — Closed loop frequency response.

**UNITV STATE VARIABLE ANALYSIS 9**

Concept of state – State Variable & State Model – State models for linear & continuous time systems–Solution of state & output equation–controllability & observability.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

Ability to

CO1: Design the basic mathematical model of physical System.
CO2: Analyze the time response analysis and techniques.
CO3: Analyze the transfer function from different plots.
CO4: Apply the stability concept in various criterion.
CO5: Assess the state models for linear and continuous Systems.

**TEXTBOOKS**


1. Farid Golnarghi **,** Benjamin C. Kuo, Automatic Control Systems Paper back McGraw Hill Education, 2018.
2. Katsuhiko Ogata, 'Modern Control Engineering', Pearson, 5th Edition2015.
3. J. Nagrath and M. Gopal, Control Systems Engineering (Multi Colour Edition), New Age International, 2018.


**REFERENCES**


1. Richard C. Dorf and Robert H. Bishop, Modern Control Systems, Pearson Education, 2010.
2. Control System Dynamics" by Robert Clark, Cambridge University Press, 1996 USA.
3. John J. D'Azzo, Constantine H. Houpis and Stuart N. Sheldon, Linear Control System AnalysisandDesign, 5th Edition, CRC PRESS, 2003.
4. S. Palani, Control System Engineering, McGraw-Hill Education Private Limited, 2009.
5. Yaduvir Singh and S.Janardhanan, Modern Control, Cengage Learning, First Impression2010.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 2 | 2 | | | | | | | 2 | 3 | 3 | 3 |
| **CO2** | 3 | 3 | 2 | 3 | 1 | | | | | | | | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 3 | 2 | 2 | | | | | | | | 3 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 2 | 2 | | | | | | | 2 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 1 | 1 | | | | | | | 1 | 3 | 3 | 3 |
| | | | | | | | | | | | | | 3 | 3 | 3 |

**OEI354 INTRODUCTION TO INDUSTRIAL AUTOMATION SYSTEMS LT P C**
**3 0 03**

**COURSE OBJECTIVES:**

1. To educate on design of signal conditioning circuits for various applications.
2. To Introduce signal transmission techniques and their design.
3. Study of components used in data acquisition systems interface techniques
4. To educate on the components used in distributed control systems
5. To introduce the communication buses used in automation industries.

**UNIT I INTRODUCTION 9**

Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA). Industrial bus systems : Modbus & Profibus

**UNIT II AUTOMATION COMPONENTS 9**

Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.

**UNIT III COMPUTER AIDED MEASUREMENT AND CONTROL SYSTEMS 9**

Role of computers in measurement and control, Elements of computer aided measurement and control, man-machine interface, computer aided process control hardware, process related interfaces, Communication and networking, Industrial communication systems, Data transfer techniques, Computer aided process control software, Computer based data acquisition system, Internet of things (IoT) for plant automation.

**UNIT IV PROGRAMMABLE LOGIC CONTROLLERS 9**

Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.

**UNIT V DISTRIBUTED CONTROL SYSTEM 9**

Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.

**TOTAL:45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 5**

1. Market survey of the recent PLCs and comparison of their features.
2. Summarize the PLC standards
3. Familiarization of any one programming language (Ladder diagram/ Sequential Function Chart/ Function Block Diagram/ Equivalent open source software)
4. Market survey of Industrial Data Networks.

**COURSE OUTCOMES:**

**Students able to**

**CO1** Design a signal conditioning circuits for various application (L3).
**CO2** Acquire a detail knowledge on data acquisition system interface and DCS system (L2).
**CO3** Understand the basics and Importance of communication buses in applied automation Engineering (L2).
**CO4** Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function BIock.(L3)
**CO5** Able to develop a PLC logic for a specific application on real world problem. (L5)

**TEXT BOOKS:**


1. S.K.Singh, “Industrial Instrumentation”, Tata Mcgraw Hill, 2nd edition companies,2003.
2. C D Johnson, “Process Control Instrumentation Technology”, Prentice Hall India,8th Edition, 2006.
3. E.A.Parr, Newnes ,NewDelhi,“Industrial Control Handbook”,3rd Edition, 2000.


**REFERENCES:**


1. John W. Webb and Ronald A. Reis, “Programmable Logic Controllers: Principles and Applications”, 5th Edition, Prentice Hall Inc., New Jersey, 2003.
2. Frank D. Petruzella, “Programmable Logic Controllers”, 5th Edition, McGraw- Hill, New York, 2016.
3. Krishna Kant, “Computer - Based Industrial Control”, 2nd Edition, Prentice Hall, New Delhi, 2011.
4. Gary Dunning, Thomson Delmar,“Programmable Logic Controller”, CeneageLearning, 3 rd Edition,2005.


**List of Open Source Software/ Learning website:**

1. https://archive.nptel.ac.in/courses/108/105/108105062/
2. https://nptel.ac.in/courses/108105063
3. https://www.electrical4u.com/industrial-automation/
4. https://realpars.com/what-is-industrial-automation/
5. https://automationforum.co/what-is-industrial-automation-2/

**CO’s- PO’s & PSO’s MAPPING**

| | PO’s | | | | | | | | | | | | PSO’s | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO’s** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| **CO1** | 3 | 2 | 2 | 2 | 1 | 1 | - | 1 | - | 1 | - | 1 | 1 | - | 1 |
| **CO2** | 3 | `1 | 1 | - | 1 | - | - | 1 | - | 1 | - | - | 1 | - | 1 |
| **CO3** | 3 | - | 1 | - | 1 | - | - | 1 | - | 1 | - | - | 1 | - | 1 |
| **CO4** | 3 | 3 | 3 | 3 | 1 | | | 1 | | 1 | | | 1 | | 1 |
| **CO5** | 3 | 3 | 3 | 3 | 1 | 1 | | 1 | | 1 | | | 1 | | 1 |
| **AVg.** | 3 | 2.25 | 2 | 2.6 | 1 | 1 | - | 1 | - | 1 | - | - | 1 | - | 1 |

**OFD354 FUNDAMENTALS OF FOOD ENGINEERING L T P C**
**3 0 0 3**

**OBJECTIVES**

The course aims to

- Acquaint and equip the students with different techniques of measurement of engineering properties.
- Make the students understand the nature of food constituents in the design of processing equipment

**UNIT I** **9**

Engineering properties of food materials: physical, thermal, aerodynamic, mechanical, optical and electromagnetic properties.

**UNIT II** **9**

Drying and dehydration: Basic drying theory, heat and mass transfer in drying, drying rate curves, calculation of drying times, dryer efficiencies; classification and selection of dryers; tray, vacuum, osmotic, fluidized bed, pneumatic, rotary, tunnel, trough, bin, belt, microwave, IR, heat pump and freeze dryers; dryers for liquid: Drum or roller dryer, spray dryer and foammat dryers

**UNIT III** **9**

Size reduction: Benefits, classification, determination and designation of the fineness of ground material, sieve/screen analysis, principle and mechanisms of comminution of food, Rittinger's, Kick's and Bond's equations, work index, energy utilization; Size reduction equipment: Principal types, crushers (jaw crushers, gyratory, smooth roll), hammer mills and impactors, attrition mills, buhr mill, tumbling mills, tumbling mills, ultra fine grinders, fluid jet pulverizer, colloid mill, cutting machines (slicing, dicing, shredding, pulping)

**UNIT IV** **9**

Mixing: theory of solids mixing, criteria of mixer effectiveness and mixing indices, rate of mixing, theory of liquid mixing, power requirement for liquids mixing; Mixing equipment: Mixers for lo.w- or medium-viscosity liquids (paddle agitators, impeller agitators, powder-liquid contacting devices, other mixers), mixers for high viscosity liquids and pastes, mixers for dry powders and particulate solids.

**UNIT V** **9**

Mechanical Separations: Theory, centrifugation, liquid-liquid centrifugation, liquid-solid centrifugation, clarifiers, desludging and decanting machine, Filtration: Theory of filtration, rate of filtration, pressure drop during filtration, applications, constant-rate filtration and constant-pressure filtration, derivation of equation; Filtration equipment; plate and frame filter press, rotary filters, centrifugal filters and air filters, filter aids, Membrane separation: General considerations, materials for membrane construction, ultra-filtration, microfiltration, concentration, polarization, processing variables, membrane fouling, applications of ultra-filtration in food processing, reverse osmosis, mode of operation, and applications; Membrane separation methods, demineralization by electro-dialysis, gel filtration, ion exchange, per-evaporation and osmotic dehydration.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course the students will be able to

CO1 Understand the importance of food polymers

CO2 Understand the effect of various methods of processing on the structure and texture of food materials

CO3 Understand the interaction of food constituents with respect to thermal, electrical properties to develop new technologies for processing and preservation.

**TEXTBOOKS:**


1. R.L. Earle. 2004. Unit Operations in Food Processing. The New Zealand Intitute of Food Science & Technology, Nz. Warren L. McCabe, Julian Smith, Peter Harriott. 2004.
2. Unit Operations of Chemical Engineering, 7th Ed. McGraw-Hill, Inc., NY, USA. Christie John Geankoplis. 2003.
3. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th Ed. Prentice-Hall, NY, USA.
4. George D. Saravacos and Athanasios E. Kostaropoulos. 2002. Handbook of Food Processing Equipment. Springer Science+Business Media, New York, USA.
5. J. F. Richardson, J. H. Harker and J. R. Backhurst. 2002. Coulson & Richardson's Chemical Engineering, Vol. 2, Particle Technology and Separation Processes, 5th Ed.


**OFD355 FOOD SAFETY AND QUALITY REGULATIONS L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To characterize different type of food hazards, physical, chemical and biological in the industry and food service establishments
- To help become skilled in systems for food safety surveillance
- To be aware of the regulatory and statutory bodies in India and the world
- To ensure processed food meets global standards

**UNIT I** **10**

Introduction to food safety and security: Hygienic design of food plants and equipments, Food Contaminants (Microbial, Chemical, Physical), Food Adulteration (Common adulterants), Food Additives (functional role, safety issues), Food Packaging & labeling. Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials. Control of rats, rodents, mice, birds, insects and microbes. Cleaning and Disinfection, ISO 22000 – Importance and Implementation

**UNIT II** **8**

Food quality: Various Quality attributes of food, Instrumental, chemical and microbial Quality control. Sensory evaluation of food and statistical analysis. Water quality and other utilities.

**UNIT III** **9**

Critical Quality control point in different stages of production including raw materials and processing materials. Food Quality and Quality control including the HACCP system. Food inspection and Food Law, Risk assessment – microbial risk assessment, dose response and exposure response modelling, risk management, implementation of food surveillance system to monitor food safety, risk communication

**UNIT IV** **9**

Indian and global regulations: FAO in India, Technical Cooperation programmes, Bio-security in Food and Agriculture, World Health Organization (WHO), World Animal Health Organization (OIE), International Plant Protection Convention (IPPC)

**UNIT V** **9**

Codex Alimentarius Commission - Codex India – Role of Codex Contact point, National Codex contact point (NCCP), National Codex Committee of India – ToR, Functions, Shadow Committees etc.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

CO1 Thorough Knowledge of food hazards, physical, chemical and biological in the industry and food service establishments

CO2 Awareness on regulatory and statutory bodies in India and the world

**REFERENCES:**


1. Handbook of food toxicology by S. S. Deshpande, 2002
2. The food safety information handbook by Cynthia A. Robert, 2009
3. Nutritional and safety aspects of food processing by Tannenbaum SR, Marcel Dekker Inc., New York 1979
4. Microbiological safety of Food by Hobbs BC, 1973
5. Food Safety Handbook by Ronald H. Schmidt, Gary E. Rodrick, A John Wiley & Sons Publication, 2003


**OPY353 NUTRACEUTICALS L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To understand the basic concepts of Nutraceuticals and functional food, their chemical nature and methods of extraction.
- To understand the role of Nutraceuticals and functional food in health and disease.

**UNIT I INTRODUCTION AND SIGNIFICANCE 6**

Introduction to Nutraceuticals and functional foods; importance, history, definition, classification, list of functional foods and their benefits, Phytochemicals, zoochemicals and microbes in food, plants, animals and microbes.

**UNIT II PHYTOCHEMICALS AS NUTRACEUTICALS 11**

Phytoestrogens in plants; isoflavones; flavonols, polyphenols, tannins, saponins, lignans, lycopene, chitin, caratenoids. Manufacturing practice of selected nutraceuticals such as lycopene, isoflavonoids, glucosamine, phytosterols. Formulation of functional foods containing nutraceuticals - stability, analytical and labelling issues.

**UNIT III ASSESSMENT OF ANTIOXIDANT ACTIVITY 11**

In vitro and in vivo methods for the assessment of antioxidant activity, Comparison of different *in vitro* methods to evaluate the antioxidant, antioxidant mechanism, Prediction of the antioxidant activity of natural phenolics from electrotopological state indices, Optimising phytochemical release by process technology; Variation of Antioxidant Activity during technological treatments, new food grade peptidases from plant sources.

**UNIT IV ROLE IN HEALTH AND DISEASE 11**

The health benefit of - Soy protein, Spirulina, Tea, Olive oil, plant sterols, Broccoli, omega3 fatty acid and eicosanoids. Nutraceuticals and Functional foods in Gastrointestinal disorder, Cancer, CVD, Diabetic Mellitus, HIV and Dental disease; Importance and function of probiotic, prebiotic and synbiotic and their applications, Functional foods and immune competence; role and use in obesity and nervous system disorders.

**UNIT V SAFETY ISSUES 6**

Health Claims, Adverse effects and toxicity of nutraceuticals, regulations and safety issues International and national.

**TOTAL: 45 PERIODS**

**TEXT BOOKS:**

1. Bisset, Normal Grainger and Max Wich H “Herbal Drugs and Phytopharmaceuticals”, 2nd Edition, CRC, 2001.
2. Handbook of Nutraceuticals and Functional Foods: Robert Wildman, CRC, Publications. 2006
3. WEBB, PP, Dietary Supplements and Functional Foods Blackwell Publishing Ltd (United Kingdom), 2006
4. Ikan, Raphael “Natural Products: A Laboratory Guide”, 2nd Edition, Academic Press / Elsevier, 2005.

**REFERENCES:**

1. Asian Functional Foods (Nutraceutical Science and Technology) by John Shi (Editor), Fereidoon Shahidi (Editor), Chi-Tang Ho (Editor), CRC Publications, Taylor & Francis, 2007
2. Functional Foods and Nutraceuticals in Cancer Prevention by Ronald Ross Watson (Author), Blackwell Publishing, 2007
3. Marketing Nutrition: Soy, Functional Foods, Biotechnology, and Obesity by Brian Wansink.
4. Functional foods: Concept to Product: Edited by G R Gibson and C M Williams, Wood head Publ., 2000
5. Hanson, James R. “Natural Products: The Secondary Metabolites”, Royal Society of Chemistry, 2003.

**COURSE OUTCOME - NUTRACEUTICALS**

| | |
|---|---|
| **CO 1** | Acquire knowledge about the Nutraceuticals and functional foods, their classification and benefits. |
| **CO 2** | Acquire knowledge of phytochemicals, zoochemicals and microbes in food, plants, animals and microbes |
| **CO 3** | Attain the knowledge of the manufacturing practices of selected nutraceutical components and formulation considerations of functional foods. |
| **CO 4** | Distinguish the various *In vitro* and *In vivo* assessment of Antioxidant activity of compounds from plant sources. |
| **CO 5** | Gain information about the health benefits of various functional foods and nutraceuticals in the prevention and treatment of various lifestyle diseases. |
| **CO 6** | Attain the knowledge of the regulatory and safety issues of nutraceuticals at national and international level. |

| **CO – PO MAPPING** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **NUTRACEUTICALS** | | | | | | | | | | | | |
| **Course outcome** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO 1** | 3 | | | | | | | | | | | 1 |
| **CO 2** | 3 | | | | | | | | | | | 1 |
| **CO 3** | 3 | | | | | 2 | | | | | | |
| **CO 4** | 3 | | | | | | | | | | | |
| **CO 5** | 3 | | | | | 2 | | | | | | 1 |
| **CO 6** | 3 | | | | | | | 2 | | | | 1 |

**OTT354 BASICS OF DYEING AND PRINTING L T P C**
**3 0 0 3**

**OBJECTIVE:**

- To enable the students to learn about the basics of Pretreatment, dyeing, printing and machinery in textile processing.

**UNIT I INTRODUCTION 9**

Impurities present in different fibres, Inspection of grey goods and lot preparation. Shearing,

**UNIT II PRE TREATMENT 9**

Desizing-Objective of Desizing- types of Desizing- Objective of Scouring- Mechanism of Scouring– Degumming of Silk, Scouring of wool - Bio Scouring. Bleaching -Objective of Bleaching: Bleaching mechanism of Hydrogen Peroxide, Hypo chlorites. Objective of Mercerizing - Physical and Chemical changes of Mercerizing.

**UNIT III DYEING 9**

Dye - Affinity, Substantively, Reactivity, Exhaustion and Fixation. Classification of dyes. Direct dyes: General properties, principles and method of application on cellulosic materials. Reactive dyes – principles and method of application on cellulosic materials hot brand, cold brand.

**UNIT IV PRINTING 9**

Definition of printing – Difference between printing and dying- Classification thickeners – Requirements to be good thickener, printing paste Preparation - different styles of printing.

**UNIT V MACHINERIES 9**

Fabric Processing - winch, jigger and soft flow machines. Beam dyeing machines: Printing -flat bed screen - Rotary screen. Thermo transfer printing machinery. Garment dyeing machines.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of the course, the students will be able to Understand the
CO1: Basics of grey fabric
CO2: Basics of pre treatment
CO3: Concept of Dyeing
CO4: Concept of Printing
CO5: Machinery in processing industry

**TEXT BOOKS:**


1. Trotman, E.R., Textile Scouring and Bleaching, Charless Griffins, Com. Ltd., London 1990.
2. Shenai V.A. “Technology of Textile Processing Vol. IV” 1998, Sevak Publications, Mumbai.


**REFERENCES:**


1. Trotman E. R., “Dyeing and Chemical Technology of Textile Fibres”, Charles Griffin & Co. Ltd., U.K., 1984, ISBN : 0 85264 165 6.
2. Dr. N N Mahapatra., “Textile dyeing”, Wood head publishing India, 2018
3. Mathews Kolanjikombil., ”Dyeing of Textile substrates III –Fibres, Yarns and Knitted fabrics”, Wood head publishing India , 2021
4. Bleaching & Mercerizing – BTRA Silver Jubilee Monograph series
5. Chakraborty, J.N, "Fundamentals and Practices in colouration of Textiles", Wood head Publishing India, 2009, ISBN-13:978-81-908001-4-3.


**Course Articulation Matrix:**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

| Course Outcomes | PROGRAM OUTCOME | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Statement | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
| CO1 | Classification of fibres and production of natural fibres | - | - | - | - | - | - | - | 2 | 1 | - | 1 | 1 | - | 1 | - |
| CO2 | Regenerated and synthetic fibres | - | - | - | - | - | - | - | 2 | 1 | - | 1 | 1 | - | 1 | - |
| CO3 | Yarn spinning | - | - | - | - | - | - | - | 2 | 1 | - | 1 | 1 | - | 1 | - |
| CO4 | Weaving | - | - | - | - | - | - | - | 2 | 1 | - | 1 | 1 | - | 1 | - |
| CO5 | Knitting and nonwoven | - | - | - | - | - | - | - | 2 | 1 | - | 1 | 1 | - | 1 | - |
| Overall CO | | - | - | - | - | - | - | - | 2 | 1 | - | 1 | 1 | - | 1 | - |

**FT3201** **FIBRE SCIENCE** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- To enable the students to learn about the types of fibre and its properties

**UNIT I INTRODUCTION TO TEXTILE FIBRES 9**

Definition of various forms of textile fibres - staple fibre, filament, bicomponent fibres. Classification of Natural and Man-made fibres, essential and desirable properties of Fibres. Production and cultivation of Natural Fibers: Cotton, Silk, Wool -Physical and chemical structure of the above fibres.

**UNIT II REGENERATED FIBRES 9**

Production Sequence of Regenerated Cellulosic fibres: Viscose Rayon, Acetate rayon – High wet modulus fibres: Modal and Lyocel ,Tencel

**UNIT III SYNTHEITC FIBRES 9**

Production Sequence of Synthetic Fibers: polymer-Polyester, Nylon, Acrylic and polypropylene. Mineral fibres: fibre glass ,carbon .Introduction to spin finishes and texturization

**UNIT IV SPECIALITY FIBRES 9**

Properties and end uses of high tenacity and high modulus fibres, high temperature and flame retardant fibres, Chemical resistant fibres

**UNIT V FUNCTIONAL SPECIALITY FIBRES 9**

**Properties and end uses :** Fibres for medical application – Biodegradable fibres based on PLA ,Super absorbent fibres elastomeric fibres, ultra-fine fibres, electrospun nano fibres, metallic fibres – Gold and Silver coated.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES**

Upon completion of this course, the student would be able to

- Understand the process sequence of various fibres
- Understand the properties of various fibres

**TEXT BOOKS:**


1. Morton W. E., and Hearle J. W. S., “Physical Properties of Textile Fibres”, The Textile Institute, Washington D.C., 2008, ISBN 978-1-84569-220-95
2. Meredith R., and Hearle J. W. S., “Physical Methods of Investigation of Textiles”, Wiley Publication, New York, 1989, ISBN: B00JCV6ZWU | ISBN-13:
3. Mukhopadhyay S. K., “Advances in Fibre Science”, The Textile Institute,1992, ISBN: 1870812379


**REFERENCES:**


1. Meredith R., “Mechanical Properties of Textile Fibres”, North Holland, Amsterdam, 1986, ISBN: 1114790699, ISBN-13: 9781114790698
2. Hearle J. W. S., Lomas B., and Cooke W. D., “Atlas of Fibre Fracture and Damage to Textiles”, The Textile Institute, 2nd Edition, 1998, ISBN: 1855733196.
3. Raheel M. (ed.)., “Modern Textile Characterization Methods”, Marcel Dekker, 1995, ISBN:0824794737
4. Mukhopadhyay. S. K., “The Structure and Properties of Typical Melt Spun Fibres”, Textile Progress, Vol. 18, No. 4, Textile Institute, 1989, ISBN: 1870812115
5. Hearle J.W.S., “Polymers and Their Properties: Fundamentals of Structures and Mechanics Vol 1”, Ellis Horwood, England, 1982, ISBN: 047027302X | ISBN-13: 9780470273029 36


**OTT355 GARMENT MANUFACTURING TECHNOLOGY L T P C**
**3 0 0 3**

**OBJECTIVE:**

- To enable the students to understand the basics of pattern making, cutting and sewing.
- To expose the students to various problems & remedies during garment manufacturing

**UNIT I PATTERN MAKING, MARKER PLANNING, CUTTING 9**

Anthropometry, specification sheet, pattern making – principles, basic pattern set drafting, grading, marker planning, spreading & cutting

**UNIT II TYPES OF SEAMS, STITCHES AND FUNCTIONS OF NEEDLES 9**

Different types of seams and stitches; single needle lock stitch machine – mechanism and accessories; needle – functions, special needles, needlepoint

**UNIT III COMPONENTS AND TRIMS USED IN GARMENT 9**

Sewing thread-construction, material, thread size, packages, accessories – labels, linings, interlinings, wadding, lace, braid, elastic, hook and loop fastening, shoulder pads, eyelets and laces, zip fasteners, buttons

**UNIT IV GARMENT INSPECTION AND DIMENSIONAL CHANGES 9**

Raw material, in process and final inspection; needle cutting; sewability of fabrics; strength properties of apparel; dimensional changes in apparel due to laundering, dry-cleaning, steaming and pressing.

**UNIT V GARMENT PRESSING, PACKING AND CARE LABELING 9**

Garment pressing – categories and equipment, packing; care 277abelling of apparels

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Upon completion of the course, the students will be able to Understand

CO1: Pattern making, marker planning, cutting

CO2: Types of seams, stitches and functions of needles

CO3: Components and trims used in garment

CO4: Garment inspection and dimensional changes

CO5: Garment pressing, packing and careabelling

**TEXT BOOKS:**


1. Carr H., and Latham B., "The Technology of Clothing Manufacture", Blackwell Science Ltd., Oxford, 1994.
2. Gerry Cooklin, "Introduction to Clothing Manufacture" Blackwell Science Ltd., 1995. 64
3. Harrison.P.W Garment Dyeing, The Textile Institute Publication, Textile Progress, Vol .19 No.2,1988.


**REFERENCES:**


1. Winifred Aldrich., "Metric Pattern Cutting", Blackwell Science Ltd., Oxford, 1994
2. Peggal H., "The Complete Dress Maker", Marshall Caverdish, London, 1985
3. Jai Prakash and Gaur R.K., "Sewing Thread", NITRA, 1994
4. Ruth Glock, Grace I. Kunz, "Apparel Manufacturing", Dorling Kindersley Publishing Inc., New Jersey, 1995.
5. Pradip V.Mehta, "An Introduction to Quality Control for the Apparel Industry", J.S.N. Internationals, 1992.


| CO's | PO's | | | | | | | | | | | | PSO's | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** | **4** |
| **1** | 1 | 1 | 1 | - | 2 | - | 1 | 1 | - | 2 | 3 | 1 | 2 | 3 | 1 | 3 |
| **2** | 2 | 2 | 1 | 1 | 1 | - | 1 | 1 | - | 2 | 2 | 1 | 2 | 2 | 1 | 2 |
| **3** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - | 1 | 2 | 1 | 1 | 3 | 1 | 3 |
| **4** | 2 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 3 |
| **5** | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | - | 2 | 2 | 1 | 2 | 2 | 1 | 2 |
| **Avg** | 1.6 | 1.2 | 1 | 0.8 | 1.4 | 0.8 | 1.4 | 1 | 0.2 | 1.8 | 2.4 | 1 | 1.8 | 2.6 | 1 | 2.6 |

**OCH353 ENERGY TECHNOLOGY L T P C**

**3 0 0 3**

**UNIT I INTRODUCTION 8**

Units of energy, conversion factors, general classification of energy, world energy resources and energy consumption, Indian energy resources and energy consumption, energy crisis, energy alternatives, Renewable and non-renewable energy sources and their availability. Prospects of Renewable energy sources

**UNIT II CONVENTIONAL ENERGY 8**

Conventional energy resources, Thermal, hydel and nuclear reactors, thermal, hydel and nuclear power plants, efficiency, merits and demerits of the above power plants, combustion processes, fluidized bed combustion.

**UNIT III NON-CONVENTIONAL ENERGY 10**

Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar energy application in India, energy plantations. Wind energy, types of windmills, types of wind rotors, Darrieus rotor and Gravian rotor, wind electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion, geothermal energy.

**UNIT IV BIOMASS ENERGY 10**

Biomass energy resources, thermo-chemical and biochemical methods of biomass conversion, combustion, gasification, pyrolysis, biogas production, ethanol, fuel cells, alkaline fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, solid polymer electrolyte fuel cell, magneto hydrodynamic power generation, energy storage routes like thermal energy storage, chemical, mechanical storage and electrical storage.

**UNIT V ENERGY CONSERVATION 9**

Energy conservation in chemical process plants, energy audit, energy saving in heat exchangers, distillation columns, dryers, ovens and furnaces and boilers, steam economy in chemical plants, energy conservation.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

On completion of the course, the students will be able to

CO1: Students will be able to describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.

CO2: Students will excel as professionals in the various fields of energy engineering

CO3: Compare different renewable energy technologies and choose the most appropriate based on local conditions.

CO4: Explain the technological basis for harnessing renewable energy sources.

CO5: Identify and critically evaluate current developments and emerging trends within the field of renewable energy technologies and to develop in-depth technical understanding of energy problems at an advanced level.

**TEXT BOOKS**

1. Rao, S. and Parulekar, B.B., Energy Technology, Khanna Publishers, 2005.
2. Rai, G.D., Non-conventional Energy Sources, Khanna Publishers, New Delhi, 1984.
3. Bansal, N.K., Kleeman, M. and Meliss, M., Renewable Energy Sources and Conversion Technology, Tata McGraw Hill, 1990.
4. Nagpal, G.R., Power Plant Engineering, Khanna Publishers, 2008.

**REFERENCES**

1. Nejat Vezirog, Alternate Energy Sources, IT, McGraw Hill, New York.
2. El. Wakil, Power Plant Technology, Tata McGraw Hill, New York, 2002.
3. Sukhatme. S.P., Solar Enery - Thermal Collection and Storage, Tata McGraw hill, New Delhi, 1981.

**COURSE ARTICULATION MATRIX**

| Course Outcomes | Program Outcomes | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Statements | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
| **CO1** | Students will be able to describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels. | **2** | **3** | **2** | **3** | **3** | **-** | **-** | **-** | **1** | **1** | **-** | **3** | **1** | **1** | **3** |
| **CO2** | Students will excel as professionals in the various fields of energy engineering | **2** | **3** | **1** | **3** | **3** | **-** | **-** | **-** | **1** | **1** | **-** | **3** | **2** | **1** | **3** |
| **CO3** | Compare different renewable energy technologies and choose the most appropriate based on local conditions. | **2** | **2** | **2** | **3** | **3** | **1** | **1** | **-** | **1** | **1** | **-** | **3** | **2** | **1** | **3** |
| **CO4** | Explain the technological basis for harnessing renewable energy sources. | **2** | **2** | **1** | **3** | **3** | **1** | **1** | **1** | **1** | **-** | **1** | **3** | **1** | **1** | **3** |
| **CO5** | Identify and critically evaluate current developments and emerging trends within the field of renewable energy technologies and to develop in-depth technical understanding of energy problems at an advanced level | **2** | **2** | **1** | **3** | **3** | **1** | **1** | **1** | **1** | **-** | **1** | **3** | **2** | **1** | **3** |
| OVERALL CO | | **2** | **2** | **1** | **3** | **3** | **2** | **2** | **1** | **1** | **1** | **1** | **3** | **2** | **1** | **3** |

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**OCH354** **SURFACE SCIENCE** **L T P C**
**3 0 0 3**

**OBJECTIVE:**

- To enable the students to analyze properties of a surfaces and correlate them to structure, chemistry, and physics and surface modification technique.

**UNIT I SURFACE STRUCTURE AND EXPERIMENTAL PROBES 9**

Relevance of surface science to Chemical and Electrochemical Engineering, Heterogeneous Catalysis and Nanoscience; Surface structure and reconstructions, absorbate structure, Band and Vibrational structure, Importance of UHV techniques, Electronic probes and molecular beams, Scanning probes and diffraction, Qualitative introduction to electronic and vibrational spectroscopy

**UNIT II ADSORPTION, DYNAMICS, THERMODYNAMICS AND KINETICS AT SURFACES 9**

Interactions at the surface, Physisorption, Chemisorption, Diffusion, dynamics and reactions of atoms/molecules on surfaces, Generic reaction mechanism on surfaces, Adsorption isotherms, Kinetics of adsorption, Use of temperature desorption methods

**UNIT III LIQUID INTERFACES 9**

Structure and Thermodynamics of liquid-solid interface, Self-assembled monolayers, Electrified interfaces, Charge transfer at the liquid-solid interfaces, Photoelectrochemical processes, Gratzel cells

**UNIT IV HETEROGENEOUS CATALYSIS 9**

Characterization of heterogeneous catalytic processes, Microscopic kinetics to catalysis, Overview of important heterogeneous catalytic processes: Haber-Bosch, Fishcher-Tropsch and Automotive catalysis, Role of promoters and poisons, Bimetallic surfaces, surface functionalization and clusters in catalysis, Role of Sabatier principle in catalyst design, Rate oscillations and spatiotemporal pattern formation

**UNIT V EPITAXIAL GROWTH AND NANO SURFACE-STRUCTURES 9**

Origin of surface forces, Role of stress and strain in epitaxial growth, Energetic and growth modes, Nucleation theory, Nonequilibrium growth modes, MBE, CVD and ablation techniques, Catalytic growth of nanotubes, Etching of surfaces, Formation of nanopillars and nanorods and its application in photoelectrochemical processes, Polymer surfaces and biointerfaces.

**TOTAL: 45 PERIODS**

**OUTCOME:**

- Upon completion of this course, the students can understand, predict and design surface properties based on surface structure. Students would understand the physics and chemistry behind surface phenomena

**TEXT BOOK:**

1. K. W. Kolasinski, “Surface Science: Foundations of catalysis and nanoscience” II Edition, John Wiley & Sons, New York, 2008.

**REFERENCE:**

1. Gabor A. Somorjai and Yimin Li “Introduction to Surface Chemistry and catalysis”, II Edition John Wiley & Sons, New York, 2010.

**OPE353 INDUSTRIAL SAFETY L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To educate about the health hazards and the safety measures to be followed in the industrial environment.
- Describe industrial legislations (Factories Acts, Workmen's Compensation and other laws) enacted for the protection of employees health at work settings
- Describe methods of prevention and control of Occupational Health diseases, accidents / emergencies and other hazards

**UNIT I INTRODUCTION 9**

Need for developing Environment, Health and Safety systems in work places - Accident Case Studies - Status and relationship of Acts - Regulations and Codes of Practice - Role of trade union safety representatives. International initiatives - Ergonomics and work place.

**UNIT II OCCUPATIONAL HEALTH AND HYGIENE 9**

Definition of the term occupational health and hygiene - Categories of health hazards - Exposure pathways and human responses to hazardous and toxic substances - Advantages and limitations of environmental monitoring and occupational exposure limits - Hierarchy of control measures for occupational health risks - Role of personal protective equipment and the selection criteria - Effects on humans - control methods and reduction strategies for noise, radiation and excessive stress.

**UNIT III WORKPLACE SAFETY AND SAFETY SYSTEMS 9**

Features of Satisfactory and Safe design of work premises – good housekeeping - lighting and colour, Ventilation and Heat Control – Electrical Safety – Fire Safety – Safe Systems of work for manual handling operations – Machine guarding – Working at different levels – Process and System Safety.

**UNIT IV HAZARDS AND RISK MANAGEMENT 9**

Safety appraisal - analysis and control techniques – plant safety inspection – Accident investigation - Analysis and Reporting – Hazard and Risk Management Techniques – major accident hazard control – Onsite and Offsite emergency Plans.

**UNIT V ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT 9**

Concept of Environmental Health and Safety Management – Elements of Environmental Health and Safety Management Policy and methods of its effective implementation and review – Elements of Management Principles – Education and Training – Employee Participation.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

After completion of this course, the student is expected to be able to:

- Describe, with example, the common work-related diseases and accidents in occupational setting
- Name essential members of the Occupational Health team
- What roles can a community health practitioners play in an Occupational setting to ensure the protection, promotion and maintenance of the health of the employee

**OPE354 UNIT OPERATIONS IN PETRO CHEMICAL INDUSTRIES L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To impart to the student basic knowledge on fluid mechanics, mechanical operations, heat transfer operations and mass transfer operations.

**UNIT I FLUID MECHANICS CONCEPTS**

Fluid definition and classification of fluids, types of fluids, Rheological behaviour of fluids & Newton’s Law of viscosity. Fluid statics-Pascal's law, Hydrostatic equilibrium, Barometric equation and pressure measurement(problems),Basic equations of fluid flow - Continuity equation, Euler’s equation and Bernoulli equation; Types of flow - laminar and turbulent; Reynolds experiment; Flow through circular and non-circular conduits - Hagen Poiseuille equation (no derivation). Flow through stagnant fluids – theory of Settling and Sedimentation – Equipment (cyclones, thickeners) Conceptual numericals.

**UNIT II FLOW MEASUREMENTS & MECHANICAL OPERATIONS**

Different types of flow measuring devices (Orifice meter, Venturimeter, Rotameter) with derivations, flow measurements –. Pumps – types of pumps (Centrifugal & Reciprocating pumps), Energy calculations and characteristics of pumps. Size reduction–characteristics of comminute products, sieve analysis, Properties and handling of particulate solids – characterization of solid particles, average particle size, screen analysis- Conceptual numerical of differential and cumulative analysis. Size reduction, crushing laws, working principle of ball mill. Filtration & types, filtration equipments (plate and frame, rotary drum). Conceptual numericals.

**UNIT III CONDUCTIVE & CONVECTIVE HEAT TRANSFER**

Modes of heat transfer; Conduction – steady state heat conduction through unilayer and multilayer walls, cylinders; Insulation, critical thickness of insulation. Convection- Forced and Natural convection, principles of heat transfer co-efficient, log mean temperature difference, individual and overall heat transfer co-efficient, fouling factor; Condensation – film wise and drop wise (no derivation). Heat transfer equipments – double pipe heat exchanger, shell and tube heat exchanger (with working principle and construction with applications).

**UNIT IV BASICS OF MASS TRANSFER**

Diffusion-Fick's law of diffusion. Types of diffusion. Steady state molecular diffusion in fluids at rest and laminar flow (stagnant / unidirection and bi direction). Measurement of diffusivity, Mass transfer coefficients and their correlations. Conceptual numerical.

**UNIT V MASS TRANSFER OPERATIONS**

Basic concepts of Liquid-liquid extraction – equilibrium, stage type extractors (belt extraction and basket extraction).Distillation – Methods of distillation, distillation of binary mixtures using McCabe Thiele method.Drying- drying operations, batch and continuous drying. Conceptual numerical.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course the student will be able to:

- State and describe the nature and properties of the fluids.
- Study the different flow measuring instruments, the principles of various size reductions, conveying equipment's, sedimentation and mixing tanks.
- Comprehend the laws governing the heat and mass transfer operations to solve the problems.
- Design the heat transfer equipment suitable for specific requirement.

**TEXTBOOKS:**


1. Unit operations in Chemical Engineering Warren L. McCabe, Julian C. Smith & Peter Harriot McGraw-Hill Education (India) Edition 2014
2. Fluid Mechanics K L Kumar S Chand & Company Ltd 2008
3. Introduction to Chemical Engineering Badger W.I. and Banchero, J.T., Tata McGraw Hill New York 1997


**REFERENCE BOOKS**


1. Principles of Unit Operations Alan S Foust, L.A. Wenzel, C.W. Clump, L. Maus, and L.B. Anderson John Wiley & Sons 2nd edition 2008
2. Unit Operations of Chemical Engineering, Vol I &II Chattopadhyaya Khanna Publishers, Delhi-6 1996
3. Heat Transfer J P Holman McGraw Hill International Ed

**OEC353** **VLSI DESIGN** **L T P C**
**3 0 0 3**

**OBJECTIVES:**

- Understand the fundamentals of IC technology components and their characteristics.
- Understand combinational logic circuits and design principles.
- Understand sequential logic circuits and clocking strategies.
- Understand Interconnects and Memory Architecture.
- Understand the design of arithmetic building blocks

**UNIT I MOS TRANSISTOR PRINCIPLES 9**

MOS logic families (NMOS and CMOS), Ideal and Non Ideal IV Characteristics, CMOS devices. MOS(FET) Transistor DC transfer Characteristics ,small signal analysis of MOSFET.

**UNIT II COMBINATIONAL LOGIC CIRCUITS 9**

Propagation Delays, stick diagram, Layout diagrams, Examples of combinational logic design, Elmore's constant, Static Logic Gates, Dynamic Logic Gates, Pass Transistor Logic, Power Dissipation.

**UNIT III SEQUENTIAL LOGIC CIRCUITS AND CLOCKING STRATEGIES 9**

Static Latches and Registers, Dynamic Latches and Registers, Pipelines, Timing classification of Digital Systems, Synchronous Design, Self-Timed Circuit Design .

**UNIT IV INTERCONNECT, MEMORY ARCHITECTURE 9**

Interconnect Parameters – Capacitance, Resistance, and Inductance, Logic Implementation using Programmable Devices (ROM, PLA, FPGA), Memory Architecture and Building Blocks.

**UNIT V DESIGN OF ARITHMETIC BUILDING BLOCKS 9**

Arithmetic Building Blocks: Data Paths, Adders-Ripple Carry Adder, Carry-Bypass Adder, Carry Select Adder, Carry-Look Ahead Adder, Multipliers, Barrel Shifter, power and speed tradeoffs.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

**Upon successful completion of the course the student will be able to**

**CO1**: Understand the working principle and characteristics of MOSFET
**CO2**: Design Combinational Logic Circuits
**CO3**: Design Sequential Logic Circuits and Clocking systems
**CO4**: Understand Memory architecture and interconnects
**CO5**: Design of arithmetic building blocks.

**TEXTBOOKS**


1. Jan D Rabaey, Anantha Chandrakasan, "Digital Integrated Circuits: A Design Perspective", PHI, 2016.(Units II, III IV and V).
2. Neil H E Weste, Kamran Eshranghian, "Principles of CMOS VLSI Design: A System Perspective," Addison Wesley, 2009.( Units - I).


**REFERENCES:**


1. D.A. Hodges and H.G. Jackson, Analysis and Design of Digital Integrated Circuits, International Student Edition, McGraw Hill 1983
2. P. Rashinkar, Paterson and L. Singh, "System-on-a-Chip Verification-Methodology and Techniques", Kluwer Academic Publishers,2001
3. Samiha Mourad and Yervant Zorian, "Principles of Testing Electronic Systems", Wiley 2000
4. M. Bushnell and V. D. Agarwal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers,2000

| C | PO | PO | PO | PO | PO | PO | PO | PO | PO | PO1 | PO1 | PO1 | PSO | PSO | PSO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 3 | 3 | 2 | 2 | 1 | 3 | - | - | - | - | 2 | 3 | 3 | 3 | 3 |
| **2** | 3 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | 2 | 3 | 3 | 3 |
| **3** | 3 | - | 3 | 2 | 1 | 2 | - | - | - | - | 3 | 2 | 3 | 2 | 3 |
| **4** | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 1 | 3 | 3 | 2 |
| **5** | 2 | - | 3 | 2 | 2 | 1 | - | - | - | - | 1 | 1 | 3 | 2 | 2 |
| **C** | **3** | **3** | **2** | **2** | **1** | **2** | **-** | **-** | **-** | **-** | **2** | **2** | **3** | **3** | **3** |

**CBM370 WEARABLE DEVICES L T P C**
**3 0 0 3**

**OBJECTIVES:**

**The student should be made to:**

- To know the hardware requirement of wearable systems
- To understand the communication and security aspects in the wearable devices
- To know the applications of wearable devices in the field of medicine

**UNIT I INTRODUCTION TO WEARABLE SYSTEMS AND SENSORS 9**

Wearable Systems- Introduction, Need for Wearable Systems, Drawbacks of Conventional Systems for Wearable Monitoring, Applications of Wearable Systems, Types of Wearable Systems, Components of wearable Systems. Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Impedance plethysmography, Wearable ground reaction force sensor.

**UNIT II SIGNAL PROCESSING AND ENERGY HARVESTING FOR WEARABLE DEVICES 9**

Wearability issues -physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, sampling frequency for reduced energy consumption, Rejection of irrelevant information. Power Requirements- Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles.

**UNIT III WIRELESS HEALTH SYSTEMS 9**

Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges- System security and reliability, BAN Architecture – Introduction, Wireless communication Techniques.

**UNIT IV SMART TEXTILE 9**

Introduction to smart textile- Passive smart textile, active smart textile. Fabrication Techniques- Conductive Fibres, Treated Conductive Fibres, Conductive Fabrics, Conductive Inks.Case study- smart fabric for monitoring biological parameters - ECG, respiration.

**UNIT V APPLICATIONS OF WEARABLE SYSTEMS 9**

Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, neural recording, Gait analysis, Sports Medicine.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

On successful completion of this course, the student will be able to

CO1: Describe the concepts of wearable system.

CO2: Explain the energy harvestings in wearable device.

CO3: Use the concepts of BAN in health care.

CO4: Illustrate the concept of smart textile

CO5: Compare the various wearable devices in healthcare system

**TEXT BOOKS**


1. Annalisa Bonfiglo and Danilo De Rossi, Wearable Monitoring Systems, Springer, 2011
2. Zhang and Yuan-Ting, Wearable Medical Sensors and Systems,Springer, 2013
3. Edward Sazonov and Micheal R Neuman, Wearable Sensors: Fundamentals, Implementation and Applications, Elsevier, 2014
4. Mehmet R. Yuce and JamilY.Khan, Wireless Body Area Networks Technology, Implementation applications,Pan Stanford Publishing Pte.Ltd, Singapore, 2012


**REFERENCES**


1. Sandeep K.S, Gupta, Tridib Mukherjee and Krishna Kumar Venkatasubramanian, Body Area Networks Safety, Security, and Sustainability, Cambridge University Press, 2013.
2. Guang-Zhong Yang, Body Sensor Networks, Springer, 2006.


**CO's- PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 2 | 1 | 1 | 2 | | | 1 | | | | | 1 | | 1 |
| 2 | 3 | 2 | 1 | 1 | 2 | | | 1 | | | | | 1 | | 1 |
| 3 | 3 | 2 | 1 | 1 | 2 | | | 1 | | | | | 1 | | 1 |
| 4 | 3 | 2 | 1 | 1 | 2 | | | 1 | | | | | 1 | | 1 |
| 5 | 3 | 2 | 1 | 1 | 2 | | | 1 | | | | | 1 | | 1 |
| AVg. | | | | | | | | | | | | | | | |

**CBM356 MEDICAL INFORMATICS L T P C**
**3 0 0 3**

**Preamble:**

1. To study the applications of information technology in health care management.
2. This course provides knowledge on resources, devices, and methods required to optimize the acquisition, storage, retrieval, and use of information in health and biomedicine.

**UNIT I INTRODUCTION TO MEDICAL INFORMATICS 9**

Introduction - Structure of Medical Informatics –Internet and Medicine -Security issues, Computer based medical information retrieval, Hospital management and information system, Functional capabilities of a computerized HIS, Health Informatics – Medical Informatics, Bioinformatics

**UNIT II COMPUTERS IN CLINICAL LABORATORY AND MEDICAL IMAGING 9**

Automated clinical laboratories-Automated methods in hematology, cytology and histology, Intelligent Laboratory Information System - Computer assisted medical imaging- nuclear medicine, ultrasound imaging, computed X-ray tomography, Radiation therapy and planning, Nuclear Magnetic Resonance.

**UNIT III COMPUTERISED PATIENT RECORD 9**

Introduction - conventional patient record, Components and functionality of CPR, Development tools, Intranet, CPR in Radiology- Application server provider, Clinical information system, Computerized prescriptions for patients.

**UNIT IV COMPUTER ASSISTED MEDICAL DECISION-MAKING 9**

Neuro computers and Artificial Neural Networks application, Expert system-General model of CMD, Computer–assisted decision support system-production rule system cognitive model, semantic networks, decisions analysis inclinical medicine-computers in the care of critically ill patients, Computer aids for the handicapped.

**UNIT V RECENT TRENDS IN MEDICAL INFORMATICS 9**

Virtual reality applications in medicine, Virtual endoscopy, Computer assisted surgery, Surgical simulation, Telemedicine - Tele surgery, Computer assisted patient education and health- Medical education and healthcare information, computer assisted instruction in medicine.

**TOTAL : 45 PERIODS**

**Course Outcomes:**

**Upon completion of the course, students will be able to:**

1. Explain the structure and functional capabilities of Hospital Information System.
2. Describe the need of computers in medical imaging and automated clinical laboratory.
3. Articulate the functioning of information storage and retrieval in computerized patient record system.
4. Apply the suitable decision support system for automated clinical diagnosis.
5. Discuss the application of virtual reality and telehealth technology in medical industry.

**TEXT BOOKS:**


1. Mohan Bansal, “Medical informatics”, Tata McGraw Hill Publishing Ltd, 2003.
2. R.D.Lele, “Computers in medicine progress in medical informatics”, Tata Mcgraw Hill,2005


**REFERENCES:**


1. Kathryn J. Hannah, Marion J Ball, “Health Informatics”, 3rd Edition, Springer, 2006.


**CO’s- PO’s & PSO’s MAPPING**

| CO’s | PO’s | | | | | | | | | | | | PSO’s | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 2 | 1 | 1 | 2 | | | 1 | | | | | 1 | 1 | 1 |
| 2 | 3 | 2 | 1 | 1 | 2 | | | 1 | | | | | 1 | 1 | 1 |
| 3 | 3 | 2 | 1 | 1 | 2 | | | 1 | | | | | 1 | 1 | 1 |
| 4 | 3 | 2 | 1 | 1 | 2 | | | 1 | | | | | 1 | 1 | 1 |
| 5 | 3 | 2 | 1 | 1 | 2 | | | 1 | | | | | 1 | 1 | 1 |
| AVg. | 3 | 2 | 1 | 1 | 2 | | | 1 | | | | | 1 | 1 | 1 |

**OBT355 BIOTECHNOLOGY FOR WASTE MANAGEMENT L T P C**

**3 0 0 3**

**UNIT I BIOLOGICAL TREATMENT PROCESS 9**

Fundamentals of biological process - Anaerobic process – Pretreatment methods in anaerobic process – Aerobic process, Anoxic process, Aerobic and anaerobic digestion of organic wastes - Factors affecting process efficiency - Solid state fermentation – Submerged fermentation – Batch and continous fermentation

**UNIT II WASTE BIOMASS AND ITS VALUE ADDITION 9**

Types of waste biomass – Solid waste management - Nature of biomass feedstock – Biobased economy/process – Value addition of waste biomass – Biotransformation of biomass – Biotransformation of marine processing wastes – Direct extraction of biochemicals from biomass – Plant biomass for industrial application

**UNIT III BIOCONVERSION OF WASTES TO ENERGY 9**

Perspective of biofuels from wastes - Bioethanol production – Biohydrogen Production – dark and photofermentative process - Biobutanol production – Biogas and Biomethane production - Single stage anaerobic digestion, Two stage anaerobic digestion - Biodiesel production - Enzymatic hydrolysis technologies

**UNIT IV CHEMICALS AND ENZYME PRODUCTION FROM WASTES 9**

Production of lactic acid, succinic acid, citric acid – Biopolymer synthesis – Production of Amylases - Lignocellulolytic enzymes - Pectinolytic enzymes - Proteases – Lipases

**UNIT V BIOCOMPOSTING OF ORGANIC WASTES 9**

Overview of composting process - Benefitis of composting, Role of microorganisms in composting - Factors affecting the composting process - Waste Materials for Composting, Fundamentals of composting process - Composting technologies, Composting systems – Nonreactor Composting, Reactor composting - Compost Quality

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

After completion of this course, the students should be able

1. To learn the various methods biological treatment
2. To know the details of waste biomass and its value addition
3. To develop the bioconversion processes to convert wastes to energy
4. To synthesize the chemicals and enzyme from wastes
5. To produce the biocompost from wastes
6. To apply the theoretical knowledge for the development of value added products

**TEXT BOOKS**


1. Antoine P. T., (2017) “Biofuels from Food Waste Applications of Saccharification Using Fungal Solid State Fermentation”, CRC press
2. Joseph C A., (2019)“Anaerobic Waste-Wastewater Treatment and Biogas Plants-A Practical Handbook”, CRC Press,


**REFERENCE BOOKS**


1. Palmiro P. and Oscar F.D’Urso, (2016) ‘Biotransformation of Agricultural Waste and By-Products’,The Food, Feed, Fibre, Fuel (4F) Economy, Elsevier
2. Kaur Brar S., Gurpreet Singh D. and Carlos R.S., (Eds), (2014)‘Biotransformation of Waste Biomass into High Value Biochemicals’, Springer.
3. Keikhosro K, Editor, (2015) ‘Lignocellulose-Based Bioproducts’, Springer.
4. John P, (2014) ‘Waste Management Practices-Municipal, Hazardous, and Industrial’, Second Edition, CRC Press, 2014.


**OBT356 LIFESTYLE DISEASES L T P C**

**3 0 0 3**

**UNIT I INTRODUCTION 9**

Lifestyle diseases – Definition ; Risk factors – Eating, smoking, drinking, stress, physical activity, illicit drug use ; Obesity, diabetes, cardiovascular diseases, respiratory diseases, cancer; Prevention – Diet and exercise.

**UNIT II CANCER 9**

Types - Lung cancer, Mouth cancer, Skin cancer, Cervical cancer, Carcinoma oesophagus; Causes Tobacco usage, Diagnosis – Biomarkers, Treatment

**UNIT III CARDIOVASCULAR DISEASES 9**

Coronoary atherosclerosis – Coronary artery disease; Causes -Fat and lipids, Alcohol abuse -– Diagnosis - Electrocardiograph, echocardiograph, Treatment, Exercise and Cardiac rehabilitation

**UNIT IV DIABETES AND OBESITY 9**

Types of Diabetes mellitus; Blood glucose regulation; Complications of diabetes – Paediatric and adolescent obesity – Weight control and BMI

**UNIT V RESPIRATORY DISEASES 9**

Chronic lung disease, Asthma, COPD; Causes - Breathing pattern (Nasal vs mouth), Smoking – Diagnosis - Pulmonary function testing

**TOTAL: 45 PERIODS**

**TEXT BOOKS:**

1. R.Kumar&Meenal Kumar, “Guide to Prevention of Lifestyle Diseases”, Deep & Deep Publications, 2003
2. Gary Eggar et al, “Lifestyle Medicine”, 3rd Edition, Academic Press, 2017

**REFERENCES:**

1. James M.R, “Lifestyle Medicine”, 2nd Edition, CRC Press, 2013
2. Akira Miyazaki et al, “New Frontiers in Lifestyle-Related Disease”, Springer, 2008

**OBT357 BIOTECHNOLOGY IN HEALTH CARE L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

The aim of this course is to

1. Create higher standard of knowledge on healthcare system and services
2. Prioritize advanced technologies for the diagnosis and treatment of various diseases

**UNIT I PUBLIC HEALTH 9**

Definition and Concept of Public Health, Historical aspects of Public Health, Changing Concepts of Public Health, Public Health versus Medical Care, Unique Features of Public Health, Determinants of Health (Social, Economic, Cultural, Environmental, Education, Genetics, Food and Nutrition). Indicators of health, Burden of disease, Role of different disciplines in Public Health.

**UNIT II CLINICAL DISEASES 9**

Communicable diseases: Chickenpox / Shingles, COVID-19, Tuberculosis, Hepatitis B, Hepatitis C, HIV / AIDS, Influenza, Swine flu. Non Communicable diseases: Diabetes mellitus, atherosclerosis, fatty liver, Obesity, Cancer

**UNIT III VACCINOLOGY 9**

History of Vaccinology, conventional approaches to vaccine development, live attenuated and killed vaccines, adjuvants, quality control, preservation and monitoring of microorganisms in seed lot systems. Instruments related to monitoring of temperature, sterilization, environment.

**UNIT IV OUTPATIENT & IN PATIENT SERVICES 9**

Radiotherapy, Nuclear medicine, surgical units, OT Medical units, G & Obs. units Pediatric, neonatal units, Critical care units, Physical medicine & Rehabilitation, Neurology, Gastroenterology, Endoscopy, Pulmonology, Cardiology.

**UNIT V BASICS OF IMAGING MODALITIES 9**

Diagnostic X-rays - Computer tomography – MRI – Ultrasonography – Endoscopy – Thermography – Different types of biotelemetry systems.

**TOTAL: 45 PERIODS**

**TEXT BOOKS**


1. Joseph J.carr and John M. Brown, Introduction to Biomedical Equipment Technology, John Wiley and sons, New York, 4th Edition, 2012.
2. Thomas M. Devlin.Textbook of Biochemistry with clinical correlations. Wiley Liss Publishers
3. The Vaccine Book (2nd Ed.), Rafi Ahmed, Roy M. Anderson et. al.Editor(s): Barry R. Bloom, PaulHenri Lambert, Academic Press, 2016, Pages xxi-xxiv.


**REFERENCE BOOKS**


1. Suh, Sang, Gurupur, Varadraj P., Tanik, Murat M., Health Care Systems, Technology and Techniques, Springer, 1st Edition, 2011
2. Burtis & Ashwood W.B. Tietz Textbook of Clinical chemistry. Saunders Company
3. Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker


## VERTICAL 1: FINTECH AND BLOCK CHAIN

**CMG331 FINANCIAL MANAGEMENT LT P C**
**3 0 0 3**

**LEARNING OBJECTIVES**

1. To acquire the knowledge of the decision areas in finance.
2. To learn the various sources of Finance
3. To describe about capital budgeting and cost of capital.
4. To discuss on how to construct a robust capital structure and dividend policy
5. To develop an understanding of tools on Working Capital Management.

**UNIT I INTRODUCTION TO FINANCIAL MANGEMENT 9**

Definition and Scope of Finance Functions - Objectives of Financial Management - Profit Maximization and Wealth Maximization- Time Value of money- Risk and return concepts.

**UNIT II SOURCES OF FINANCE 9**

Long term sources of Finance -Equity Shares – Debentures - Preferred Stock – Features – Merits and Demerits. Short term sources - Bank Sources, Trade Credit, Overdrafts, Commercial Papers, Certificate of Deposits, Money market mutual funds etc

**UNIT III INVESTMENT DECISIONS 9**

Investment Decisions: capital budgeting – Need and Importance – Techniques of Capital Budgeting -– Payback -ARR – NPV – IRR –Profitability Index.

Cost of Capital - Cost of Specific Sources of Capital - Equity -Preferred Stock- Debt - Reserves - Concept and measurement of cost of capital - Weighted Average Cost of Capital.

**UNIT IV FINANCING AND DIVIDEND DECISION 9**

Operating Leverage and Financial Leverage- EBIT-EPS analysis. Capital Structure – determinants of Capital structure- Designing an Optimum capital structure .

Dividend policy - Aspects of dividend policy - practical consideration - forms of dividend policy - - Determinants of Dividend Policy

**UNIT V WORKING CAPITAL DECISION 9**

Working Capital Management: Working Capital Management - concepts - importance - Determinants of Working capital. Cash Management: Motives for holding cash – Objectives and Strategies of Cash Management. Receivables Management: Objectives - Credit policies.

**TOTAL : 45 PERIODS**

**TEXT BOOKS**

1. M.Y. Khan and P.K.Jain Financial management, Text, Tata McGraw Hill
2. M. Pandey Financial Management, Vikas Publishing House Pvt. Ltd

**REFERENCES** .

1. James C. Vanhorne –Fundamentals of Financial Management– PHI Learning,.
2. Prasanna Chandra, Financial Management,
3. Srivatsava, Mishra, Financial Management, Oxford University Press, 2011

**CMG332 FUNDAMENTALS OF INVESTMENT LT P C**

**3 0 0 3**

**OBJECTIVES:**

1. Describe the investment environment in which investment decisions are taken.
2. Explain how to Value bonds and equities
3. Explain the various approaches to value securities
4. Describe how to create efficient portfolios through diversification
5. Discuss the mechanism of investor protection in India.

**UNIT I THE INVESTMENT ENVIRONMENT**

The investment decision process, Types of Investments – Commodities, Real Estate and FinancialAssets, the Indian securities market, the market participants and trading of securities, securitymarket indices, sources of financial information, Concept of return and risk, Impact of Taxes andInflationonreturn.

**UNIT II FIXED INCOME SECURITIES**

Bond features, types of bonds, estimating bond yields, Bond Valuation types of bond risks, defaultrisk andcreditrating.

**UNIT III APPROACHES TOEQUITYANALYSIS**

Introduction to Fundamental Analysis, Technical Analysis and Efficient Market Hypothesis, dividend capitalisation models, and price-earnings multiple approach to equity valuation.

**UNIT IV PORTFOLIO ANALYSIS AND FINANCIAL DERIVATIVES**

Portfolio and Diversification, Portfolio Risk and Return; Mutual Funds; Introduction to Financial Derivatives; Financial Derivatives Markets in India

**UNIT V INVESTOR PROTECTION**

Role of SEBI and stock exchanges in investor protection; Investor grievances and their redressal system, insider trading, investors' awareness andactivism

**TOTAL: 45 PERIODS**

**REFERENCES**

1. Charles P. Jones, Gerald R. Jensen. Investments: analysis and management. Wiley, 14TH Edition, 2019.
2. Chandra, Prasanna. Investment analysis and portfolio management. McGraw-hill education, 5th, Edition, 2017.
3. Rustagi, R. P. Investment Management Theory and Practice. Sultan Chand & Sons, 2021.
4. ZviBodie, Alex Kane, Alan J Marcus, PitabusMohanty, Investments, McGraw Hill Education (India), 11 Edition(SIE), 2019

**CMG333 BANKING, FINANCIAL SERVICES AND INSURANCE LT P C**
**3 0 0 3**

**OBJECTIVES**

- Understand the Banking system in India
- Grasp how banks raise their sources and how they deploy it
- Understand the development in banking technology
- Understand the financial services in India
- Understand the insurance Industry in India

**UNIT I INTRODUCTION TO INDIAN BANKING SYSTEM 9**

Overview of Banking system – Structure – Functions –Banking system in India - Key Regulations in Indian Banking sector –RBI. Relationship between Banker and Customer - Retail & Wholesale Banking – types of Accounts - Opening and operation of Accounts.

**UNIT II MANAGING BANK FUNDS/ PRODUCTS 9**

Liquid Assets - Investment in securities - Advances - Loans.Negotiable Instruments – Cheques, Bills of Exchange & Promissory Notes.Designing deposit schemes– Asset and Liability Management – NPA's – Current issues on NPA's – M&A's of banks into securities market

**UNIT III DEVELOPMENT IN BANKING TECHNOLOGY 9**

Payment system in India – paper based – e payment –electronic banking –plastic money – e-money –forecasting of cash demand at ATM's –The Information Technology Act, 2000 in India – RBI's Financial Sector Technology vision document – security threats in e-banking & RBI's Initiative.

**UNIT IV FINANCIAL SERVICES 9**

Introduction – Need for Financial Services – Financial Services Market in India – NBFC –– Leasing and Hire Purchase –– mutual funds. Venture Capital Financing –Bill discounting –factoring – Merchant Banking

**UNIT V INSURANCE 9**

Insurance –Concept - Need - History of Insurance industry in India. Insurance Act, 1938 –IRDA – Regulations – Life Insurance - Annuities and Unit Linked Policies - Lapse of the Policy – revival – settlement of claim

**TOTAL : 45 PERIODS**

**REFERENCES :**

1. Padmalatha Suresh and Justin Paul, "Management of Banking and Financial Services, Pearson, Delhi, 2017.
2. Meera Sharma, "Management of Financial Institutions – with emphasis on Bank and Risk Management", PHI Learning Pvt. Ltd., New Delhi 2010
3. Peter S. Rose and Sylvia C. and Hudgins, "Bank Management and Financial Services", Tata McGraw Hill, New Delhi, 2017

**CMG334 INTRODUCTION TO BLOCKCHAIN AND ITS APPLICATIONS LT P C**
**3 0 0 3**

**UNIT I INTRODUCTION TO BLOCKCHAIN 9**

Blockchain: The growth of blockchain technology - Distributed systems - The history of blockchain and Bitcoin - Features of a blockchain - Types of blockchain, Consensus: Consensus mechanism - Types of consensus mechanisms - Consensus in blockchain. Decentralization: Decentralization using blockchain - Methods of decentralization - Routes to decentralization- Blockchain and full ecosystem decentralization - Smart contracts - Decentralized Organizations- Platforms for decentralization.

**UNIT II INTRODUCTION TO CRYPTOCURRENCY 9**

Bitcoin – Digital Keys and Addresses – Transactions – Mining – Bitcoin Networks and Payments – Wallets – Alternative Coins – Theoretical Limitations – Bitcoin limitations – Name coin – Prime coin – Zcash – Smart Contracts – Ricardian Contracts- Deploying smart contracts on a blockchain

**UNIT III ETHEREUM 9**

Introduction - The Ethereum network - Components of the Ethereum ecosystem - Transactions and messages - Ether cryptocurrency / tokens (ETC and ETH) - The Ethereum Virtual Machine (EVM), Ethereum Development Environment: Test networks - Setting up a private net - Starting up the private network

**UNIT IV WEB3 AND HYPERLEDGE ` 9**

Introduction to Web3 – Contract Deployment – POST Requests – Development Frameworks – Hyperledger as a Protocol – The Reference Architecture – Hyperledger Fabric – Distributed Ledger – Corda.

**UNIT V EMERGING TRENDS 9**

Kadena – Ripple – Rootstock – Quorum – Tendermint – Scalability – Privacy – Other Challenges – Blockchain Research – Notable Projects – Miscellaneous Tools.

**TOTAL : 45 PERIODS**

**REFERENCE**


1. Imran. Bashir. Mastering block chain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained. Packt Publishing, 2nd Edition, 2018
2. Peter Borovykh , Blockchain Application in Finance, Blockchain Driven, 2nd Edition, 2018
3. ArshdeepBahga, Vijay Madisetti, “Blockchain Applications: A Hands On Approach”, VPT, 2017.


**CMG335 FINTECH PERSONAL FINANCE AND PAYMENTS LT P C**
**3 0 0 3**

**UNIT I CURRENCY EXCHANGE AND PAYMENT 9**

Understand the concept of Crypto currency- Bitcoin and Applications -Cryptocurrencies and Digital Crypto Wallets -Types of Cryptocurrencies - Cryptocurrencies and Applications, block chain, Artificial Intelligence, machine learning. Fintech users, Individual Payments, RTGS Systems, Immediate Page 54 of 90 Payment Service (IMPS), Unified Payments Interface (UPI).Legal and Regulatory Implications of Crypto currencies, Payment systems and their regulations.Digital Payments Smart Cards, Stored-Value Cards, EC Micropayments, Payment Gateways, Mobile Payments, Digital and Virtual Currencies, Security, Ethical, Legal, Privacy, and Technology Issues

**UNIT II DIGITAL FINANCE AND ALTERNATIVE FINANCE 9**

A Brief History of Financial Innovation, Digitization of Financial Services, Crowd funding, Charity and Equity,. Introduction to the concept of Initial Coin Offering

**UNIT III INSURETECH 9**

InsurTech Introduction , Business model disruption AI/ML in InsurTech IoT and InsurTech ,Risk Modeling ,Fraud Detection Processing claims and Underwriting Innovations in Insurance Services

**UNIT IV PEER TO PEER LENDING 9**

P2P and Marketplace Lending, New Models and New Products in market place lending P2P Infrastructure and technologies , Concept of Crowdfunding Crowdfunding Architecture and Technology ,P2P and Crowdfunding unicorns and business models , SME/MSME Lending: Unique opportunities and Challenges, Solutions and Innovations

**UNIT V REGULATORY ISSUES 9**

FinTech Regulations: Global Regulations and Domestic Regulations, Evolution of RegTech, RegTech Ecosystem: Financial Institutions, RegTech Ecosystem: StartupsRegTech, Startups: Challenges, RegTech Ecosystem: Regulators, Use of AI in regulation and Fraud detection.

**TOTAL: 45 PERIODS**

**REFERENCES:**


1. Swanson Seth, Fintech for Beginners: Understanding and Utilizing the power of technology, Createspace Independent Publishing Platform,2016.
2. Models AuTanda, Fintech Bigtech And Banks Digitalization and Its Impact On Banking Business, Springer, 2019
3. Henning Diedrich, Ethereum: Blockchains, Digital Assets, Smart Contracts, Decentralized Autonomous Organizations, Wildfire Publishing, 2016
4. Jacob William, FinTech:TheBeginner's Guide to Financial Technology, Createspace Independent Publishing Platform, 2016
5. IIBF, Digital Banking, Taxmann Publication, 2016
6. Jacob William, Financial Technology, Create space Independent Pub, 2016
7. Luke Sutton, Financial Technology: Bitcoin & Blockchain, Createspace Independent Pub, 2016


**CMG336 INTRODUCTION TO FINTECH LT P C**

**3 0 0 3**

**OBJECTIVES:**

1. To learn about history, importance and evolution of Fintech
2. To acquire the knowledge of Fintech in payment industry
3. To acquire the knowledge of Fintech in insurance industry
4. To learn the Fintech developments around the world
5. To know about the future of Fintech

**UNIT I INTRODUCTION 9**

Fintech - Definition, History, concept, meaning, architecture, significance, Goals, key areas in Fintech, Importance of Fintech, role of Fintech in economic development, opportunities and challenges in Fintech, Evolution of Fintech in different sectors of the industry - Infrastructure, Banking Industry, Startups and Emerging Markets, recent developments in FinTech, future prospects and potential issues with Fintech.

**UNIT II PAYMENT INDUSTRY 9**

FinTech in Payment Industry-Multichannel digital wallets, applications supporting wallets, onboarding and KYC application, FinTech in Lending Industry- Formal lending, Informal lending, P2P lending, POS lending, Online lending, Payday lending, Microfinance, Crowdfunding.

**UNIT III INSURANCE INDUSTRY 9**

FinTech in Wealth Management Industry-Financial Advice, Automated investing, Socially responsible investing, Fractional Investing, Social Investing. FinTech in Insurance Industry- P2P insurance, On-Demand Insurance, On-Demand Consultation, Customer engagement through Quote to sell, policy servicing, Claims Management, Investment linked health insurance.

**UNIT IV FINTECH AROUND THE GLOBE 9**

FinTech developments - US, Europe and UK, Germany, Sweden, France, China, India, Africa, Australia, New Zealand, Brazil and Middle East, Regulatory and Policy Assessment for Growth of FinTech. FinTech as disruptors, Financial institutions collaborating with FinTech companies, The new financial world.

**UNIT V FUTURE OF FINTECH 9**

How emerging technologies will change financial services, the future of financial services, banking on innovation through data, why FinTech banks will rule the world, The FinTech Supermarket, Banks partnering with FinTech start-ups, The rise of BankTech, Fintech impact on Retail Banking, A future without money, Ethics in Fintech.

**TOTAL: 45 PERIODS**

**REFERENCES:**


1. Arner D., Barbers J., Buckley R, The evolution of FinTech: a new post crisis paradigm, University of New South Wales Research Series, 2015
2. Susanne Chishti, Janos Barberis, The FINTECH Book: The Financial Technology Handbook for Investors, Entrepreneurs and Visionaries, Wiley Publications, 2016
3. Richard Hayen, FinTech: The Impact and Influence of Financial Technology on Banking and the Finance Industry, 2016
4. Parag Y Arjunwadkar, FinTech: The Technology Driving Disruption in the financial service industry CRC Press, 2018
5. Sanjay Phadke, Fintech Future : The Digital DNA of Finance Paperback .Sage Publications, 2020
6. Pranay Gupta, T. Mandy Tham, Fintech: The New DNA of Financial Services Paperback, 2018


## VERTICAL 2: ENTREPRENEURSHIP

**CMG337 FOUNDATIONS OF ENTREPRENERUSHIP L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- To develop and strengthen the entrepreneurial quality and motivation of learners.
- To impart the entrepreneurial skills and traits essential to become successful entrepreneurs.
- To apply the principles and theories of entrepreneurship and management in Technology oriented businessess.
- To empower the learners to run a Technology driven business efficiently and effectively

**UNIT I INTRODUCTION TO ENTREPRENEURSHIP 9**

Entrepreneurship- Definition, Need, Scope - Entrepreneurial Skill & Traits - Entrepreneur vs. Intrapreneur; Classification of entrepreneurs, Types of entrepreneurs -Factors affecting entrepreneurial development – Achievement Motivation – Contributions of Entreprenrship to Economic Development.

**UNIT II BUSINESS OWNERSHIP & ENVRIONMENT 9**

Types of Business Ownership – Buiness Envrionemental Factors – Political-Economic-Sociological-Technological-Environmental-Legal aspects – Human Reosurces Mobilisation-Basics

of Managing Finance- Esentials of Marketing Management - Production and Operations Planning – Systems Management and Administration

**UNIT III FUNDAMENTALS OF TECHNOPRENEURSHIP 9**

Introduction to Technopreneurship - Definition, Need, Scope- Emerging Concepts- Principles - Characterisitcis of a technopreneur - Impacts of Technopreneurship on Society – Economy- Job Opportuinites in Technopreneurship - Recent trends

**UNIT IV APPLICATIONS OF TECHNOPRENEURSHIP 9**

Technology Entrepreneurship - Local, National and Global practices - Intrapreneurship and Technology interactions, Networking of entrepreneurial activities – Launching - Managing Technology based Product / Service entrepreneurship -– Success Stories of Technopreneurs - Case Studies

**UNIT V EMERGING TRENDS IN ENTREPRENERUSHIP 9**

Effective Business Management Strategies For Franchising - Sub-Contracting- Leasing- Technopreneurs – Agripreneurs - Netpreneurs- Portfolio entrepreneruship - NGO Entrepreneurship – Recent Entrperneruial Develoments - Local – National – Global perspectives.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the student should be able to:

CO 1 Learn the basics of Entrepreneurship
CO 2 Understand the business ownership patterns and evnironment
CO 3 Understand the Job opportunites in Industries relating to Technopreneurship
CO 4 Learn about applications of tehnopreneurship and successful technopreneurs
CO 5 Acquaint with the recent and emerging trends in entreprenerushipp

**TEXT BOOKS:**


1) S.S.Khanka, “Entrepreneurial Development” S.Chand & Co. Ltd. Ram Nagar New Delhi, 2021.
2) Donal F Kuratko Entrepreneurship (11th Edition) Theory, Process, Practice by Published 2019 by Cengage Learning,


**REFERENCES:**


1) Daniel Mankani. 2003. Technopreneurship: The successful Entrepreneur in the new Economy. Prentice Hall
2) Edward Elgar. 2007. Entrepreneurship, Cooperation and the Firm: The Emergence and Survival of High-Technology Ventures in Europe. Edi: Jan Ulijn, Dominique Drillon, and Frank Lasch. Wiley Pub.
3) Lang, J. 2002, The High Tech Entrepreneur's Handbook, Ft.com.
4) David Sheff 2002, China Dawn: The Story of a Technology and Business Revolution,
5) HarperBusiness,https://fanny.staff.uns.ac.id/files/2013/12/Technopreneur-BASED-EDUCATION-REVOLUTION.pdf
6) JumpStart: A Technoprenuership Fable, Dennis Posadas, (Singapore: Pearson Prentice Hall, 2009
7) Basics of Technoprenuership: Module 1.1-1.2, Frederico Gonzales, President-PESO Inc; M. Barcelon, UP
8) Journal articles pertaining to Entrepreneurship

**CMG338 TEAM BUILDING & LEADERSHIP MANAGEMENT FOR BUSINESS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To develop and strengthen the Leadership qualities and motivation of learners.
- To impart the Leadership skills and traits essential to become successful entrepreneurs.
- To apply the principles and theories of Team Building in managing Technology oriented businessess.
- To empower the learners to build robust teams for running and leading a business efficiently and effectively

**UNIT I INTRODUCTION TO MANAGING TEAMS 9**

Introduction to Team - Team Dynamics - Team Formation – Stages of Team Devlopment - Enhancing teamwork within a group - Team Coaching - Team Decision Making - Virtual Teams - Self Directed Work Teams (SDWTs) -Multicultural Teams.

**UNIT II MANAGING AND DEVELOPING EFFECTIVE TEAMS 9**

Team-based Organisations- Leadershp roles in team-based organisations - Offsite training and team development - Experiential Learning - Coaching and Mentoring in team building - Building High-Performance Teams - Building Credibility and Trust - Skills for Developing Others - Team Building at the Top - Leadership in Teamwork Effectiveness.

**UNIT III INTRODUCTION TO LEADERSHIP 9**

Introduction to Leadership - Leadership Myths – Characteristics of Leader, Follower and Situation - Leadership Attributes - Personality Traits and Leadership- Intelligence Types and Leadership - Power and Leadership - Delegation and Empowerment .

**UNIT IV LEADERSHIP IN ORGANISATIONS 9**

Leadership Styles – LMX Theory- Leadership Theory and Normative Decision Model - Situational Leadership Model - Contingency Model and Path Goal Theory – Transactional and Transformational Leadership - Charismatic Leadership - Role of Ethics and Values in Organisational Leadership.

**UNIT V LEADERSHIP EFFECTIVENESS 9**

Leadership Behaviour - Assessment of Leadership Behaviors - Destructive Leadership - Motivation and Leadership - Managerial Incompetence and Derailment Conflict Management - Negotiation and Leadership - Culture and Leadership - Global Leadership – Recent Trends in Leadership.

**TOTAL 45 : PERIODS**

**OUTCOMES:**

Upon completion of this course, the student should be able to:

CO 1 Learn the basics of managing teams for business.
CO 2 Understand developing effective teams for business management.
CO 3 Understand the fundamentals of leadership for running a business.
CO 4 Learn about the importance of leadership for business development.
CO 5 Acquaint with emerging trends in leadership effectiveness for entreprenerus.''

**REFERENCES:**


1. Hughes, R.L., Ginnett, R.C., & Curphy, G.J., Leadership: Enhancing the lessons of experience ,9th Ed, McGraw Hill Education, Chennai, India. (2019).
2. Katzenback, J.R., Smith, D.K., The Wisdom of Teams: Creating the High Performance Organisations, Harvard Business Review Press, (2015).
3. Haldar, U.K., Leadership and Team Building, Oxford University Press, (2010). 4. Daft, R.L., The Leadership Experience, Cengage, (2015).
5. Daniel Levi, Group Dynamics for Teams ,4th Ed, (2014), Sage Publications.
6. Dyer, W. G., Dyer, W. G., Jr., & Dyer, J. H..Team building: Proven strategies for improving team performance, 5thed, Jossey-Bass, (2013).

**CMG339 CREATIVITY & INNOVATION IN ENTREPRENEURSHIP L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- To develop the creativity skills among the learners
- To impart the knowledge of creative intelligence essential for entrepreneurs
- To know the applications of innovation in entprerenship.
- To develeop innovative business models for business.

**UNIT I CREATIVITY 9**

Creativity: Definition- Forms of Creativity-Essence, Elaborative and Expressive Creativities-Quality of Creativity-Existential, Entrepreneurial and Empowerment Creativities – Creative Environment- Creative Technology- - Creative Personality and Motivation.

**UNIT II CREATIVE INTELLIGENCE 9**

Creative Intelligence: Convergent thinking ability – Traits Congenial to creativity – Creativity Training--Criteria for evaluating Creativity-Credible Evaluation- Improving the quality of our creativity – Creative Tools and Techniques - Blocks to creativity- fears and Disabilities- Strategies for Unblocking- Designing Creativity Enabling Environment.

**UNIT III INNOVATION 9**

Innovation: Definition- Levels of Innovation- Incremental Vs Radical Innovation-Product Innovation and Process- Technological, Organizational Innovation – Indicators- Characteristics of Innovation in Different Sectors. Theories in Innovation and Creativity- Design Thinking and Innovation-Innovation as Collective Change-Innovation as a system

**UNIT IV INNOVATION AND ENTREPRENEURSHIP 9**

Innovation and Entrepreneurship: Entrepreneurial Mindset , Motivations and Behaviours-Opportunity Analysis and Decision Making- Industry Understanding - Entrepreneurial Opportunities- Entrepreneurial Strategies – Technology Pull/Market Push – Product -Market fit

**UNIT V INNOVATIVE BUSINESS MODELS 9**

Innovative Business Models: Customer Discovery-Customer Segments-Prospect Theory and Developing Value Propositions- Developing Business Models: Elements of Business Models – Innovative Business Models: Elements, Designing Innovative Business Models- Responsible Innovation and Creativity.

**TOTAL 45 : PERIODS**

**OUTCOMES:**

Upon completion of this course, the student should be able to:

CO 1 Learn the basics of creativity for developing Entrepreneurship
CO 2 Understand the importance of creative inteligence for business growth
CO 3 Understand the advances through Innovation in Industries
CO 4 Learn about applications of innovation in building successful ventures
CO 5 Acquaint with developing innovative business models to run the business effecientlty and effectively

**SUGGESTED READINGS:**

Creativity and Inovation in Entrepreneurship, Kankha, Sultan Chand
Pradip N Khandwalla, Lifelong Creativity, An Unending Quest, Tata Mc Graw Hill, 2004.
Paul Trott, Innovation Management and New Product Development, 4e, Pearson, 2018.
Vinnie Jauhari, Sudanshu Bhushan, Innovation Management, Oxford Higher Education, 2014.
Innovation Management, C.S.G. Krishnamacharyulu, R. Lalitha, Himalaya Publishing House, 2010.
A. Dale Timpe, Creativity, Jaico Publishing House, 2003.
Brian Clegg, Paul Birch, Creativity, Kogan Page, 2009.
Strategic Innovation: Building and Sustaining Innovative Organizations- Course Era, Raj Echambadi.

**CMG340 PRINCIPLES OF MARKETING MANAGEMENT FOR BUSINESS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To provide basic knowledge of concepts, principles, tools and techniques of marketing for entrepreneurs
- To provide an exposure to the students pertaining to the nature and Scope of marketing, which they are expected to possess when they enter the industry as practitioners.
- To give them an understanding of fundamental premise underlying market driven strategies and the basic philosophies and tools of marketing management for business owners.

**UNIT I INTRODUCTION TO MARKETING MANAGEMENT 9**

Introduction - Market and Marketing – Concepts- Functions of Marketing - Importance of Marketing - Marketing Orientations - Marketing Mix-The Traditional 4Ps - The Modern Components of the Mix - The Additional 3Ps - Developing an Effective Marketing Mix.

**UNIT II MARKETING ENVIRONMENT 9**

Introduction - Environmental Scanning - Analysing the Organisation's Micro Environment and Macro Environment - Differences between Micro and Macro Environment – Techniques of Environment Scanning - Marketing organization - Marketing Research and the Marketing Information System, Types and Components.

**UNIT III PRODUCT AND PRICING MANAGEMENT 9**

Product- Meaning, Classification, Levels of Products – Product Life Cycle (PLC) - Product Strategies - Product Mix - Packaging and Labelling - New Product Development - Brand and Branding - Advantages and disadvantages of branding Pricing - Factors Affecting Price Decisions - Cost Based Pricing - Value Based and Competition Based Pricing - Pricing Strategies - National and Global Pricing.

**UNIT IV PROMOTION AND DISTRIBTUION MANAGEMENT 9**

Introduction to Promotion – Marketing Channels- Integrated Marketing Communications (IMC) - Introduction to Advertising and Sales Promotion – Basics of Public Relations and Publicity - Personal Selling - Process - Direct Marketing - Segmentation, Targeting and Positioning (STP)- Logistics Management- Introduction to Retailing and Wholesaling.

**UNIT V CONTEMPORARY ISSUES IN MARKETING MANAGEMENT 9**

Introduction - Relationship Marketing Vs. Relationship Management - Customer Relationship Management (CRM) - Forms of Relationship Management - CRM practices - Managing Customer Loyalty and Development – Buyer-Seller Relationships- Buying Situations in Industrial / Business Market - Buying Roles in Industrial Marketing - Factors that Influence Business - Services Marketing - E-Marketing or Online Marketing.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

After completion of this course, the students will be able to :

CO1 Have the awareness of marketing management process
CO 2 Understand the marketing environment
CO 3 Acquaint about product and pricing strategies
CO 4 Knowledge of promotion and distribution in marketing management.
CO5 Comprehend the contemporary marketing scenairos and offer solutions to marketing issues.

**REFERENCES:**

1. Marketing Management, Sherlekar S.A, Himalaya Publishing House, 2016.
2. Marketing Management , Philip Kortler and Kevin Lane Keller, PHI 15th Ed, 2015.
3 Marketing Management- An Indian perspective, Vijay Prakash Anand, Biztantra, Second edition, 2016.
4. Marketing Management Global Perspective, Indian Context, V.S.Ramaswamy & S.Namakumari, Macmillan Publishers India,5th edition, 2015.
5. Marketing Management, S.H.H. Kazmi, 2013, Excel Books India.
6. Marketing Management- text and Cases, Dr. C.B.Gupta & Dr. N.Rajan Nair, 17th edition, 2016.

**CMG341 HUMAN RESOURCE MANAGEMENT FOR ENTREPRENEURS**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**OBJECTIVES**:

- To introduce the basic concepts, structure and functions of human resource management for entrepreneurs.
- To create an awareness of the roles, functions and functioning of human resource department.
- To understand the methods and techniques followed by Human Resource Management practitioners.

**UNIT I INTRODUCTION TO HRM** **9**

Concept, Definition, Objectives- Nature and Scope of HRM - Evolution of HRM - HR Manager Roles- Skills - Personnel Management Vs. HRM - Human Resource Policies - HR Accounting - HR Audit - Challenges in HRM.

**UNIT II HUMAN RESOURCE PLANNING** **9**

HR Planning - Definition - Factors- Tools - Methods and Techniques - Job analysis- Job rotation- Job Description - Career Planning - Succession Planning - HRIS - Computer Applications in HR - Recent Trends

**UNIT III RECRUITMENT AND SELECTION** **9**

Sources of recruitment- Internal Vs. External - Domestic Vs. Global Sources -eRecruitment - Selection Process- Selection techniques -eSelection- Interview Types- Employee Engagement.

**UNIT IV TRAINING AND EMPLOYEE DEVELOPMENT** **9**

Types of Training - On-The-Job, Off-The-Job - Training Needs Analysis – Induction and Socialisation Process - Employee Compensation - Wages and Salary Administration – Health and Social Security Measures- Green HRM Practices

**UNIT V CONTROLLING HUMAN RESOURCES** **9**

Performance Appraisal – Types - Methods - Collective Bargaining - Grievances Redressal Methods – Employee Discipline – Promotion – Demotion - Transfer – Dismissal - Retrenchment - Union Management Relationship - Recent Trends

**TOTAL 45 : PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course the learners will be able:

CO 1 To understand the Evolution of HRM and Challenges faced by HR Managers
CO 2 To learn about the HR Planning Methods and practices.
CO 3 To acquaint about the Recruitment and Selection Techniques followed in Industries.
CO 4 To known about the methods of Training and Employee Development.
CO 5 To comprehend the techniques of controlling human resources in organisations.

**REFERENCES:**

1) Gary Dessler and Biju Varkkey, Human Resource Management, 14e , Pearson, 2015.
2) Mathis and Jackson, Human Resource Management, Cengage Learning 15e, 2017.
3) David A. Decenzo, Stephen.P.Robbins, and Susan L. Verhulst, Human Resource Management, Wiley, International Student Edition, 11th Edition, 2014
4) R. Wayne Mondy, Human Resource Management, Pearson , 2015.
5) Luis R.Gomez-Mejia, David B.Balkin, Robert L Cardy. Managing Human Resource. PHI Learning. 2012
6) John M. Ivancevich, Human Resource Management,12e, McGraw Hill Irwin,2013.
7) K. Aswathappa, Sadhna Dash , Human Resource Management - Text and Cases , 9th Edition, McGraw Hill, 2021.
8) Uday Kumar Haldar, Juthika Sarkar. Human Resource management. Oxford. 2012

**CMG342 FINANCING NEW BUSINESS VENTURES L T P C**
**3 0 0 3**

**Course Objectives**

- To develop the basics of business venture financing.
- To impart the knowledge essential for entrepreneurs for financing new ventures.
- To acquaint the learners with the sources of debt and quity financing.
- To empower the learners towards fund rasiing for new ventures effectively.

**UNIT I ESSENTIALS OF NEW BUSINES VENTURE 9**

Setting up new Business Ventures – Need - Scope - Franchising - Location Strategy, Registration Process - State Directorate of Industries- Financing for New Ventures - Central and State Government Agencies - Types of loans – Financial Institutions - SFC, IDBI, NSIC and SIDCO.

**UNIT II INTRODUCTION TO VENTURE FINANCING 9**

Venture Finance – Definition – Historic Background - Funding New Ventures- Need – Scope – Types - Cost of Project - Means of Financing - Estimation of Working Capital - Requirement of funds – Mix of Dent and Equity - Challenges and Opportunities.

**UNIT III SOURCES OF DEBT FINANCING 9**

Fund for Capital Assets - Term Loans - Leasing and Hire-Purchase - Money Market instruments – Bonds, Corporate Papers – Preference Capital- Working Capital Management- Fund based Credit Facilities - Cash Credit - Over Draft.

**UNIT IV SOURCES OF EQUITY FINANCING 9**

Own Capital, Unsecured Loan - Government Subsidies , Margin Money- Equity Funding - Private Equity Fund- Schemes of Commercial banks - Angel Funding – Crowdfunding- Venture Capital.

**UNIT V METHODS OF FUND RAISING FOR NEW VENTURES 9**

Investor Decision Process - Identifying the appropriate investors- Targeting investors- Developing Relationships with investors - Investor Selection Criteria- Company Creation- Raising Funds - Seed Funding- VC Selection Criteria – Process- Methods- Recent Trends

**TOTAL: 45 PERIODS**

**OUTCOMES**:

Upon completion of this course, the students should be able to:

CO 1 Learn the basics of starting a new business venture.
CO 2 Understand the basics of venture financing.
CO 3 Understand the sources of debt financing.
CO 4 Understanf the sources of equity financing.
CO 5 Acquaint with the methods of fund raising for new business ventures.

**REFERENCES :**

1) Principles of Corporate Finance by Brealey and Myers et al.,12TH ed, McGraw Hill Education (India) Private Limited, 2018
2) Prasanna Chandra, Projects : Planning ,Analysis,Selection ,Financing,Implementation and Review, McGraw Hilld Education India Pvt Ltd ,New Delhi , 2019.
3) Introduction to Project Finance. Andrew Fight,Butterworth-Heinemann, 2006.
4) Metrick, Andrew; Yasuda, Ayako. Venture Capital And The Finance Of Innovation. Venture Capital And The Finance Of Innovation, 2nd Edition, Andrew Metrick And Ayako Yasuda, Eds., John Wiley And Sons, Inc, 2010.
5) Feld, Brad; Mendelson, Jason. Venture Deals. Wiley, 2011.
6) May, John; Simons, Cal. Every Business Needs An Angel: Getting The Money You Need To Make Your Business Grow. Crown Business, 2001.
7) Gompers, Paul Alan; Lerner, Joshua. The Money Of Invention: How Venture Capital Creates New Wealth. Harvard Business Press, 2001.
8) Camp, Justin J. Venture Capital Due Diligence: A Guide To Making Smart Investment Choices And Increasing Your Portfolio Returns. John Wiley & Sons, 2002.
9) Byers, Thomas. Technology Ventures: From Idea To Enterprise. Mcgraw-Hill Higher Education, 2014.
10) Lerner, Josh; Leamon, Ann; Hardymon, Felda. Venture Capital, Private Equity, And The Financing Of Entrepreneurship. 2012.

## VERTICAL 3: PUBLIC ADMINISTRATION

**CMG343 PRINCIPLES OF PUBLIC ADMINISTRATION**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**UNIT-I** **(9)**

1. Meaning, Nature and Scope of Public Administration
2. Importance of Public Administration
3. Evolution of Public Administration

**UNIT-II** **(9)**

1. New Public Administration
2. New Public Management
3. Public and Private Administration

**UNIT-III** **(9)**

1. Relationships with Political Science, History and Sociology
2. Classical Approach
3. Scientific Management Approach

**UNIT-IV** **(9)**

1. Bureaucratic Approach: Max Weber
2. Human Relations Approach : Elton Mayo
3. Ecological Approach : Riggs

**UNIT-V** **(9)**

1. Leadership: Leadership - Styles - Approaches
2. Communication: Communication Types - Process - Barriers
3. Decision Making: Decision Making - Types, Techniques and Processes.

**TOTAL: 45 PERIODS**

**REFERENCES**:

1. Avasthi and Maheswari: Public Administration in India, Agra:Lakshmi Narain Agarwal,2013.

2. Ramesh K Arora: Indian Public Administration, New Delhi: Wishwa Prakashan, 2012.
3. R.B. Jain: Public Administration in India,21st Century Challenges for Good Governance, New Delhi: Deep and Deep, 2002.
4. Rumki Basu: Public Administration:Concept and Theories, New Delhi:Sterling, 2013.
5. R. Tyagi, Public Administration, Atma Ram & Sons, New Delhi, 1983.

**CMG344 CONSTITUTION OF INDIA** **L T P C**
**3 0 0 3**

**UNIT-I** (9)

1. Constitutional Development Since 1909 to 1947
2. Making of the Constitution.
3. Constituent Assembly

**UNIT-II** (9)

1. Fundamental Rights
2. Fundamental Duties
3. Directive Principles of State Policy

**UNIT-III** (9)

1. President
2. Parliament
3. Supreme Court

**UNIT-IV** (9)

1. Governor
2. State Legislature
3. High Court

**UNIT-V** (9)

1. Secularism
2. Social Justice
3. Minority Safeguards

**TOTAL: 45 PERIODS**

**REFERENCES**:

1. Basu. D.D.: Introduction to Indian Constitution ; Prentice Hall; New Delhi.
2. Kapur. A.C: Indian Government and Political System; S.Chand and Company Ltd., New Delhi.
3. Johari J.C.: Indian Politics, Vishal Publications Ltd, New Delhi
4. Agarwal R.C: Indian Political System; S.Chand & Co., New Delhi

**CMG345 PUBLIC PERSONNEL ADMINISTRATION** **L T P C**
**3 0 0 3**

**UNIT-I** **(9)**

1. Meaning, Scope and Importance of Personnel Administration
2. Types of Personnel Systems: Bureaucratic, Democratic and Representative systems

**UNIT-II** (9)

1. Generalist Vs Specialist
2. Civil Servants' Relationship with Political Executive
3. Integrity in Administration.

**UNIT-III** (9)

1. Recruitment: Direct Recruitment and Recruitment from Within
2. Training: Kinds of Training
3. Promotion

**UNIT-IV** (9)

1. All India Services
2. Service Conditions
3. State Public Service Commission

**UNIT-V** (9)

1. Employer Employee Relations
2. Wage and Salary Administration
3. Allowances and Benefits

**TOTAL: 45 PERIODS**

**REFERENCES**:


1. Stahl Glean O: Public Personnel Administration
2. Parnandikar Pai V.A: Personnel System for Development Administration.
3. Bhambhiru . P: Bureaucracy and Policy in India.
4. Dwivedi O.P and Jain R.B: India's Administrative state.
5. Muttalis M.A: Union Public Service Commission.
6. Bhakara Rao .V: Employer Employee Relations in India.
7. Davar R.S. Personnel Management & Industrial Relations


**CMG346 ADMINISTRATIVE THEORIES L T P C**
**3 0 0 3**

**UNIT I** (9)

Meaning, Scope and significance of Public Administration, Evolution of Public Administration as a discipline and Identity of Public Administration

**UNIT II** (9)

Theories of Organization: Scientific Management Theory, Classical Model,
Human Relations Theory

**UNIT III** (9)

Organization goals and Behaviour, Groups in organization and group dynamics, Organizational Design.

**UNIT IV** (9)

Motivation Theories, content, process and contemporary; Theories of Leadership: Traditional and Modern: Process and techniques of decision-making

**UNIT V** (9)

Administrative thinkers: Kautilya, Woodrow Willson, C.I. Barnard . Peter Drucker

**TOTAL: 45 PERIODS**

**REFERENCES**:

1. Crozior M : The Bureaucratic phenomenon (Chand)
2. Blau. P.M and Scott. W : Formal Organizations (RKP)
3. Presthus. R : The Organizational Society (MAC)
4. Alvi, Shum Sun Nisa : Eminent Administrative Thinkers.
5. Keith Davis : Organization Theory (MAC)

**CMG347 INDIAN ADMINISTRATIVE SYSTEM L T P C**

**3 0 0 3**

**UNIT I** **(9)**

Evolution and Constitutional Context of Indian Administration, Constitutional Authorities: Finance Commission, Union Public Services Commission, Election Commission, Comptroller and Auditor General of India, Attorney General of India

**UNIT II** **(9)**

Role & Functions of the District Collector, Relationship between the District Collector and Superintendent of Police, Role of Block Development Officer in development programmes, Local Government

**UNIT III** **(9)**

Main Features of 73rd Constitutional Amendment Act 1992, Salient Features of 74th Constitutional Amendment Act 1992

**UNIT IV** **(9)**

Coalition politics in India, Integrity and Vigilance in Indian Administration

**UNIT V** **(9)**

Corruption – Ombudsman, Lok Pal & Lok Ayuktha

**TOTAL: 45 PERIODS**

**REFERENCES**:

1. S.R. Maheswari : Indian Administration
2. Khera. S.S : Administration in India
3. Ramesh K. Arora : Indian Public Administration
4. T.N. Chaturvedi : State administration in India
5. Basu, D.D : Introduction to the Constitution of India

**CMG348 PUBLIC POLICY ADMINISTRATION L T P C**

**3 0 0 3**

**UNIT-I** **(9)**

Meaning and Definition of Public Policy - Nature, Scope and Importance of public policy – Public policy relationship with social sciences especially with political science and Public Administration.

**UNIT-II** **(9)**

Approaches in Policy Analysis - Institutional Approach – Incremental Approach and System's Approach – Dror's Optimal Model

**UNIT-III** **(9)**
Major stages involved in Policy making Process – Policy Formulation – Policy Implementation – Policy Evaluation.

**UNIT-IV** **(9)**
Institutional Framework of Policy making – Role of Bureaucracy – Role of Interest Groups and Role of Political Parties.

**UNIT-V** **(9)**
Introduction to the following Public Policies – New Economic Policy – Population Policy – Agriculture policy - Information Technology Policy.

**TOTAL: 45 PERIODS**

**REFERENCES**:
1. Rajesh Chakrabarti & Kaushik Sanyal : Public Policy in India, Oxford University Press, 2016.
2. Kuldeep Mathur : Public Policy and Politics in India, Oxford University Press, 2016.
3. Bidyutv Chakrabarty: Public Policy: Concept, Theory and Practice, 2015.
4. Pradeep Saxena : Public Policy Administration and Development
5. Sapru R.K. : Public Policy: Formulation, Implementation and Evaluation, Sterling Publishers, 2016.

## VERTICAL 4: BUSINESS DATA ANALYTICS

**CMG349 STATISTICS FOR MANAGEMENT L T P C**
**3 0 0 3**

**OBJECTIVE**:
- To learn the applications of statistics in business decision making.

**UNIT I INTRODUCTION 9**
Basic definitions and rules for probability, Baye‘s theorem and random variables, Probability distributions: Binomial, Poisson, Uniform and Normal distributions.

**UNIT II SAMPLING DISTRIBUTION AND ESTIMATION 9**
Introduction to sampling distributions, Central limit theorem and applications, sampling techniques, Point and Interval estimates of population parameters.

**UNIT III TESTING OF HYPOTHESIS - PARAMETIRC TESTS 9**
Hypothesis testing: one sample and two sample tests for means of large samples (z-test), one sample and two sample tests for means of small samples (t-test), ANOVA one way.

**UNIT IV NON-PARAMETRIC TESTS 9**
Chi-square tests for independence of attributes and goodness of fit, Kolmogorov-Smirnov – test for goodness of fit, Mann – Whitney U test and Kruskal Wallis test.

**UNIT V CORRELATION AND REGRESSION 9**
Correlation –Rank Correlation – Regression – Estimation of Regression line – Method of Least Squares – Standard Error of estimate.

**TOTAL:45 PERIODS**

**OUTCOMES**:
- To facilitate objective solutions in business decision making.
- To understand and solve business problems
- To apply statistical techniques to data sets, and correctly interpret the results.
- To develop skill-set that is in demand in both the research and business environments
- To enable the students to apply the statistical techniques in a work setting.

**REFERENCES**:
1. Richard I. Levin, David S. Rubin, Masood H.Siddiqui, Sanjay Rastogi, Statistics for Management, Pearson Education, 8th Edition, 2017.
2. Prem. S. Mann, Introductory Statistics, Wiley Publications, 9th Edition, 2015.
3. T N Srivastava and Shailaja Rego, Statistics for Management, Tata McGraw Hill, 3rd Edition 2017.
4. Ken Black, Applied Business Statistics, 7th Edition, Wiley India Edition, 2012.
5. David R. Anderson, Dennis J. Sweeney, Thomas A.Williams, Jeffrey D.Camm, James J.Cochran, Statistics for business and economics, 13th edition, Thomson (South – Western) Asia, Singapore, 2016.
6. N. D. Vohra, Business Statistics, Tata McGraw Hill, 2017.

**CMG350 DATAMINING FOR BUSINESS INTELLIGENCE L T P C**
**3 0 0 3**

**OBJECTIVES :**
- To know how to derive meaning form huge volume of data and information.
- To understand how knowledge discovering process is used in business decision making.

**UNIT I INTRODUCTION 9**
Data mining, Text mining, Web mining, Data ware house.

**UNIT II DATA MINING PROCESS 9**
Datamining process – KDD, CRISP-DM, SEMMA
Prediction performance measures

**UNIT III PREDICTION TECHNIQUES 9**
Data visualization, Time series – ARIMA, Winter Holts,

**UNIT IV CLASSIFICATION AND CLUSTERING TECHNIQUES 9**
Classification, Association, Clustering.

**UNIT V MACHINE LEARNING AND AI 9**
Genetic algorithms, Neural network, Fuzzy logic, Ant Colony optimization, Particle Swarm optimization

**TOTAL: 45 PERIODS**

**OUTCOMES:**
1. Learn to apply various data mining techniques into various areas of different domains.
2. Be able to interact competently on the topic of data mining for business intelligence.
3. Apply various prediction techniques.
4. Learn about supervised and unsupervised learning technique.
5. Develop and implement machine learning algorithms

**REFERENCES :**
1. Jaiwei Ham and Micheline Kamber, Data Mining concepts and techniques, Kauffmann Publishers 2006
2. Efraim Turban, Ramesh Sharda, Jay E. Aronson and David King, Business Intelligence, Prentice Hall, 2008.
3. W.H.Inmon, Building the Data Warehouse, fourth edition Wiley India pvt. Ltd. 2005.
4. Ralph Kimball and Richard Merz, The data warehouse toolkit, John Wiley, 3rd edition,2013.
5. Michel Berry and Gordon Linoff, Mastering Data mining, John Wiley and Sons Inc, 2nd Edition, 2011

6. Michel Berry and Gordon Linoff, Data mining techniques for Marketing, Sales and Customer support, John Wiley, 2011
7. G. K. Gupta, Ïntroduction to Data mining with Case Studies, Prentice hall of India, 2011
8. Giudici, Applied Data mining – Statistical Methods for Business and Industry, John Wiley. 2009
9. Elizabeth Vitt, Michael Luckevich Stacia Misner, Business Intelligence, Microsoft, 2011
10. Michalewicz Z., Schmidt M. Michalewicz M and Chiriac C, Adaptive Business Intelligence, Springer – Verlag, 2007
11. GalitShmueli, Nitin R. Patel and Peter C. Bruce, Data Mining for Business Intelligence – Concepts, Techniques and Applications Wiley, India, 2010.

**CMG351 HUMAN RESOURCE ANALYTICS L T P C**
**3 0 0 3**

**OBJECTIVE:**

- To develop the ability of the learners to define and implement HR metrics that are aligned with the overall business strategy.
- To know the different types of HR metrics and understand their respective impact and application.
- To understand the impact and use of HR metrics and their connection with HR analytics.
- To understand common workforce issues and resolving them using people analytics.

**UNIT I - INTRODUCTION TO HR ANALYTICS 9**

People Analytics - stages of maturity - Human Capital in the Value Chain: impact on business – HR metrics and KPIs.

**UNIT II - HR ANLYTICS I: RECRUITMENT 9**

Recruitment Metrics : Fill-up ratio - Time to hire - Cost per hire - Early turnover - Employee referral hires - Agency hires - Lateral hires - Fulfillment ratio- Quality of hire.

**UNIT III - HR ANALYTICS - TRAINING AND DEVELOPMENT 9**

Training & Development Metrics: Percentage of employees trained- Internally and externally trained -Training hours and cost per employee - ROI.

**UNIT IV - HR ANALYTICS EMPLOYEE ENGAGEMENT AND CAREER PROGRESSION 9**

Employee Engagement Metrics: Talent Retention index - Voluntary and involuntary turnover- grades, performance, and service tenure - Internal hired index Career Progression Metrics: Promotion index - Rotation index - Career path index.

**UNIT V - HR ANALYTICS IV: WORKFORCE DIVERSITY AND DEVELOPMENT 9**

Workforce Diversity and Development Metrics : Employees per manager – Workforce age profiling - Workforce service profiling - Churnover index - Workforce diversity
index - Gender mix

**TOTAL: 45 PERIODS**

**OUTCOME:**

- The learners will be conversant about HR metrics and ready to apply at work settings.
- The learners will be able to resolve HR issues using people analytics.

**REFERENCES:**


1. JacFitzenz , The New HR Analytics, AMACOM , 2010.
2. Edwards M. R., & Edwards K, Predictive HR Analytics: Mastering the HR Metric.London: Kogan Page.2016.
3. Human Resources kit for Dummies – 3 rd edition – Max Messmer, 2003
4. Dipak Kumar Bhattacharyya, HR Analytics ,Understanding Theories and Applications, SAGE Publications India ,2017.
5. Sesil, J. C. , Applying advanced analytics to HR management decisions: Methods fo selection, developing incentives, and improving collaboration. Upper Saddle River,New Jersey: Pearson Education,2014.
6. Pease, G., & Beresford, B, Developing Human Capital: Using Analytics to Plan and Optimize Your Learning and Development Investments. Wiley ,2014.
7. Phillips, J., & Phillips, P.P, Making Human Capital Analytics Work: Measuring the ROI of Human Capital Processes and OUTCOME. McGraw-Hill,2014.
8. HR Scorecard and Metrices, HBR, 2001.


**CMG352 MARKETING AND SOCIAL MEDIA WEB ANALYTICS L T P C**
**3 0 0 3**

**OBJECTIVE:**

- To showcase the opportunities that exist today to leverage the power of the web and social media

**UNIT I MARKETING ANALYTICS 9**

Marketing Budget and Marketing Performance Measure, Marketing - Geographical Mapping, Data Exploration, Market Basket Analysis

**UNIT II COMMUNITY BUILDING AND MANAGEMENT 9**

History and Evolution of Social Media-Understanding Science of Social Media –Goals for using Social Media- Social Media Audience and Influencers - Digital PR- Promoting Social Media Pages-Linking Social Media Accounts-The Viral Impact of Social Media.

**UNIT III SOCIAL MEDIA POLICIES AND MEASUREMENTS 9**

Social Media Policies-Etiquette, Privacy- ethical problems posed by emerging social media technologies - The Basics of Tracking Social Media.

**UNIT IV WEB ANALYTICS 9**

Data Collection, Overview of Qualitative Analysis, Business Analysis, KPI and Planning, Critical Components of a Successful Web Analytics Strategy, Proposals & Reports, Web Data Analysis.

**UNIT V SEARCH ANALYTICS 9**

Search engine optimization (SEO), user engagement, user-generated content, web traffic analysis, online security, online ethics, data visualization.

**TOTAL: 45 PERIODS**

**OUTCOME:**

- The Learners will understand social media, web and social media analytics and their potential impact.

**REFERENCES:**

1. K. M. Shrivastava, Social Media in Business and Governance, Sterling Publishers Private Limited, 2013
2. Christian Fuchs, Social Media a critical introduction, SAGE Publications Ltd, 2014
3. Bittu Kumar, Social Networking, V & S Publishers, 2013
4. Avinash Kaushik, Web Analytics - An Hour a Day, Wiley Publishing, 2007
5. Ric T. Peterson, Web Analytics Demystified, Celilo Group Media and CafePress 2004
6. Takeshi Moriguchi, Web Analytics Consultant Official Textbook, 7th Edition, 2016

**CMG353 OPERATION AND SUPPLY CHAIN ANALYTICS L T P C**
**3 0 0 3**

**OBJECTIVE:**

- To treat the subject in depth by emphasizing on the advanced quantitative models and methods in operations and supply chain management and its practical aspects and the latest developments in the field.

**UNIT I INTRODUCTION 9**

Descriptive, predictive and prescriptive analytics, Data Driven Supply Chains – Basics, transforming supply chains.

**UNIT II WAREHOUSING DECISIONS 9**

P-Median Methods - Guided LP Approach, Greedy Drop Heuristics, Dynamic Location Models, Space Determination and Layout Methods.

**UNIT III INVENTORY MANAGEMENT 9**

Dynamic Lot sizing Methods, Multi-Echelon Inventory models, Aggregate Inventory system and LIMIT, Risk Analysis in Supply Chain, Risk pooling strategies.

**UNIT IV TRANSPORTATION NETWORK MODELS 9**

Minimal Spanning Tree, Shortest Path Algorithms, Maximal Flow Problems, Transportation Problems, Set covering and Set Partitioning Problems, Travelling Salesman Problem, Scheduling Algorithms.

**UNIT V MCDM MODELS 9**

Analytic Hierarchy Process(AHP), Data Envelopment Analysis (DEA), Fuzzy Logic an Techniques, the analytical network process (ANP), TOPSIS.

**TOTAL: 45 PERIODS**

**OUTCOME:**

- To enable quantitative solutions in business decision making under conditions of certainty, risk and uncertainty.

**REFERENCES:**

1. Nada R. Sanders, Big data driven supply chain management: A framework for implementing analytics and turning information into intelligence, Pearson Education, 2014.
2. Michael Watson, Sara Lewis, Peter Cacioppi, Jay Jayaraman, Supply Chain Network Design: Applying Optimization and Analytics to the Global Supply Chain, Pearson Education, 2013.
3. Anna Nagurney, Min Yu, Amir H. Masoumi, Ladimer S. Nagurney, Networks Against Time: Supply Chain Analytics for Perishable Products, Springer, 2013.
4. Muthu Mathirajan, Chandrasekharan Rajendran, Sowmyanarayanan Sadagopan, Arunachalam Ravindran, Parasuram Balasubramanian, Analytics in Operations/Supply Chain Management , I.K. International Publishing House Pvt. Ltd., 2016.
5. Gerhard J. Plenert, Supply Chain Optimization through Segmentation and Analytics, CRC Press, Taylor & Francis Group, 2014.

**CMG354 FINANCIAL ANALYTICS L T P C**
**3 0 0 3**

**OBJECTIVE:**

- This course introduces a core set of modern analytical tools that specifically target finance applications.

**UNIT I CORPORATE FINANCE ANALYSIS 9**

Basic corporate financial predictive modelling- Project analysis- cash flow analysis- cost of capital, Financial Break even modelling, Capital Budget model-Payback, NPV, IRR.

**UNIT II FINANCIAL MARKET ANALYSIS 9**

Estimation and prediction of risk and return ( bond investment and stock investment) –Time series- examining nature of data, Value at risk, ARMA, ARCH and GARCH.

**UNIT III PORTFOLIO ANALYSIS 9**

Portfolio Analysis – capital asset pricing model, Sharpe ratio, Option pricing models- binomial model for options, Black Scholes model and Option implied volatility.

**UNIT IV TECHNICAL ANALYSIS 9**

Prediction using charts and fundamentals – RSI, ROC, MACD, moving average and candle charts, simulating trading strategies. Prediction of share prices.

**UNIT V CREDIT RISK ANALYSIS 9**

Credit Risk analysis- Data processing, Decision trees, logistic regression and evaluating credit risk model.

**TOTAL: 45 PERIODS**

**OUTCOME**

- The learners should be able to perform financial analysis for decision making using excel, Python and R.

**REFERENCES:**


1. Financial analytics with R by Mark J. Bennett, Dirk L. Hugen, Cambridge university press.
2. Haskell Financial Data Modeling and Predictive Analytics Paperback – Import, 25 Oct 2013 by Pavel Ryzhov.
3. Quantitative Financial Analytics: The Path To Investment Profits Paperback – Import, 11 Sep 2017 by Edward E Williams (Author), John A Dobelman.
4. Python for Finance - Paperback – Import, 30 Jun 2017 by Yuxing Yan (Author).
5. Mastering Python for Finance Paperback – Import, 29 Apr 2015 by James Ma Weiming.


## VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY

**CES331 SUSTAINABLE INFRASTRUCTURE DEVELOPMENT L T P C**
**3 0 0 3**

**OBJECTIVE:**

- To impart knowledge about sustainable Infrastructure development goals, practices and to understand the concepts of sustainable planning, design, construction, maintenance and decommissioning of infrastructure projects.

**UNIT I SUSTAINABLE DEVELOPMENT GOALS 9**

Definitions, principles and history of Sustainable Development - Sustainable development goals (SDG): global and Indian – Infrastructure Demand and Supply - Environment and Development linkages - societal and cultural demands – Sustainability indicators - Performance indicators of sustainability and Assessment mechanism - Policy frameworks and practices: global and Indian – Infrastructure Project finance – Infrastructure project life cycle - Constraints and barriers for sustainable development - future directions.

**UNIT II SUSTAINABLE INFRASTRUCTURE PLANNING 9**

Overview of Infrastructure projects: Housing sector, Power sector, Water supply, road, rail and port transportation sector, rural and urban infrastructure. Environmental Impact Assessment (EIA), Land acquisition -Legal aspects, Resettlement &Rehabilitation and Development - Cost effectiveness Analysis - Risk Management Framework for Infrastructure Projects, Economic, demand, political, socio-environmental and cultural risks. Shaping the Planning Phase of Infrastructure Projects to mitigate risks, Designing Sustainable Contracts, Negotiating with multiple Stakeholders on Infrastructure Projects. Use of ICT tools in planning – Integrated planning - Clash detection in construction - BIM (Building Information Modelling).

**UNIT III SUSTAINABLE CONSTRUCTION PRACTICES AND TECHNIQUES 9**

Sustainability through lean construction approach - Enabling lean through information technology – Lean in planning and design - IPD (Integrated Project Delivery) - Location Based Management System - Geospatial Technologies for machine control, site management, precision control and real time progress monitoring - Role of logistics in achieving sustainable construction – Data management for integrated supply chains in construction - Resource efficiency benefits of effective logistics - Sustainability in geotechnical practice – Design considerations, Design Parameters and Procedures – Quality control and Assurance - Use of sustainable construction techniques: Precast concrete technology, Pre-engineered buildings.

**UNIT IV SUSTAINABLE CONSTRUCTION MATERIALS 9**

Construction materials: Concrete, steel, glass, aluminium, timber and FRP - No/Low cement concrete - Recycled and manufactured aggregate - Role of QC and durability - Sustainable consumption – Eco-efficiency - green consumerism - product stewardship and green engineering - Extended producer responsibility – Design for Environment Strategies, Practices, Guidelines, Methods, And Tools. Eco-design strategies –Design for Disassembly - Dematerialization, rematerialization, transmaterialization – Green procurement and green distribution - Analysis framework for reuse and recycling – Typical constraints on reuse and recycling - Communication of Life Cycle Information - Indian Eco mark scheme - Environmental product declarations – Environmental marketing- Life cycle Analysis (LCA), Advances in LCA: Hybrid LCA, Thermodynamic LCA - Extending LCA - economic dimension, social dimension - Life cycle costing (LCC) - Combining LCA and LCC – Case studies

**UNIT V SUSTAINABLE MAINTENANCE OF INFRASTRUCTURE PROJECTS 9**

Case Studies - Sustainable projects in developed countries and developing nations - An Integrated Framework for Successful Infrastructure Planning and Management - Information Technology and Systems for Successful Infrastructure Management, - Structural Health Monitoring for Infrastructure projects - Innovative Design and Maintenance of Infrastructure Facilities - Capacity Building and Improving the Governments Role in Infrastructure Implementation, Infrastructure Management Systems and Future Directions. – Use of Emerging Technologies – IoT, Big Data Analytics and Cloud Computing, Artificial Intelligences, Machine and Deep Learning, Fifth Generation (5G) Network services for maintenance .

**TOTAL: 45 PERIODS**

**OUTCOMES:**

On completion of the course, the student is expected to be able to

**CO1** Understand the environment sustainability goals at global and Indian scenario.

**CO2** Understand risks in development of projects and suggest mitigation measures.

**CO3** Apply lean techniques, LBMS and new construction techniques to achieve sustainability in infrastructure construction projects.

**CO4** Explain Life Cycle Analysis and life cycle cost of construction materials.

**CO5** Explain the new technologies for maintenance of infrastructure projects.

**REFERENCES:**


1. Charles J Kibert, Sustainable Construction : Green Building Design & Delivery, 4th Edition , Wiley Publishers 2016.
2. Steve Goodhew, Sustainable Construction Process, Wiley Blackwell,UK, 2016.
3. Craig A. Langston & Grace K.C. Ding, Sustainable Practices in the Built Environment, Butterworth Heinemann Publishers, 2011.
4. William P Spence, Construction Materials, Methods & Techniques (3e), Yesdee Publication Pvt. Ltd, 2016.
5. New Building Materials and Construction World magazine
6. Kerry Turner. R, "Sustainable Environmental Management", Principles and Practice Publisher:Belhaven Press,ISBN:1852930039.
7. Munier N, "Introduction to Sustainability", Springer2005
8. Sharma, "Sustainable Smart Cities In India: Challenges And Future Perspectives", SPRINGER, 2022.
9. Ralph Horne, Tim Grant, KarliVerghese, Life Cycle Assessment: Principles, Practice and Prospects, Csiro Publishing,2009
10. European Commission - Joint Research Centre - Institute for Environment and Sustainability: International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance. Luxembourg. European Union;2010
11. Hudson, Haas, Uddin, Infrastructure management: integrating design, construction, maintenance, rehabilitation, and renovation, McGraw Hill, (1997).
12. GregerLundesjö, Supply Chain Management and Logistics in Construction: Delivering Tomorrow's Built Environment, Kogan Page Publishers, 2015.


**CO's- PO's & PSO's MAPPING**

| | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO's | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 2 | | 1 | 1 | | 2 | 3 | 1 | 1 | | 2 | 1 | 1 | 2 | 1 |
| 2 | 3 | 1 | 3 | 2 | 1 | 2 | 2 | | 1 | 1 | 1 | 2 | 2 | 2 | 2 |
| 3 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | | | | 1 | 1 | 1 | 3 | 1 |
| 4 | 3 | 1 | 3 | 2 | 2 | 1 | 3 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 |
| 5 | 3 | 1 | 2 | 2 | 2 | 2 | 3 | 1 | | 1 | 1 | 2 | 2 | 3 | 2 |
| Avg. | 3 | 1 | 3 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 2 |

**CES332 SUSTAINABLE AGRICULTURE AND ENVIRONMENTAL MANAGEMENT L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To educate the students about the issues of sustainability in agroecosystems, introduce the concepts and principles of agroecology as applied to the design and management of sustainable agricultural systems for a changing world.

**UNIT I AGROECOLOGY, AGROECOSYSTEM AND SUSTAINABLE AGRICULTURE CONCEPTS 9**

Ecosystem definition - Biotic *Vs*. abiotic factors in an ecosystem - Ecosystem processes - Ecological services and agriculture - Problems associated with industrial agriculture/food systems - Defining sustainability - Characteristics of sustainable agriculture - Difference between regenerative and sustainable agriculture systems

**UNIT II SOIL HEALTH, NUTRIENT AND PEST MANAGEMENT 9**

Soil health definition - Factors to consider (physical, chemical and biological) - Composition of healthy soils - Soil erosion and possible control measures - Techniques to build healthy soil - Management practices for improving soil nutrient - Ecologically sustainable strategies for pest and disease control

**UNIT III WATER MANAGEMENT 9**

Soil water storage and availability - Plant yield response to water - Reducing evaporation in agriculture - Earthworks and tanks for rainwater harvesting - Options for improving the productivity of water - Localized irrigation - Irrigation scheduling - Fertigation - Advanced irrigation systems and agricultural practices for sustainable water use

**UNIT IV ENERGY AND WASTE MANAGEMENT 9**

Types and sources of agricultural wastes - Composition of agricultural wastes - Sustainable technologies for the management of agricultural wastes - Useful and high value materials produced using different processes from agricultural wastes - Renewable energy for sustainable agriculture

**UNIT V EVALUATING SUSTAINABILITY IN AGROECOSYSTEMS 9**

Indicators of sustainability in agriculture - On-farm evaluation of agroecosystem sustainability - Alternative agriculture approaches/ farming techniques for sustainable food production **-** Goals and components of a community food system - Case studies

**TOTAL: 45 PERIODS**

**OUTCOME**

- On completion of the course, the student is expected to be able to

CO1 Have an in-depth knowledge about the concepts, principles and advantages of sustainable agriculture
CO2 Discuss the sustainable ways in managing soil health, nutrients, pests and diseases
CO3 Suggest the ways to optimize the use of water in agriculture to promote an ecological use of resources
CO4 Develop energy and waste management plans for promoting sustainable agriculture in non-sustainable farming areas
CO5 Assess an ecosystem for its level of sustainability and prescribe ways of converting to a sustainable system through the redesign of a conventional agroecosystem

**REFERENCES:**


1. Approaches to Sustainable Agriculture – Exploring the Pathways Towards the Future of Farming, Oberc, B.P. & Arroyo Schnell, A., IUCN, Belgium, 2020
2. Natural bioactive products in sustainable agriculture, Singh, J. & Yadav, A.N., Springer, 2020
3. Organic Farming for Sustainable Agriculture, Nandwani, D., Springer, 2016
4. Principles of Agronomy for Sustainable Agriculture, Villalobos, F.J. & Fereres, E., Springer, 2016
5. Sustainable Agriculture for Food Security: A Global Perspective, Balkrishna, A., CRC Press, 2021
6. Sustainable Energy Solutions in Agriculture, Bundschuh, J. & Chen, G., CRC Press, 2014

**CO – PO Mapping - SUSTAINABLE AGRICULTURE PRACTICES**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | | 2 | | | | | | 2 | | 2 | | | 2 | 2 | |
| 2 | | 2 | | 2 | 2 | 2 | | | | | | | 3 | 2 | |
| 3 | | | | 2 | | 2 | | | | | | | 3 | 2 | 3 |
| 4 | 3 | 2 | | | 2 | | | 2 | 2 | 2 | 2 | | 3 | 2 | 3 |
| 5 | | 2 | 3 | 2 | | | 1 | | | | | 1 | | 2 | |
| Avg. | 3 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 1 | 3 | 2 | 3 |

**1 – Low; 2 – Medium; 3 – High; '- "– No correlation**

## CES333 SUSTAINABLE BIOMATERIALS L T P C 3 0 0 3

**OBJECTIVES**

- To Impart knowledge of biomaterials and their properties
- To learn about Fundamentals aspects of Biopolymers and their applications
- To learn about bioceramics and biopolymers
- To introduce the students about metals as biomaterials and their usage as implants
- To make the students understand the significance of bionanomaterials and its applications.

**UNIT I INTRODUCTION TO BIOMATERIALS 9**

Introduction: Definition of biomaterials, requirements & classification of biomaterials- Types of Biomaterials- Degradable and resorbable biomaterials- engineered natural materials- Biocompatibility-Hydrogels-pyrolitic carbon for long term medical implants-textured and porous materials-Bonding types- crystal structure-imperfection in crystalline structure-surface properties and adhesion of materials –strength of biological tissues-performance of implants-tissue response to implants- Impact and Future of Biomaterials

**UNIT II BIO POLYMERS 9**

Molecular structure of polymers -Molecular weight - Types of polymerization techniques–Types of polymerization reactions- Physical states of polymers- Common polymeric biomaterials - Polyethylene -Polymethylmethacrylate (PMMA-Polylactic acid (PLA) and polyglycolic acid (PGA) - Polycaprolactone (PCL) - Other biodegradable polymers –Polyurethan- reactions polymers for medical purposes - Collagens- Elastin- Cellulose and derivatives-Synthetic polymeric membranes and their biological applications

**UNIT-3 BIO CERAMICS AND BIOCOMPOSITES 9**

General properties- Bio ceramics -Silicate glass - Alumina (Al2O3) -Zirconia (ZrO2)-Carbon-Calcium phosphates (CaP)- Resorbable Ceramics- surface reactive ceramics- Biomedical Composites-Polymer Matrix Compsite(PMC)-Ceramic Matrix Composite(CMC)-Metal Matrix Composite (MMC)–glass ceramics - Orthopedic implants-Tissue engineering scaffolds

**UNIT-4 METALS AS BIOMATERIALS 9**

Biomedical metals-types and properties-stainless steel-Cobalt chromium alloys-Titanium alloys-Tantalum-Nickel titanium alloy (Nitinol)- magnesium-based biodegradable alloys-surface properties of metal implants for osteointegration-medical application-corrosion of metallic implants – biological tolerance of implant metals

**UNIT-5 NANOBIOMATERIALS 9**

Meatllicnanobiomaterials–Nanopolymers-Nanoceramics- Nanocomposites -Carbon based nanobiomaterials - transport of nanoparticles- release rate-positive and negative effect of nanosize-nanofibres-Nano and micro features and their importance in implant performance-Nanosurface and coats-Applications nanoantibiotics-Nanomedicines- Biochips – Biomimetics-BioNEMs -Biosensor**-**Bioimaging/Molecular Imaging**-** challenges and future perspective.

**TOTAL : 45 PERIODS**

**OUTCOMES**

- Students will gain familiarity with Biomaterials and they will understand their importance.
- Students will get an overview of different biopolymers and their properties
- Students gain knowledge on some of the important Bioceramics and Biocomposite materials
- Students gain knowledge on metals as biomaterials
- Student gains knowledge on the importance of nanobiomaterials in biomedical applications.

**REFERENCES**


1. C. Mauli Agrawal, Joo L. Ong, Mark R. Appleford, Gopinath Mani “Introduction to Biomaterials Basic Theory with Engineering Applications” Cambridge University Press, 2014.
2. Donglu shi “Introduction to Biomaterials” Tsinghua University press, 2006.
3. Joon Park, R.S.Lakes “Biomaterials An Introduction” third edition, Springer 2007.
4. M.Jaffe,W.Hammond, P.Tolias and T.Arinzeh “Characterization of Biomaterials” Wood head publishing, 2013.
5. Buddy D.Ratner and Allan S.Hoffman Biomaterials Science “An Introduction to Material in Medicine” Third Edition, 2013.
6. VasifHasirci, NesrinHasirci “Fundamentals of Biomaterials” Springer, 2018
7. Leopoido Javier Rios Gonzalez. “Handbook of Research on Bioenergy and Biomaterials: Consolidated and green process” Apple academic press, 2021.
8. Devarajan Thangadurai, Jeyabalan Sangeetha, Ram Prasad “Functional Bionanomaterials” springer, 2020.
9. Sujata.V.Bhat Biomaterials; Narosa Publishing house, 2002.


**CES334 MATERIALS FOR ENERGY SUSTAINABILITY L T P C**
**3 0 0 3**

**OBJECTIVES**

- To familiarize the students about the challenges and demands of energy sustainability
- To provide fundamental knowledge about electrochemical devices and the materials used.
- To introduce the students to various types of fuel cell
- To enable students to appreciate novel materials and their usage in photovoltaic application
- To introduce students to the basic principles of various types Supercapacitors and the materials used.

**UNIT-1 SUSTAINABLE ENERGY SOURCES 9**

Introduction to energy demand and challenges ahead – sustainable source of energy (wind, solar etc.) – electrochemical energy systems for energy harvesting and storage – materials for sustainable electrochemical systems building – India centric solutions based on locally available materials – Economics of wind and solar power generators vs. conventional coal plants – Nuclear energy

**UNIT-2 ELECTROCHEMICAL DEVICES 9**

Electrochemical Energy – Difference between primary and secondary batteries – Secondary battery (Li-ion battery, Sodium-ion battery, Li-S battery, Li-$O_2$ battery, Nickel Cadmium, Nickel Metal Hydride) – Primary battery (Alkaline battery, Zinc-Carbon battery) – Materials for battery (Anode materials – Lithiated graphite, Sodiated hard carbon, Silicon doped graphene, Lithium Titanate) (Cathode Materials – S, $LiCoO_2$, $LiFePO_4$, $LiMn_2O_4$) – Electrolytes for Lithium-ion battery (ethylene carbonate and propylene carbonate based)

**UNIT-3 FUEL CELLS 9**

Principle of operation of fuel cells – types of fuel cells (Proton exchange membrane fuel cells, alkaline fuel cell, direct methanol fuel cells, direct borohydride fuel cells, phosphoric acid fuel cells, solid oxide fuel cells, and molten carbonate fuel cells) – Thermodynamics of fuel cell – Fuel utilization – electrolyte membrane ( proton conducting and anion conducting) – Catalysts ( Platinum, Platinum alloys, carbon supported platinum systems and metal oxide supported platinum catalysts) – Anatomy of fuel cells (gas diffusion layer, catalyst layer, flow field plate, current conductors, bipolar plates and monopolar plates).

**UNIT-4 PHOTOVOLTAICS 9**

Physics of the solar cell – Theoretical limits of photovoltaic conversion – bulk crystal growth of Si and wafering for photovoltaic application - Crystalline silicon solar cells – thin film silicon solar cells – multijunction solar cells – amorphous silicon based solar cells – photovoltaic concentrators – $Cu(InGa)Se_2$ solar cells – Cadium Telluride solar cells – dye sensitized solar cells – Perovskite solar cells – Measurement and characterization of solar cells - Materials used in solar cells ( metallic oxides, CNT films, graphene, OD fullerenes, single-multi walled carbon nanotubes, two-dimensional Graphene, organic or Small molecule-based solar cells materials - copper-phthalocyanine and perylenetetracarboxylicbis - benzine – fullerenes - boron subphthalocyanine-tin (II) phthalocyanine)

**UNIT-5 SUPERCAPACITORS 9**

Supercapacitor –types of supercapacitors (electrostatic double-layer capacitors, pseudo capacitors and hybrid capacitors) - design of supercapacitor-three and two electrode cell-parameters of supercapacitor- Faradaic and non - Faradaic capacitance – electrode materials (transition metal oxides (MO), mixed metal oxides, conducting polymers (CP), Mxenes, nanocarbons, non-noble metal, chalcogenides, hydroxides and 1D-3D metal-organic frame work (MOF), activated carbon fibres (ACF)- Hydroxides-Based Materials - Polyaniline (PANI), a ternary hybrid composite-conductive polypyrrole hydrogels – Different types of nanocomposites for the SC electrodes (carbon–carbon composites, carbon-MOs composites, carbon-CPs composites and MOs-CPs composites) - Two-Dimensional (2D) Electrode Materials - 2D transition metal carbides, carbonitrides, and nitrides.

**TOTAL : 45 PERIODS**

**OUTCOMES**

- Students will acquire knowledge about energy sustainability.
- Students understand the principles of different electrochemical devices.
- Students learn about the working of fuel cells and their application.
- Students will learn about various Photovoltaic applications and the materials used.
- The students gain knowledge on different types of supercapacitors and the performance of various materials

**REFERENCES**


1. Functional materials for sustainable energy applications; John A. Kilner, Stephen J. Skinner, Stuart J. C. Irvine and Peter P. Edwards.
2. Hand Book of Fuel Cells: Fuel Cell Technology and Applications, Wolf Vielstich, Arnold Lamm, Hubert Andreas Gasteiger, Harumi Yokokawa, Wiley, London 2003.
3. B.E. Conway, Electrochemical supercapacitors: scientific fundamentals and technological applications, Kluwer Academic / Plenum publishers, New York, 1999.
4. T.R. Crompton, Batteries reference book, Newners, 3rd Edition, 2002.
5. Materials for Supercapacitor applications; B.Viswanathan. M.Aulice Scibioh
6. Electrode Materials for Supercapacitors: A Review of Recent Advances, Parnia Forouzandeh, Vignesh Kumaravel and Suresh C. Pillai, catalysts 2020.
7. Recent advances, practical challenges, and perspectives of intermediate temperature solid oxide fuel cell cathodes Amanda Ndubuisi, Sara Abouali, Kalpana Singh and VenkataramanThangadurai, J. Mater. Chem. A, 2022.
8. Review of next generation photovoltaic solar cell technology and comparative materialistic development Neeraj Kant, Pushpendra Singh, Materials Today: Proceedings, 2022.


**CES335 GREEN TECHNOLOGY L T P C**
**3 0 0 3**

**COURSE OBJECTIVE:**

- To acquire knowledge on green systems and the environment, energy technology and efficiency, and sustainability.
- To provide green engineering solutions to energy demand, reduced energy footprint.

**UNIT I PRINCIPLES OF GREEN CHEMISTRY 9**

Historical Perspectives and Basic Concepts. The twelve Principles of Green Chemistry and green engineering. Green chemistry metrics- atom economy, E factor, reaction mass efficiency, and other green chemistry metrics, application of green metrics analysis to synthetic plans.

**UNIT II POLLUTION TYPES 9**

Pollution – types, causes, effects, and abatement. Waste – sources of waste, different types of waste, chemical, physical and biochemical methods of waste minimization and recycling.

**UNIT III GREEN REAGENTS AND GREEN SYNTHESIS 9**

Environmentally benign processes- alternate solvents- supercritical solvents, ionic liquids, water as a reaction medium, energy-efficient design of processes- photo, electro and sono chemical methods, microwave-assisted reactions

**UNIT IV DESIGNING GREEN PROCESSES 9**

Safe design, process intensification, in process monitoring. Safe product and process design – Design for degradation, Real-time Analysis for pollution prevention, inherently safer chemistry for accident prevention

**UNIT V GREEN NANOTECHNOLOGY 9**

Nanomaterials for water treatment, nanotechnology for renewable energy, nanotechnology for environmental remediation and waste management, nanotechnology products as potential substitutes for harmful chemicals, environmental concerns with nanotechnology

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

CO1: To understand the principles of green engineering and technology
CO2: To learn about pollution using hazardous chemicals and solvents
CO3: To modify processes and products to make them green and safe.
CO4: To design processes and products using green technology
CO5 – To understand advanced technology in green synthesis

**TEXT BOOKS**

1. Green technology and design for the environment, Samir B. Billatos, Nadia A. Basaly, Taylor & Francis, Washington, DC, ©1997
2. Green Chemistry – An introductory text - M. Lancaster, RSC,2016.
3. Green chemistry metrics - Alexi Lapkin and david Constable (Eds) , Wiley publications,2008

**REFERENCE BOOKS**

1. Environmental chemistry, Stanley E Manahan, Taylor and Francis, 2017

**CES336 ENVIRONMENTAL QUALITY MONITORING AND ANALYSIS L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To understand and study the complexity of the environment in relation to pollutants generated due to industrial activity.
- To analyze the quality of the environmental parameters and monitor the same for the purpose of environmental risk assessment.

**UNIT I ENVIRONMENTAL MONITORING AND STANDARDS 9**

Introduction- Environmental Standards- Classification of Environmental Standards- Global Environmental Standards- Environmental Standards in India- Ambient air quality standards- water quality standard- Environmental Monitoring-Need for environmental monitoring- Concepts of environmental monitoring- Techniques of Environmental Monitoring.

**UNIT II MONITORING OF ENVIRONMENTAL PARAMETERS 9**

Current Environmental Issues- Global Environmental monitoring programme-International conventions- Application of Environmental Monitoring- Atmospheric Monitoring - screening parameters – Significance of environmental sampling- sampling methods – water sampling - sampling of ambient air-sampling of flue gas.

**UNIT III ANALYTICAL METHODS FOR ENVIRONMENTAL MONITORING 9**

Classification of Instrumental Method- Analysis of Organic Pollutants by Spectrophotometric methods -Determination of nitrogen, phosphorus and, chemical oxygen demand (COD) in sewage; Biochemical oxygen demand (BOD)- Sampling techniques for air pollution measurements; analysis of particulates and air pollutants like oxides of nitrogen, oxides of sulfur, carbon monoxide, hydrocarbon; Introduction to advanced instruments for environmental analysis

**UNIT IV ENVIRONMENTAL MONITORING PROGRAMME (EMP) & RISKASSESSMENT 9**

Water quality monitoring programme- national water quality monitoring- Parameters for National Water Quality Monitoring- monitoring protocol; Process of risk assessment- hazard identification- exposure assessment- dose-response assessment; risk characterization.

**UNIT V AUTOMATED DATA ACQUISITION AND PROCESSING 9**

Data Acquisition for Process Monitoring and Control - The Data Acquisition System - Online Data Acquisition, Monitoring, and Control - Implementation of a Data Management System - Review of Observational Networks -Sensors and transducers- classification of transducers- data acquisition system- types of data acquisition systems- data management and quality control; regulatory overview.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

After completion of this course, the students will know

| | |
|---|---|
| CO1 | Basic concepts of environmental standards and monitoring. |
| CO2 | the ambient air quality and water quality standards; |
| CO3 | the various instrumental methods and their principles for environmental monitoring |
| CO4 | The significance of environmental standards in monitoring quality and sustainability of the environment. |
| CO5 | the various ways of raising environmental awareness among the people. |
| CO6 | Know the standard research methods that are used worldwide for monitoring the environment. |

**TEXTBOOKS**


1. Environmental monitoring Handbook, Frank R. Burden, © 2002 by The McGraw-Hill Companies, Inc.
2. Handbook of environmental analysis: chemical pollutants in the air, water, soil, and soild wastes / Pradyot Patnaik, © 1997 by CRC Press, Inc


**REFERENCES**


1. Environmental monitoring / edited by G. Bruce Wiersma, © 2004 by CRC Press LLC.
2. H. H. Willard, L. L. Merit, J. A. Dean and F. A. Settle, Instrumental Methods of Analysis, CBP Publishers and Distributors, New Delhi, 1988.
3. Heaslip, G. (1975) Environmental Data Handling. John Wiley & Sons. New York.


**Course Articulation Matrix**

| Course Outcomes | Program Outcomes | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO1 | PSO2 | PSO3 |
| CO1 | 1 | 1 | 1 | - | - | - | - | - | - | - | - | - | 3 | - | - |
| CO2 | 1 | 1 | 1 | 1 | 1 | - | - | - | 1 | - | 2 | 2 | 2 | 1 | 1 |
| CO3 | 1 | 1 | 2 | 1 | 1 | - | - | - | 2 | - | 1 | 1 | 1 | - | - |
| CO4 | 1 | 2 | 3 | 3 | 1 | - | - | - | 2 | - | 3 | 3 | 1 | - | - |
| CO5 | 1 | 1 | 3 | 2 | 1 | - | - | - | 3 | - | 3 | 1 | 2 | - | - |
| CO6 | 3 | 2 | 3 | 3 | 2 | - | - | - | 3 | - | 3 | 3 | 3 | 1 | 1 |
| Over all | 3 | 2 | 3 | 3 | 2 | - | - | - | 3 | - | 3 | 3 | 3 | 1 | 1 |

**CES337 INTEGRATED ENERGY PLANNING FOR SUSTAINABLE DEVELOPMENT L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

1. To create awareness on the energy scenario of India with respect to world
2. To understand the fundamentals of energy sources, energy efficiency and resulting environmental implications of energy utilisation
3. Familiarisation on the concept of sustainable development and its benefits
4. Recognize the potential of renewable energy sources and its conversion technologies for attaining sustainable development
5. Acquainting with energy policies and energy planning for sustainable development

**UNIT I ENERGY SCENARIO 9**

Comparison of energy scenario – India and World (energy sources, generation mix, consumption pattern, T&D losses, energy demand, per capita energy consumption) – energy pricing – Energy security

**UNIT II ENERGY AND ENVIRONMENT 9**

Conventional Energy Sources - Emissions from fuels – Air, Water and Land pollution – Environmental standards - measurement and controls

**UNIT III SUSTAINABLE DEVELOPMENT 9**

Sustainable Development: Concepts and Stakeholders, Sustainable Development Goal (SDG) - Social development: Poverty, conceptual issues and measures, impact of poverty. Globalization and Economic growth - Economic development: Economic inequalities, Income and growth.

**UNIT IV RENEWABLE ENERGY TECHNOLOGY 9**

Renewable Energy – Sources and Potential – Technologies for harnessing from Solar, Wind, Hydro, Biomass and Oceans – Principle of operation, relative merits and demerits

**UNIT V ENERGY PLANNING FOR SUSTAINABLE DEVELOPMENT 9**

National & State Energy Policy - National solar mission - Framework of Central Electricity Authority - National Hydrogen Mission - Energy and climate policy - State Energy Action Plan, RE integration, Road map for ethanol blending, Energy Efficiency and Energy Mix

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to

1. Understand the world and Indian energy scenario
2. Analyse energy projects, its impact on environment and suggest control strategies
3. Recognise the need of Sustainable development and its impact on human resource development
4. Apply renewable energy technologies for sustainable development
5. Fathom Energy policies and planning for sustainable development.

**REFERENCES:**


1. Energy Manager Training Manual (4Volumes) available at http://www.em-ea.org/gbook1.asp, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.2004
2. Robert Ristirer and Jack P. Kraushaar, “Energy and the environment”, Willey, 2005.
3. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, U.K., 2012
4. Twidell, J.W. & Weir A., “Renewable Energy Resources”, EFNSpon Ltd., UK, 2015.
5. Dhandapani Alagiri, Energy Security in India Current Scenario, The ICFAI University Press, 2006.
6. M.H. Fulekar,Bhawana Pathak, R K Kale,“Environment and Sustainable Development” Springer,2016
7. https://www.niti.gov.in/verticals/energy

**CES338 ENERGY EFFICIENCY FOR SUSTAINABLE DEVELOPMENT L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

1. To understand the types of energy sources, energy efficiency and environmental implications of energy utilisation
2. To create awareness on energy audit and its impacts
3. To acquaint the techniques adopted for performance evaluation of thermal utilities
4. To familiarise on the procedures adopted for performance evaluation of electrical utilities
5. To learn the concept of sustainable development and the implication of energy usage

**UNIT I ENERGY AND ENVIRONMENT 9**

Primary energy sources - Coal, Oil, Gas – India Vs World with respect to energy production and consumption, Climate Change, Global Warming, Ozone Depletion, UNFCCC, COP

**UNIT II ENERGY AUDITING 9**

Need and types of energy audit. Energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments

**UNIT III ENERGY EFFICIENCY IN THERMAL UTILITIES 9**

Energy conservation avenues in steam generation and utilisation, furnaces, Thermic Fluid Heaters. Insulation and Refractories - Commercial waste heat recovery devices: recuperator, regenerator, heat pipe, heat exchangers (Plate, Shell & Tube), heat pumps, and thermocompression

**UNIT IV ENERGY CONSERVTION IN ELECTRICAL UTILITIES 9**

Demand side management - Power factor improvement – Energy efficient transformers - Energy conservation avenues in Motors, HVAC, fans, blowers, pumps, air compressors, illumination systems and cooling towers

**UNIT V SUSTAINABLE DEVELOPMENT 9**

Sustainable Development: Concepts and Stakeholders, Sustainable Development Goal (SDG). Globalization and Economic growth. Economic development: Economic inequalities, Income and growth. Social development: Poverty, conceptual issues and measures, impact of poverty,

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to

1. Understand the prevailing energy scenario
2. Familiarise on energy audits and its relevance
3. Apply the concept of energy audit on thermal utilities
4. Employ relevant techniques for energy improvement in electrical utilities
5. Understand Sustainable development and its impact on human resource development

**REFERENCES:**


1. Energy Manager Training Manual (4Volumes) available at http://www.em-ea.org/gbook1.asp, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.2004
2. Eastop.T.D& Croft D.R, “Energy Efficiency for Engineers and Technologists”, Logman Scientific & Technical, ISBN-0-582-03184, 1990
3. W.R. Murphy and G. McKay “Energy Management” Butterworths, London 1987
4. Pratap Bhattacharyya, “Climate Change and Greenhouse Gas Emission”, New India Publishing Agency- Nipa,2020

5. Matthew John Franchetti , Defne Apul “Carbon Footprint Analysis: Concepts, Methods, Implementation, and Case Studies” CRC Press,2012
6. Robert A. Ristinen, Jack J. Kraushaar, Jeffrey T. Brack, “Energy and the Environment”, 4th Edition,Wiley,2022
7. M.H. Fulekar,Bhawana Pathak, R K Kale,“Environment and Sustainable Development” Springer,2016
8. Sustainable development in India: Stocktaking in the run up to Rio+20: Report prepared by TERI for MoEF, 2011.