ANNA UNIVERSITY: CHENNAI
NON-AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY
REGULATIONS 2021
M.TECH. PLASTICS TECHNOLOGY
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULUM AND SYLLABUS
SEMESTER I

S. No	COURSE CODE	COURSETITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA4112	Mathematics for Plastic Technology	FC	4	0	0	4	4
2.	PA4101	Plastics Materials Technology	PCC	3	0	0	3	3
3.	PA4102	Manufacture of Plastic Products	PCC	3	0	0	3	3
4.	PA4103	Polymer Characterization	PCC	3	0	0	3	3
5.	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2
6.		Professional Elective I	PEC	3	0	0	3	3
7.		Audit Course I	AC	2	0	0	2	0
PRACTICALS								
8.	PA4111	Polymer Characterization Laboratory	PCC	0	0	4	4	2
9.	PA4112	Plastic Processing Laboratory	PCC	0	0	4	4	2
			TOTAL	**20**	**0**	**8**	**28**	**22**

***Audit Course is Optional**

SEMESTER II

S. No	COURSE CODE	COURSETITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PA4201	Plastics Testing	PCC	4	0	0	4	4
2.	PA4202	Polymer Composites	PCC	4	0	0	4	4
3.	PA4203	Plastic recycling Technology	PCC	3	0	0	3	3
4.	PA4204	Plastic Product and Mould Design	PCC	4	0	0	4	4
5.	PA4205	Additive Manufacturing	PCC	3	0	0	3	3
6.		Professional Elective II	PEC	3	0	0	3	3
7.		Audit Course II	AC	2	0	0	2	0
PRACTICALS								
8.	PA4211	Plastics Testing Laboratory	PCC	0	0	4	4	2
9.	PA4212	Product Design Laboratory	PCC	0	0	4	4	2
10.	PA4312	Internship (2 weeks)	EEC					0
			TOTAL	**23**	**0**	**8**	**31**	**25**

***Audit Course is Optional**

SEMESTER III

S. No	COURSE CODE	COURSETITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Professional Elective III	PEC	3	0	0	3	3
2.		Professional Elective IV	PEC	3	0	0	3	3
3.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
4.	PA4311	Project Work I	EEC	0	0	12	12	6
5.	PA4312	Internship (2 weeks)		0	0	0	0	1
			TOTAL	**9**	**0**	**12**	**21**	**16**

SEMESTER IV

S. No.	COURSE CODE	COURSETITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	PA4411	Project Work II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL NO. OF CREDITS:75

LIST OF PROFESSIONAL ELECTIVES

SEMESTER I, ELECTIVE I

S. No.	COURSE CODE	COURSETITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	PA4001	Rheology in Polymer Processing	PEC	3	0	0	3	3
2.	PA4002	Plastics Packaging	PEC	3	0	0	3	3
3.	PA4003	Additives and Compounding	PEC	3	0	0	3	3
4.	PA4004	Polymer nanocomposites	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE II

S. No.	COURSE CODE	COURSETITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	PA4005	Secondary Processing Operations	PEC	3	0	0	3	3
2.	PA4006	Rubber Technology	PEC	3	0	0	3	3
3.	PA4007	Science and Technology of Advanced Coatings	PEC	3	0	0	3	3
4.	PA4008	CAD/CAM/CAE Applications in Mould / Die Designs	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE III

S. No.	COURSE CODE	COURSETITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	PA4009	Reverse Engineering	PEC	3	0	0	3	3
2.	PA4010	Mechanical Behaviour of Materials	PEC	3	0	0	3	3
3.	PA4011	Advanced Plastics Processing	PEC	3	0	0	3	3
4.	PA4012	Fracture Mechanism and Analyses in Polymers	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE IV

S. No.	COURSE CODE	COURSETITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	PA4013	Biomedical Plastics	PEC	3	0	0	3	3
2.	PA4014	Shape Memory Polymers	PEC	3	0	0	3	3
3.	PA4015	Conducting Polymers	PEC	3	0	0	3	3
4.	PA4016	Liquid Crystalline Polymers	PEC	3	0	0	3	3

AUDIT COURSES - I (AC)

REGISTRATION FOR ANY OF THESE COURSES IS OPTIONAL TO STUDENTS

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	AX4091	English for Research Paper Writing	2	0	0	0
2.	AX4092	Disaster Management	2	0	0	0
3.	AX4093	Constitution of India	2	0	0	0
4.	AX4094	நற்றமிழ்இலக்கியம்	2	0	0	0

FOUNDATION COURSE (FC)

SL. NO.	COURSE CODE	COURSE NAME	CATE GORY	PERIOD PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	MA4112	Mathematics for Plastic Technology	FC	4	0	0	4	4

PROFESSIONAL CORE (PCC)

SL. NO.	COURSE CODE	COURSE NAME	CATE GORY	PERIOD PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	PA4101	Plastics Materials Technology	PCC	3	0	0	3	3
2.	PA4102	Manufacture of Plastic Products	PCC	3	0	0	3	3
3.	PA4103	Polymer Characterization	PCC	3	0	0	3	3
4.	PA4111	Polymer Characterization Laboratory	PCC	0	0	4	4	2
5.	PA4112	Plastic Processing Laboratory	PCC	0	0	4	4	2
6.	PA4201	Plastics Testing	PCC	4	0	0	4	4
7.	PA4202	Polymer Composites	PCC	4	0	0	4	4
8.	PA4203	Plastic Recycling Technology	PCC	3	0	0	3	3
9.	PA4204	Plastic Product and Mould Design	PCC	4	0	0	4	4
10.	PA4205	Additive Manufacturing	PCC	3	0	0	3	3
11.	PA4211	Plastics Testing Laboratory	PCC	0	0	4	4	2
12.	PA4212	Product Design Laboratory	PCC	0	0	4	4	2

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL. NO.	COURSE CODE	COURSE NAME	CATE GORY	PERIOD PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	PA4312	Internship (2 weeks)	EEC	-	-	-	-	0
2.	PA4311	Project Work I	EEC	0	0	12	12	6
3.	PA4312	Internship (2 weeks)	EEC	0	0	0	0	1
4.	PA4411	Project Work II	EEC	0	0	24	24	12

RESEARCH METHODOLOGY AND IPR (RMC)

SL. NO.	COURSE CODE	COURSE NAME	CATE GORY	PERIOD PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2

LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	OCE431	Integrated Water Resources Management	3	0	0	3
2.	OCE432	Water, Sanitation and Health	3	0	0	3
3.	OCE433	Principles of Sustainable Development	3	0	0	3
4.	OCE434	Environmental Impact Assessment	3	0	0	3
5.	OIC431	Blockchain Technologies	3	0	0	3
6.	OIC432	Deep Learning	3	0	0	3
7.	OME431	Vibration and Noise Control Strategies	3	0	0	3
8.	OME432	Energy Conservation and Management in Domestic Sectors	3	0	0	3
9.	OME433	Additive Manufacturing	3	0	0	3
10.	OME434	Electric Vehicle Technology	3	0	0	3
11.	OME435	New Product Development	3	0	0	3
12.	OBA431	Sustainable Management	3	0	0	3
13.	OBA432	Micro and Small Business Management	3	0	0	3
14.	OBA433	Intellectual Property Rights	3	0	0	3
15.	OBA434	Ethical Management	3	0	0	3
16.	ET4251	IoT for Smart Systems	3	0	0	3
17.	ET4072	Machine Learning and Deep Learning	3	0	0	3
18.	PX4012	Renewable Energy Technology	3	0	0	3
19.	PS4093	Smart Grid	3	0	0	3
20.	CP4391	Security Practices	3	0	0	3
21.	MP4251	Cloud Computing Technologies	3	0	0	3
22.	IF4072	Design Thinking	3	0	0	3
23.	MU4153	Principles of Multimedia	3	0	0	3
24.	DS4015	Big Data Analytics	3	0	0	3
25.	NC4201	Internet of Things and Cloud	3	0	0	3
26.	MX4073	Medical Robotics	3	0	0	3
27.	VE4202	Embedded Automation	3	0	0	3

SUMMARY

S.NO.	Subject Area	Credits per Semester				Credits Total
		I	II	III	IV	
1	FC	4	-	-	-	4
2	PCC	13	22	-	-	35
3	PEC	3	3	6	-	12
4	OEC	-		3	-	3
5	EEC	-	-	7	12	19
	RMC	2	-	-	-	2
	Total	**22**	**25**	**16**	**12**	**75**
	Audit courses (Non Credit)	*	*			

SEMESTER I

MA4112	MATHEMATICS FOR PLASTIC TECHNOLOGY	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES :

- To understand the basic concept of numerical methods in solving ordinary differential equations.
- To understand the basic concept of numerical methods in solving partial differential equations.
- To understand the basics of random variables withemphases on the standard discrete and continuos distributions.
- To introduce the basic concept of Markovian Queueing Systems.
- To apply small and large sample tests through tests of hypothèses.

UNIT I NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 12

Solution of first order ordinary differential equation - Taylor's method - Euler's method - Runge - Kutta method of fourth order - Predictor – Corrector Methods - Milne's and Adam's – Bashforth methods - Introduction to numeric use of the above techniques in plastics engineering and calculations.

UNIT II NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS 12

Classification of second order linear partial differential equations - Elliptic equations – Solution of Laplace equations – Solution of Poisson's equation - Parabolic equations – Solution of one - dimensional heat equation - Hyperbolic equations – Solution of wave equation.

UNIT III PROBABILITY AND STATISTICS 12

Probability – Addition theorem - Multiplication theorem - Conditional probability – Baye's theorem - Distribution functions - Binomial distribution - Poisson distribution - Normal distribution - Uniform distribution - Curve fitting – Fitting a straight line and second degree curve - Fitting a non linear curve - Correlation and regression.

UNIT IV QUEUEING MODELS 12

Poisson process – Markovian queues – Single and multiserver models – Little's formula – Steady state analysis – Self service queue.

UNIT V TESTING OF HYPOTHESIS 12

Sampling distribution – Large sample and small samples - Testing of null hypothesis - Type I and Type II errors - "t" test and Chi square test - Goodness of fit - Fisher's "F" test.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

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

CO1 Develop a good understanding of the various methods used for the numerical solution of scientific problems.

CO2 Learn various numerical methods of solving partial differential equations.

CO3 Analyze the performance in terms of probabilities and distributions achieved by the determined solutions.

CO4 Formulate the various kinds of Non-Markovian, MarkovianQueueing Models.

CO5 Apply the basic principles underlying statistical inference.(estimation and hypothesis testing)

REFERENCES:

1. Burden, R. C. and Faires, J. D., "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
2. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", 9th Edition, Pearson Education, Asia, 2016.
3. Gupta, S. C. and Kapoor, Y. K., "Fundamentals of Mathematical Statistics", 12th Edition, Sultan Chand and Sons, 2020.
4. Gross, D., Shortle, J.F., Thomson, J. M. and Harris, C. M., "Fundamentals of Queuing Theory ", 4th Edition, Wiley, 2014.

MAPPING OF CO'S WITH PO'S

	PO01	PO02	PO03	PO04	PO05	PO06
CO1	2	1	3	-	-	-
CO2	3	1	3	-	-	-
CO3	2	1	2	-	-	-
CO4	3	1	3	-	-	-
CO5	2	1	2	-	-	-
Avg.	2.4	1	2.6	-	-	-

PA4101 PLASTICS MATERIALS TECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the mechanism of polymerization, techniques of polymerization and the significance of different molecular weight averages.
- To provide in depth knowledge about different kinds of plastic materials based on their structure and properties
- To make the student familiar about properties and end application of different plastics materials
- To apply knowledge of thermoplastics for industrial applications.
- To understand the role of polymer blends & alloys in current scenario

UNIT I POLYMER CHEMISTRY 9

Introduction to polymers- homopolymers, Copolymers. Different types of polymerizations -addition, condensation and stereoregular polymerization. Initiators, important steps involved, kinetics and mechanism of addition, condensation and stereoregular polymerizations. Copolymerization and its kinetics. Polymerization techniques- emulsion, bulk, solution and suspension, Molecular weight & its determination.

UNIT II COMMODITY THERMOPLASTICS 9

Introduction, source of raw materials, Manufacture, General Properties, processing and applications of Olefine Polymers such as Polyethylene - Polypropylene and their copolymers-Styrene Polymer such asPolystyrene and Copolymers (Styrene Acrylonitrile, Acrylonitrile Butadiene Styrene) -Vinyl polymers such as Poly Vinyl Chloride, Poly vinyl acetate- Acrylic and copolymers-Cellulose Polymers.

UNIT III ENGINEERINGAND HIGH PERFORMANCE THERMOPLASTICS 9

Introduction, source of raw materials, Manufacture, General Properties, processing and applications of engineering thermoplastics such as-Acetal–Homopolymer& Co-polymer , polycarbonates, polyamides-Nylon 6, 66, 610, 11 and 12,Polyesters (Poly Ethylene Terephthalate & Poly Butylene Terephthalate) polyimides, Poly (benzimidazoles), polyphenylene oxide, Poly(aryl ether ketone), Poly(ether ketone), Poly(aryl ether sulfone), poly (phenylene sulfides), Polysulfones-Fluoropolymers (PolyVinyl Fluoride,

Poly Vinyledene Fluoride, Poly Tetra Fluoro Ethylene,Polychloro TriFluoro Ethylene), Liquid crystalline polymers and Thermoplastic Polyurethane.

UNIT IV THERMOSETTING PLASTICS 9

Introduction, source of raw materials, Manufacture, General Properties, processing and applications of Phenolic resin - Urea Formaldehyde - Melamine Formaldehyde – Unsaturated Polyesters-Epoxy resins- Polyurethane and Silicones.

UNIT V POLYMER BLENDS AND ALLOYS 9

Introduction to polymer blends and alloys- Definitions, compatibilization mechanism and methods, criteria for making polymer blends, Selection of polymer for blend, Types of polymer blends. Thermodynamics of polymer miscibility, Blend preparation techniques, Commercial polymer blends such as plastic-plastic, rubber-plastic, rubber-rubber blends, High performance polymer blends.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Apply suitable polymerization technique to prepare the plastics as per the requirement.
CO2 Select the plastic materials for particular end use based on properties.
CO3 Predict the behavior of different kinds of plastics material based on their structure and property relationship.
CO4 Gain knowledge on manufacturing process of thermosetting Plastics
CO5 Classify the types of polymer blends & alloys

REFERENCES:

1. Brydson, J A. *Plastics Materials*. Oxford: Butterworth-Heinemann, 1999.
2. Paul, Donald R, and Clive B. Bucknall. *Polymer Blends: Vol 1*. New York: Wiley, 2000.
3. Utracki, L A. *Polymer Blends Handbook*. , 2003.
4. R.P.Singh, C. K. Das, S. K. Mustafi, Polymer Blends and Alloys an Overview, Asian Books Pvt., New Delhi, 2002.
5. Simon, George P., ed. Polymer blends and alloys. Routledge, 2019.
6. Gilbert, Marianne, and J A. Brydson. Brydson's Plastics Materials. , 2017.

MAPPING OF CO'S WITH PO'S

Course outcome Statement	PO1	PO2	PO 3	PO4	PO 5	PO6	PO7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	2	2	2	1	2	3	1	--	2	2	2	2
CO2	2	2	2	3	1	1	1	--	2	2	--	2
CO3	2	3	2	3	1	2	2	1	2	2	1	2
CO4	1	2	2	2	--	2	2	1	2	2	1	2
CO5	1	--	2	--	--	1	1	--	1	1	--	2
AVg.	1.6	2.2	2	2.2	1.3	1.8	1.4	1	1.8	1.8	1.3	2

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

PA4102 MANUFACTURE OF PLASTICS PRODUCTS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the functions of each of these additives, technical requirements, types & mechanism, and their effective evaluation are dealt with in this subject.

- To select suitable plastics material compounding and mixing techniques like two roll milling, internal blender, single / twin screw extruder, etc.
- To learn the fundamentals of compression moulding & transfer moulding.
- To impact knowledge on basic processing of thermoplastics.
- To analyze the various processing techniques of plastics materials

UNIT I COMPOUNDING OF THERMOPLASTICS 9

Compounding-Importance, ingredients, master batch, equipments- Twin screw extrusion, compression moulding and compounding lines -compounding of polyolefins, polystyrene and styrene copolymers, engineering polymers, natural fiber filled plastics, post compounding operations.

UNIT II INJECTION MOULDING AND EXTRUSION PROCESS 9

Injection Moulding: processing outline- Types-effect of processing parameters on moulding quality, Troubleshooting. Basic principles of extrusion–Types of extruders, general features of extruders. Melt fracture &Bambooing. Production of blown film, cast film/slot film, BO film, coextruded film. Tube/pipe-sizing take off equipment, extrusion coating, wire & cable covering–pretreatment of conductor, cooling, constructional features of dies for the above processes and trouble shooting. Applications of extrusion and new developments.

UNIT III BLOW MOULDING, COMPRESSION & TRANSFER MOULDING PROCESS 9

Basic principles of blow moulding–Injection Blow moulding, extrusion blow moulding, Parison programming, Advantage & disadvantage of blow moulding. Basic principles of compression and transfer moulding-Bulk factor-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. Advantages of transfer moulding over compression moulding-Equipment used-Moulding faults–causes and remedies.

UNIT IV THERMOFORMING, CALENDERING AND ROTO MOULDINGPROCESS 9

Basic principles–Raw materials & types of thermoforming processes, Thermoforming moulds processing parameters—faults, causes and remedies. Calendaring-Principle and process description, types of calendar units 2, 3 and 4 rolled calendars, Design of calendar roll, Heating and temp control, roll crown, roll crossing and roll bending, materials for calendaring, calendaring sheets and films, embossing, coating and lamination by calendar. Rotational moulding - Introduction-principle-process-machinery used-materials-moulds process parameters-merits & demerits of rotomoulding.

UNIT V SELECTIVE LASER SINTERING (SLS) PROCESS 9

Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy. Applications; Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications. Other Additive Manufacturing Systems: Shape Deposition Manufacturing (SDM), Ballastic Particle Manufacturing (BPM), Selective Laser Melting, Electron Beam Melting;

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Acquire knowledge of processing of plastic materials by injection moulding, extrusion, and blow moulding.

CO2 Understand processing techniques like compression molding and transfer moulding of thermoset plastics.

CO3 Acquire the knowledge of processing of plastics materials

CO4 Gain knowledge on extrusion & Laser sintering technique

CO5 Acquire knowledge on thermoforming, calendaring & roto moulding process.

REFERENCES:

1. Fisher, Edwin George., and E. C. Whitfield. Extrusion of Plastics: [by] E.G. Fisher, Assisted by E.C. Whitfield. 1976.
2. Hornsby, P R. "Plastics Extrusion Technology. Edited by Friedhelm Henson, Carl HanserVerlag, Munich, 1988.
3. Donald V. Rossato, Injection MouldingHanbook, International Thomson Publishing Co., 1995.
4. M.S. Welling, Injection Moulding Technology, VDI–VerlagGmbh, 1981.
5. Seymour S. Schwartz & Sidney H. Goodman, Plastics Materials and process, Van Nostr and Reinhold Company, New York, 1982.
6. Innovation in Polymer Processing By Stevenson., 1996.
7. Extrusion The definitive Processing Guide and Hand Book By Giles, H.H & Others., 2004.
8. Iyesew, A.I., Compression Molding
9. Bruins Basic Principle of Rotational Molding
10. Brycle, D.M, Basic Principle of Thermoforming

MAPPING OF CO'S WITH PO'S

Course outcome Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	3	2	2	1	2	2	2	1
CO2	2	2	1	1	3	2	2	1	2	2	2	1
CO3	2	2	2	1	1	1	1	--	2	3	---	2
CO4	1	2	2	2	2	2	---	---	1	2	1	2
CO5	1	2	2	2	2	2	---	---	1	2	1	2
AVg.	1.6	2	1.6	1.4	2.2	1.8	1	1	1.6	2.2	1.5	1.6

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

PA4103 POLYMER CHARACTERIZATION LT P C
3 0 0 3

COURSE OBJECTIVES:

- To develop knowledge of National & International standards for testing methods.
- To create the knowledge about the conditioning of samples and sample preparation techniques for testing various properties of plastics materials.
- To enable the students to learn about the evaluation of mechanical & thermal properties of plastics materials.
- To enable the students to learn about the evaluation of electrical & optical properties of plastics materials.
- To enable the students to understand the testing of raw materials and components for evaluating various properties; testing the products for predicting product performance

UNITI STANDARDS AND IDENTIFICATION OF PLASTICS 9

Application of national and international standards (BIS-ASTM-ISO) for testing and their significance, Knowledge and exposure on Sectorial Testing Standards. National and International standards Identification of plastics-Determination of necessary manufacturing conditions-Assessment of properties of finished products in relation to service requirements-Standard and specification-Test specimen preparation-Preconditioning and test atmosphere.

UNITII MECHANICAL PROPERTIES 9

Density and dimensions-Hardness-tensile strength-compressive strength-shear strength-flexural strength-impact strength-dynamic stress-strain Properties- creep-relaxation and set tests-friction and wear-abrasion test-fatigue-burst strength and folding endurance.

UNIT III THERMAL PROPERTIES 9

Specific heat and thermal conductivity, thermal dependent properties- thermal Endurance-glass transition temperature-thermal yield tests-Heat deflection temperature-Vicat softening temperature-Marten's heat resistance test-low temperature brittle point and flexibility test-coefficient of thermal expansion-shrinkage-Thermal stability- Thermal ageing and flammability. Permanence Properties: Water absorption-soluble and insoluble matter-chemical resistance environmental stress cracking resistance-ageing-gas permeability-water vapour permeability and weathering.

UNIT IV OPTICAL AND ELECTRICAL PROPERTIES 9

Refractive index-light transmission-haze-clarity-gloss-colour guard and microscope. Electrical Properties- Insulation resistance-power factor-permittivity – dielectric strength- tracking resistance-arc resistance and antistatic test, volume and surface resistivity.

UNIT V PRODUCT TESTING 9

Testing of Pipe and fittings-film and sheets-container and FRP based products. Factors for designing tests for newer products, Factors affecting the quality of materials and products. Analysis of failure and its measurements. Techniques of characterization-Principles, equipments and application of DSC, DMA, TGA and FTIR, Concepts of non-destructive testing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the various standards & specifications for different plastics material tests.
CO2 Analyse various plastics materials for its chemical & mechanical properties as per the standard.
CO3 Assess various plastics materials for their thermo-physical as well as thermomechanical properties as per the standard.
CO4 Test various plastics materials for their Optical & electrical properties as per the standard.
CO5 Evaluate the quality of plastics products by testing.

REFERENCES:

1. D. Campbell and J. R. White 'Polymer Characterization, Physical Techniques' Chapman and Hall, 1989.
2. Arza Seidel 'Characterization and Analysis of Polymers', Wiley Interscience 2008.
3. Techniques for Polymer Organization and Morphology Characterization, by R. A. Pethrick and C. Viney, Wiley Interscience, 2003.
4. Peter A. Mirau 'A practical Guide to understanding the NMR of polymers', Wiley Interscience, 2005.
5. Edith A. Turi Thermal Characterization of Polymeric Materials, 2nd Edition, Vol. 1-2, 1982.
6. Allen; W.S and Baker; P.N, Hand Book of Plastics Technology, Volume 2,Identification Testing & Recycling of Plastics, CBS Publishers and distributors, New Delhi 2004).
7. Brown; Paul F (Ed), Hand Book of Plastics Test Methods, Longman Scientific and Technical, Harlow (1988).
8. Brown; Roger P (Ed.), Hand Book of Polymer Testing, Marcel Dekker, Inc, New York (1999).
9. ASTM test standards for plastics Vol.8.01 to 8.04, 9.01 & 9.02, 2002.
10. ISO test standards, 1998.
11. Shah, Vishnu, Hand Book of Plastics Testing Technology, John Wiley and Sons, SPE Monograph (1984).

MAPPING OF CO'S WITH PO'S

Course outcome Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	2	1	2	2	2	1	1	-	2
CO2	2	1	1	2	2	2	1	1	1	2	1	2
CO3	2	1	1	2	2	2	1	1	1	2	1	2
CO4	2	1	1	2	2	2	1	1	1	2	1	2
CO5	2	1	1	2	2	2	1	1	1	2	1	2
AVg.	2	1	1.2	2	1.8	2	1.2	1.2	1	1.8	0.8	2

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

RM4151 RESEARCH METHODOLOGY AND IPR L T P C
2 0 0 2

UNIT I RESEARCH DESIGN 6

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II DATA COLLECTION AND SOURCES 6

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

UNIT III DATA ANALYSIS AND REPORTING 6

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

UNIT IV INTELLECTUAL PROPERTY RIGHTS 6

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT V PATENTS 6

atents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

TOTAL: 30 PERIODS

REFERENCES

1. Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, "Patent Searching: Tools & Techniques", Wiley, 2007.
4. The Institute of Company Secretaries of India, Statutory body under an Act of Parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.

PA4111 POLYMER CHARACTERIZATION LABORATORY L T P C
0 0 4 2

COURSE OBJECTIVES:

- To get practice in testing the Physico-mechanical properties of plastic materials.
- To provide hands on experience on various polymerization techniques.
- To make the student understand simple experimental procedures to determine molecular weight and molecular weight distribution of polymers.
- To make the student familiarize with the thermal properties of polymers.
- To make the student understand simple techniques to identify the plastic materials.

LIST OF EXPERIMENTS:

1. Identification of Plastics materials.
2. Density determination.
3. Bulk polymerization - Preparation of polymethyl methacrylate.
4. Solution Polymerization - Preparation of polyacrylamide.
5. Preparation of Phenol-Formaldehyde, UF and MF resins.
6. Synthesis of copolymers by Emulsion, Bulk, solution & suspension Polymerization.
7. Measurement of viscosity of polymer solutions and determination of molecular weight of the polymer.
8. End group analysis.
9. Determination of acid value of a resin.
10. Study of Molecular weight distribution (GPC).
11. Determination of cure of a phenolic moulding (percentage acetone soluble matter).
12. Study of Thermal Stability of polymers.
13. Determination of K-value for PVC.
14. Viscosity and Molecular Weight Determination
15. Determination of Filler content

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1 Measure viscosity the of polymer solutions.
CO2 Synthesize various types of polymers by using suitable polymerisation techniques.
CO3 Identify plastics materials by simple methods.

EQUIPMENT REQUIRED:

Glassware for reactions and spot tests, Ostwald/Ubbelohde viscometer,

REFERENCES:

1. ASTM test standards for plastics Vol.8.01 to 8.04, 9.01 & 9.02, 2002.
2. ISO test standards, 1998.
3. Vishu Shah, Hand Book of Plastics Testing Technology, John Wiley & Sons. Inc. New York, 1998.
4. Saunders, K J. The Identification of Plastics and Rubbers. London: Chapman and Hall, 1970.
5. R.P. Brown, Hand Book of Plastics Test Methods, George Godwin Ltd., London, 1981.

MAPPING OF CO'S WITH PO'S

Course outcome Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	1	2	1	1	1	3	-	3
CO2	3	3	3	2	1	2	2	1	2	3	-	3
CO3	3	3	3	1	-	2	2	1	1	3	-	3
AVg.	3	3	3	1.3	1	2	1.6	1	1.3	3	-	3

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

PA4112 PLASTICS PROCESSING LABORATORY L T P C
0 0 4 2

COURSE OBJECTIVES:

- To gain practical knowledge about hand operated injection moulding, semi automatic& automatic injection moulding machine, Blow moulding process.
- To identify defects, causes & remedies of the process.
- To select the suitable process parameters for a particular process.
- To learn about microprocessor controlled injection moulding machines, Blow moulding process, rotational moulding, thermoforming with different moulds and material.
- To understand the possible defects, its causes and setting of process parameters.

LIST OF EXPERIMENTS

1. Injection Moulding (Hand Operated ,Semi -Automatic)
2. Microprocessor controlled Injection moulding operation
3. Extrusion Process
4. Compression Moulding
5. Blow Moulding
6. Vacuum Forming
7. Rotational Moulding
8. Coating of Plastics
9. Welding & Sealing of Plastics
10. Screen Printing
11. FRP – Hand layup process
12. Co-extrusion process
13. Machine Maintenance
14. Mould Study

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1 Select suitable process parameters.

CO2 Understand all the manufacturing techniques, machine components, their function and setting of process parameters.

CO3 Analyze the cycle time and process parameters to overcome the troubleshoots.

REFERENCES:

1. A.S. Athaly, Injection Moulding Practice, Multi-Tech. Publishing Co., New Delhi, 1997.
2. Lee, Blow Moulding Design Guide, Hausar Publishers, Munich, 1998.

3. FriedhelmHensen, Plastics Extrusion Technology, Hansar Publishers, Vienna, 1988.
4. Irvin Rubin, Injection Moulding Theory and Practice, A. Wiley interscience Publication.1972.

LABORATORY REQUIREMENTS

1. Injection moulding machine (conventional) - 2Nos.
2. Plastic tube extrusion machine - 1No.
3. Plastic film extrusion machine - 1No.
4. Compression moulding machine - 1No.
5. Microprocessor controlled inj. moulding machine - 1 No.
6. Blow moulding machine (Automatic) - 1 No.
7. Vacuum forming machine - 1 No.
8. Rotational moulding machine - 1 No.
9. Plastics coating machine - 1 No.
10. Ultrasonic welding machine - 1 No.
11. Plastic sealing machine - 1 No.
12. Printing machine (on plastics) - 1 No.
13. Machine maintenance kit - 1 No.
14. Moulds maintenance kit - 2 Nos.
15. Moulds for plastic products - 1 No.
16. FRP hand layup kit - 1 No.
17. Plastic co-extrusion film plant - 1 No.

MAPPING OF CO'S WITH PO'S

Course outcome Statement	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7	PO 8	PO 9	PO10	PO 11	PO 12
CO1	3	3	3	2	2	3	1	2	3	3	-	1
CO2	3	3	3	2	2	3	2	2	3	3	-	1
CO3	3	3	3	2	2	3	1	2	3	3	-	1
AVg.	3	3	3	2	2	3	1.3	2	3	3	-	1

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

SEMESTER II

PA4201 **PLASTICS TESTING** **L T P C**
4 0 0 4

OBJECTIVES:

- Develop the knowledge of National & International standards for testing methods
- Enable the students to identify and compare the properties of different plastics materials.
- Enable the students to learn about the evaluation of thermal, electrical, optical and mechanical properties of plastics materials.
- To enable the students to learn about the property of the plastic material for several
- Create knowledge about testing of plastics products as per the standards

UNIT I STANDARDS AND SPECIFICATIONS 12

Concepts of Testing & Identification of Plastics Basic concepts of testing-Specification and Standards–National and International Standards–Test specimen preparation–Pre-conditioning and test atmosphere. Identification of plastics by simple test: Visual examination – Density – Melting point – Solubility test – Flame test – Chemical tests.

UNIT II TESTING FOR MECHANICAL PROPERTIES 12

Physical Testing Long–term Mechanical Properties: Creep–Stress relaxation. Short-term Mechanical Properties: Tensile properties–Flexural properties–Compressive properties–Shear properties – Impact properties–Tear resistance – Hardness tests–abrasion resistance–Friction test. Gas and Moisture Permeability–Environmental stress cracking resistance–Crazing.

UNIT III TESTING FOR ELECTRICAL AND OPTICAL PROPERTIES 12

Dielectric Strength–Dielectric Constant and dissipation factor–insulation resistance–volume and surface resistivity – Arc resistance – Antistatic tests. Refractive index–Luminous transmittance – Clarity and Haze – Photo –elastic properties–colour measurements and Specular Gloss.

UNIT IV TESTING FOR THERMAL PROPERTIES 12

Thermal Properties Melt flow index : Heat deflection temperature – Vicat softening temperature – Marten's Heat resistance test–Brittleness temperature – Specific Heat – Glass transition temperature – Thermal conductivity–Co-efficient of thermal expansion – Shrinkage – Thermal stability – Flammability.

UNIT V TESTING FOR CHEMICAL AND WEATHER RESISTANCE 12

Permanence Properties and Product Testing Water absorption: Chemical Resistance – UV resistance–Ozone resistance – weathering resistance – salt spray and straining resistance – Irradiation effects–Microbiological attack. Testing of pipes and fittings–films and sheets – container – Foam–Laminates and FRP based products–Failure Analysis.

TOTAL: 60 PERIODS

OUTCOMES:

Students will be able to

- Identify the plastic materials for some specified applications based on its property
- Assess the plastics materials for their chemical, mechanical, electrical, optical, thermal, and permanence properties as per the standard.
- Understand the basic principle of polymer testing machines.
- Identify the plastic materials by reverse engineering for some specified applications with the knowledge of testing.
- Control the quality of plastics products by testing.

REFERENCES :

1. Vishu Shah, Hand Book of Plastics Testing Technology, John Wiley & Sons Inc. New York
2. R.P.Brown, Hand Book of Plastics Test Methods, George Godwin Ltd., London, 1981.
3. J.S.Anand, K.Ramamurthy, K.Palanivelu how to identify Plastics by Simple Methods.
4. G.C.Lves, J.A.Mead, M.M.Riley, Hand Book of Plastics Test Methods, The Plastics Institute,
5. Frank T.Traceski, Specifications & Standards for Plastics & Composites, ASM International, Metals Park, OH, 1990.

MAPPING OF CO'S WITH PO'S

Course outcome Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PO1 0	PO11	PO1 2
CO1	2	2	1	2	2	1	1	1	---	1	---	1
CO2	2	2	1	2	2	2	2	1	---	1	---	2
CO3	2	3	1	3	2	1	2	1	---	1	---	3
CO4	3	2	1	2	3	1	2	1	---	1	---	1
CO5	2	1	2	1	2	1	2	1	---	3	1	2
AVg.	2	2	1.2	2	2.2	1.2	1.8	1	---	1.4	0.2	1.8

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

PA4202 POLYMER COMPOSITES L T P C
4 0 0 4

OBJECTIVES:

- To impart knowledge of various types of composites and its advantages and needs.
- To understand the knowledge of various resins materials used in processing of composites
- To make the student understand the various types of fiber materials and its applications for making Composites.
- To acquire knowledge about various processing methods of composites
- To enable the students understand the basic destructive and non-destructive testing of composites

UNIT I MATRIX AND REINFORCEMENT MATERIALS 12

Introduction–Resins for composites – polyester resins, epoxy resin, phenolic Resins, vinyl ester resins, alkyd resins. Reinforcements for composites–Natural fibers, jute, sisal, synthetic fibers, glass Fibers, carbon fibers, graphite fibers, polyethylene fibers, silicon carbide and boron fibers.

UNIT II ADDITIVES FOR COMPOSITES 12

Additives for composites, catalysts, room temperature and elevated temperature, accelerators, coupling agents, fillers, flame retardants, toughening agents, UV, stabilizers.

UNIT III MECHANICAL PROPERTIES OF COMPOSITES 12

Theory of composite materials - calculation of composite properties- mechanism of load transfer, minimum and critical fibre content, critical fibre length- Rule of mixtures–Halpin -Tsai - equation.

UNIT IV PROCESSING OF COMPOSITES 12

Processing of composites–Important processes like hand lay-up, spray-up, resin transfer moulding, vacuum bag, pressure bag moulding, centrifugal casting, pultrusion, filament winding, moulding compounds–SMC, DMC, BMC.

UNIT V TESTING OF COMPOSITES 12

Testing Quality control & end use of plastics–Testing for mechanical, electrical, thermal, optical and chemical properties, Determination of shelf life and gel time–Non-destructive testing methods. Application of FRP products - in marine, chemical, railways, electrical and electronic industry, space structures–Robotics.

TOTAL: 60 PERIODS

OUTCOMES:

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

- Acquire knowledge of various types of composites and their advantages and needs.
- Familiarize with resins used in the FRP system
- Know various types of fibers and their applications in making composite products.
- Acquire knowledge of various processing operations for composites
- Gain knowledge of the basic destructive and non-destructive testing of composites

REFERENCES

1. Mallick, Pankaj K., ed. *Composites engineering handbook*. CRC Press, 1997.
2. Hollaway, L. C., ed. *Handbook of polymer composites for engineers*. Woodhead publishing, 1994.
3. Åström, B. Tomas. *Manufacturing of polymer composites*. Routledge, 2018.
4. Barbero, Ever J. *Introduction to composite materials design*. CRC press, 2010.
5. Clyne, Trevor William, and Derek Hull. *An introduction to composite materials*. Cambridge university press, 2019.

MAPPING OF CO'S WITH PO'S

Course outcome Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PO1 0	PO11	PO1 2
CO1	3	2	2	2	1	2	2	1	---	1	1	2
CO2	2	2	1	2	2	2	2	1	---	1	1	2
CO3	2	2	3	2	2	2	2	1	---	1	1	2
CO4	2	3	1	2	3	2	2	1	2	2	2	2
CO5	2	2	2	2	3	2	2	1	2	2	2	2
AVg.	2.2	2.2	1.8	2	2.2	2	2	1	0.8	1.4	1.4	2

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

PA4203 PLASTIC RECYCLING TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To emphasize the fundamentals and importance of plastics recycling.
- To know various sources of plastics waste generation
- To know recycling codes of commodity and engineering plastics.
- To impart the knowledge on various sorting and separation techniques.
- To highlight recycling procedures for commodity and engineering plastics.
- To familiarize rubber recycling procedures.

UNIT I FUNDAMENTALS OF PLASTICS RECYCLING 9

Need for recycling –Source of Plastic waste–depolymerization-Thermal depolymerization- Ceiling temperature and its importance–Degradation–Biodegradation, Primary, Secondary and Tertiary recycling.

UNIT II RECYCLING OPERATIONS 9

Sorting and separation techniques–Density based–Optical sorting–Electrostatic sorting –Sorting by

melting temperature–Sorting by selective dissolution-sorting of metal contaminants, size reduction-cutting–Densification–Pulverization–Chemical methods, melt filtration of contamination in recycled plastics–screen changers–filtration requirements of different recycled plastics-Pyrolysis.

UNIT III RECYCLING OF MATERIALS- I 9

Recycling of PET–PET separation–Melt reprocessing–Chemical reprocessing–Energy recovery–application. HDPE recycling–Application of HDPE recyclate–LDPE recycling–Application of LDPE recycle LDPE–film recycling–Polypropylene recycling–Application of recycled PP–Recycling of polystyrene-Application of Recycled EPS. Nylon recycling–Chemical recycling – Mechanical recycling–applications Depolymerization of PMMA.

UNIT IV RECYCLING OF MATERIALS- II 9

Recycling of Engineering Thermoplastics–PC–ABS Mechanical and chemical recycling of polyacetals–Uses, recycling of polyurethanes–Physical methods–Chemical methods, Feedstock recycling and energy recovery. Recycling of Thermoset composites–grinding of SMC – selective chemical degradation of SMC scrap–solvent recycling – pyrolysis – Energy recovery from SMC scrap – Recycling of thermoplastics composites. Recycling of PVC - Separation techniques for PVC and PET–size reduction–melt filtration – Mechanical recycling–chemical recycling – Energy recovery–applications. Feedstock Recycling – Pyrolysis–kiln / Retort – Fluidized bed–application–Hydrogenation of plastics waste–Gasification–different gasification process – economic aspects – Incineration of plastic waste with energy recovery.

UNIT V RUBBER RECYCLING 9

Tyre size reduction–Application of ground Rubber crumb–Filler–Bound Rubber products–Thermoplastics binder–Civil engineering applications–Surface treated crumb rubber– applications–Rubber reclaiming and devulcanization scrap rubber and fuel source (Tyre derived fuel TDF)–Pyrolysis.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Understand the impact of plastic waste on the environment.
- Sort and separate mixed plastics.
- Apply the principles of various methods of recycling and relate the methods to various polymeric materials.
- Understand the need for recycling and the classification of recycling methods.
- Recycle domestic and engineering thermoplastics.
- Acquire knowledge of various techniques for rubber recycling

REFERENCES

1. Ann Christine Albertson and Samuel J Huang, Degradable Polymers, Recycling And Plastics, Marcel Dekker Inc, 1995.
2. Gerald D Andrews and Pallatheri M Subramanian, Emerging Technologies in Plastics Recycling, ACS Symposium Series, 513, 1992.
3. John Scheirs, Polymer Recycling Science, Technology and Applications, John Wiley & Sons, 1998.
4. Mustafa.N. Plastics Waste Management Disposal Recycling and Reuse, Marcel DekkerInc, 1993.
5. Randall Curlec, T. and Sujit Das, Plastics Wastes: Management Control, Recycling and Disposal, US Environmental Protection Agency, Noyes Data Corporation, 1991.

MAPPING OF CO'S WITH PO'S

Course outcome Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PO1 0	PO11	PO1 2
CO1	2	3	2	2	2	2	3	2	----	2	----	3
CO2	2	3	2	2	3	2	3	2	2	2	1	2
CO3	2	2	2	2	1	2	3	2	1	2	---	3
CO4	2	2	2	2	1	2	3	2	---	2	1	3
CO5	2	2	2	3	2	2	3	2	1	2	1	2
CO6	2	2	2	3	2	2	3	2	1	2	1	2
AVg.	2	2.3	2	2.3	1.8	2	3	2	0.83	2	0.6	2.5

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

PA4204 PLASTICS PRODUCT AND MOULD DESIGN L T P C
4 0 0 4

OBJECTIVES:

- To understand basic concepts of product design
- To learn the design concepts for various mould elements.
- To acquire knowledge about various moulds for different processing techniques
- To learn the basic design aspects related to Injection Mould, Compression Mould, Transfer Mould, Blow Mould.
- To learn the basic design aspects related to extrusion dies

UNIT I PRODUCT DESIGN 12

Principles & Methodical approach for Product Design – Product Design Appraisal- Tooling Aspects on Product Design – Cost Analysis for Product Design. Features: Geometry Features- Wall thickness, Taper & Draft, Radii, Fillets, Ribs, Bosses Holes, Undercuts –External & Internal- Moulded threads- Inserts - Shrinkage- Assembly Features - Fits &Tolerances - Snap Fits - Hinges – Types -Design of Integral hinges - Welding - Bonding. Structural Elements: Design of Tension bars, Columns, Beams, Pipes, Plates and Shells- Design of Joints – Bolted joints and bonded joints- Design of plastics under Static load & dynamic load Design of plastic Gears, Bearings, springs.

UNIT II INJECTION MOULD DESIGN 12

Introduction–Elements of Injection Mould - Factors considered for Mould Design- -Shot Capacity Plasticising Rate -Clamping Force- Injection Time – Cooling Time - Number of Cavities –Layout of Cavities. Design of Injection mould systems–Parting surface and its types - Core–Cavity – Bolster construction methods for core & cavity-Guide pillar- Guide bush - Sprue bush - Locating Ring Standard Mould System – Mould alignment – Mould Assembly – Mould Clamping. Feed System: Sprue – types of sprue – Runner – types of runner - cross section and size of runner –runner layout – balancing of runners – Gates - Gate location and balancing - types of gates – Mould Venting.

UNIT III EJECTION & COOLING SYSTEM DESIGN 12

Ejection System: Requirements – Elements of Ejection system - Ejector grid, Ejector plate assembly, Ejection techniques – Ejection from fixed half - Sprue Pullers- Ejection Force Calculation - Ejection Assembly Actuation. Mould Temperature Control System: Introduction -Heat Transfer Fluids- Chillers- Temperature Controllers - Factors Affecting the Cooling Cycle -Cooling Efficiency - Mould Cooling Variables -Cooling Calculations -Cooling of Integer type mould plates - Cooling of Insert Bolster assembly -cooling of other mould parts- connections of cooling channels and seals. Types of Injection

Moulds: Cold Runner – Hot Runner – Hand – Semi Automatic – Automatic Two plate - Three Plate – Moulds for Internal & External Undercuts.

UNIT IV DESIGN OF COMPRESSION & TRANSFER MOULD 12

Compression Mould Design: Introduction -Types - Open flash, Semi-positive, Positive moulds Bulk factor - Design of loading chambers and Pressure pad - Calculations of Flash thickness, Projected area, Compression Pressure, Clamping Force, No. of impressions- Design of heating system - Advantages , Disadvantages and Applications Compression Mould. Transfer Mould Design: Introduction -Types – Design of Pot and Plunger - Calculations of Projected area, Transfer Pressure, clamping force - Design of Pressure pad and Feed system-Advantages, Disadvantages and Applications of Transfer Mould

UNIT V DESIGN OF OTHER MOULDS & DIES 12

Blow Mould Design: Introduction-Types of blow moulds-Blow ratio - Parison design–Pinch off design - parting line-mould cooling-mould alignment. Rotational Mould Design: Introduction – Construction-Advantages, Disadvantages and Applications. Extrusion Die Design: Principles of extrusion - construction of die - die geometry - die swell–die land design - sizing die -Advantages, Disadvantages and Applications.

TOTAL: 60 PERIODS

OUTCOMES:

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

- Understand the basics of plastics product design.
- Understand the basics of plastics mould design.
- Acquire knowledge about various moulds for different processing techniques.
- Apply the basic design aspects related to Injection Mould, Compression Mould, Transfer Mould, Blow Mould
- Apply the basic design aspects related to extrusion dies

REFERENCES

1. Robert A. Malloy, “Plastic Part Design for Injection Moulding”, Hanser Publishers, Munich Vienna, New York, 1994.
2. Peter Jones, the Mould Design Guide, Smithers Rapra Technology Limited, Shawbury, Shrewsbury, Shropshire, SY4 4NR, UK, 2008,
3. Belofsky, H, “Plastics Product Design and Processing Engineering, Hanser Publishers, Munich Vienna New York, 1994.
4. Dym J.B Injection Mould & Moulding A practical manual, Springer, 2nd ed. XVIII, 396P, 1987.
5. Nayak, Sanjay K, Pratap C. Padhi, and Y Hidayathullah. *Fundamentals of Plastics Mould Design*. New Delhi: Tata McGraw Hill Education, 2012.
6. Glanvill, Alan B, and E N. Denton. *Injection-mould Design Fundamentals*. New York: Industrial Press, 1965.
7. Unger, Peter. *Gastrow Injection Molds: 130 Proven Designs*. Munich: Hanser, 2006.
8. R.D. Beck “Plastics Product Design”, Van Nostr and Reinhold, New York,1980

MAPPING OF CO’S WITH PO’S

Course outcome Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PO1 0	PO11	PO1 2
CO1	3	2	2	2	2	2	2	1	---	1	1	2
CO2	3	2	2	2	2	1	2	1	---	1	1	2
CO3	2	2	2	3	2	1	1	1	---	1	1	2
CO4	1	2	2	2	2	1	1	1	1	1	1	2
CO5	1	2	2	2	2	1	1	1	1	1	1	2
AVg.	2	2	2	2.2	2	1.2	1.4	1	0.4	1	1	2

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

PA4205 ADDITIVE MANUFACTURING LT 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 of additive manufacturing process.
- To acquire knowledge about various additive manufacturing processes
- To learn the application of additive manufacturing in mould development
- To understand the important research challenges associated with AM and its data processing Tools

UNIT I INTRODUCTION TO ADDITIVE MANUFACTURING 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: Liquid polymer system, molten material systems, discrete particle system, solid sheet system.

UNIT II TYPES OF ADDITIVE MANUFACTURING – I 9

Stereolithography Apparatus (SLA) - Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, Advantages, limitations and applications; Solid Ground Curing (SGC): Principle, process, Advantages, limitation, and applications; Fused deposition Modeling (FDM): Principle, details of processes Advantages, limitation, and applications; Laminated Object Manufacturing (LOM): Principles, details of processes, products, materials, advantages, limitations and applications;

UNIT III TYPES OF ADDITIVE MANUFACTURING –II 9

Selective Laser Sintering (SLS) - Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications; Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications. Other Additive Manufacturing Systems: Shape Deposition Manufacturing (SDM), Ballistic Particle Manufacturing (BPM), Selective Laser Melting, Electron Beam Melting;

UNIT IV DESIGN FOR ADDITIVE MANUFACTURING 9

Design for AM: Motivation, DFMA concepts and objectives, AM unique capabilities, exploringdesign freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers etc;

UNIT V APPLICATIONS OF ADDITIVE MANUFACTURING 9

AM Applications: 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; Post processing of AM parts: Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Develop knowledge about the fundamentals of Additive Manufacturing
- Choose a suitable Additive Manufacturing (AM) method.

- Learn about a variety of Additive Manufacturing (AM) technologies, their potential to support design and manufacturing
- Understand the application of additive manufacturing in mold development
- Face the research challenges associated with AM and its data processing tools

REFERENCES

1. Gebhardt, Andreas. "Rapid Prototyping–Rapid Tooling–Rapid Manufacturing." *Carl Hanser, München* (2007).
2. Chua, C.K., Leong K.F. and Lim C.S., “Rapid prototyping: Principles and applications”, second edition, World Scientific Publishers, 2010
3. Gibson, I., Rosen, D.W. and Stucker, B., “Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010
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MAPPING OF CO’S WITH PO’S

Course outcome Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PO1 0	PO11	PO1 2
CO1	3	2	1	1	2	1	1	1	---	2	---	2
CO2	2	3	1	1	2	1	1	1	1	---	1	2
CO3	3	2	2	1	2	1	1	1	---	2	1	2
CO4	1	2	1	1	2	1	1	1	---	2	1	2
CO5	1	2	1	1	2	2	1	1	1	---	1	2
AVg.	2	2.2	1.2	1	2	1.2	1	1	0.4	1.2	0.8	2

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

PA4211 PLASTICS TESTING LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- To train the students in testing of plastics for properties. The various testing methods of plastics materials as per the ASTM standards.
- To prepare sheet specimens by Contour cutting & Punching
- To learn about the compounding of plastics materials
- To get practice in testing the Physico-mechanical properties of plastic materials.
- To understand the various testing done on different plastics products.

LIST OF EXPERIMENTS

1. Specimen Preparation: Specimen preparation using injection moulding machine – Compression moulding machine – Two roll mill and Contour cutter.
2. Physio-Mechanical properties of plastics : Tensile strength – Flexural strength – Compression strength –Tear strength - Impact strength – Hardness
3. Compounding, Blending using Two Roll Mill and Specimen
4. Determinations of Carbon Black Content
5. Determination of environmental stress cracking resistance for olefins
6. Testing of HDPE/RPVC Pipes
7. Testing of Water Storage Tanks/Containers
8. Testing of Films/Sheets
9. Testing of HDPE/PP Woven Sacks/Tapes
10. Testing of Bottles/Vanaspati, Ghee, Milk Packing

TOTAL: 60 PERIODS

LABORATORY REQUIREMENTS

1. Carbon black content tester - 1 No.
2. Environmental stress cracking resistance tester - 1 No.
3. Specimen Preparation Laboratory
4. Injection moulding machine - 1 No.
5. Compression moulding machine - 1 Nos.
6. Two roll mill - 1 No.
7. Contour cutter - 1 No.
8. Scrap grinder - 1 No.
9. Blender - 1 No.
10. Universal testing machine - 1 Nos.
11. Tear strength tester - 1 No.
12. Impact strength tester - 1 Nos.
13. Shore A – Hardness tester - 1 No.
14. Shore D – Hardness tester - 1 No.
15. Rockwell Hardness tester - 1 No.
16. Abrasion resistance tester - 1 No.
17. Folding endurance tester - 1 No.
18. Burst strength tester - 1 No.
19. Humidity chamber - 1 No.
20. Gas permeability tester - 1 No.
21. Sieve analysis apparatus - 1 No.
22. Volume and Surface resistivity-1 No
23. Dielectric strength-1 No
24. Arc Resistance-1 No
25. Haze meter-1 No

OUTCOMES:

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

- Prepare specimen by injection moulding and contour cutting
- Gain knowledge about compounding of plastics with additives
- Learn how the plastics materials are tested for its mechanical, electrical, optical, properties.
- Practice on testing of various plastic products

REFERENCES

1. ASTM test standards for plastics Vol.8.01 to 8.04, 9.01 & 9.02, 2002.
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4. Vishu Shah, Handbook of Plastics Testing Technology, John Wiley & Sons. Inc.New York, 1998.
5. R.P. Brown, Handbook of Plastics Test Methods, George Godwin Ltd., London, 1981.

MAPPING OF CO'S WITH PO'S

Course outcome Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	3	1	3	2	1	1	2	1	1	3
CO2	3	3	3	2	3	2	2	1	2	2	1	3
CO3	3	3	3	3	3	2	2	2	2	2	1	3
CO4	3	3	3	3	3	3	2	2	2	2	2	3
CO5												
AVg.	3	2.5	3	2.25	3	2.25	1.75	1.5	2	1.75	1.25	3

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

PA4212 **PRODUCT DESIGN LABORATORY** **L T P C**
0 0 4 2

OBJECTIVES:

- To learn the use of Computer Aided Design in Plastic products and mould designing.
- To analysis the flow behavior and temperature control of plastics materials while processing using mold flow software.

LIST OF EXPERIMENTS

I. Plastics Product Design using CAD

1. 2D and 3D modeling using CAD.
2. Product drawing practice.

II. Mold Design using CAD/CAM

3. Design of two plates Injection Mould.
4. Design of three plate Injection Mould
5. Design of split type Injection Mould.
6. Design of Compression Mould.
7. Design of Blow Mould.
8. Design of Extrusion Die.
9. Design for Industrial Components.

III. Mold flow Analysis using CAE

10. Optimization of Mould design and Process parameters using Mold flow Software

TOTAL: 60 PERIODS

OUTCOMES:

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

- Design and develop the Plastic products and moulds using CAD/ CAM/CAE software.
- Design and develop extrusion dies
- Predict the flow behavior and temperature control of the materials in the designed mould.

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. LaszcoSors and ImreBlazs, 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

MAPPING OF CO’S WITH PO’S

Course outcome Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PO1 0	PO11	PO1 2
CO1	3	3	3	3	3	1	1	2	2	2	1	3
CO2	3	3	3	3	3	1	1	2	2	2	1	3
CO3	3	3	3	3	3	1	1	2	2	2	1	3
CO4												
CO5												
AVg.	3	3	3	3	3	1	1	2	2	2	1	3

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

PA4311 **PROJECT WORK I** **L T P C**
0 0 12 6

OBJECTIVES

The course aims to enable the students to

- identify the problem/process relevant to their field of interest that can be carried out
- search databases and journals to collect and analyze relevant data
- plan, learn and perform experiments to find the solution
- prepare project report

TOTAL : 180 PERIODS

Individual students will identify a problem relevant to his/her field of study, collect and analyze literature, design, and carryout experiment, collect data, interpret the result and prepare the project report.

OUTCOMES:

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

CO1 Identify the research/industrial problems
CO2 Collect and analyze the relevant literature
CO3 Design, conduct experiment and analyse the data
CO4 Prepare project report

PA4411 **PROJECT WORK II** **L T P C**
0 0 24 12

OBJECTIVES

The course aims to

- train students to analyze the problem/ think innovatively to develop new methods/product /process
- make them understand how to find solutions/ create products economically and in an environmentally sustainable way
- enable them to acquire technical and experimental skills to conduct experiment, analyze the results and prepare project report
- enable them to effectively think about strategies to commercialize the product .

TOTAL : 360 PERIODS

Individual students will identify a problem relevant to his/her field of study, collect and analyze literature, design, and carryout experiment, collect data, interpret the result and prepare the project report.

COURSE OUTCOMES

At the end of the project the student will be able to

CO1 Formulate and analyze problems for developing new methods/solutions/processes.
CO2 Plan and conduct experiments to find solutions in a logical manner
CO3 Analyze the results, interpret and prepare project report/know the strategies for commercialization

PA4001 RHEOLOGY IN POLYMER PROCESSING LT P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the conformational property of polymer chain using different models.
- To study the chain conformation in polymer solution and melt based on thermodynamics.
- To introduce fundamental flow properties and methods used to investigate the flow behaviour under stress.
- To understand the flow behaviour in different processing methods.
- To understand the concept of melt rheology & rheometry

UNIT I MOLECULAR CONFORMATION AND CONFIGURATION 9

Potential and conformational energy of molecules-polymer conformation and configuration–isomerism in polymers- stereo isomerism, geometrical isomerism, sequential isomerism. Conformation of an ideal chain-mean square end to end distance-freely jointed and freely rotating chain model, worm like chain model, hindered rotation model. Radius of gyration of an ideal chain. Real chain- excluded volume, Flory theory of polymer in a solvent, deforming real and ideal chains.

UNIT II ELASTICITY 9

Thermoelasticity-Thermodynamics of rubbers–Flory construction- entropic and energetic contributions to the elastic force in rubbers–unentangled rubber elasticity-Affine network model- Phantom network model-entangled rubber elasticity-Edwards tube model-Mooney-Rivlin model

UNIT III SOLUTION PROPERTIES 9

Polymer solutions-theta condition-Thermodynamic view of miscibility-upper critical solution temperature (UCST)-lower critical solution temperature (LCST)-Concentration regimes in polymer solutions Viscoelasticity-elastic deformation-irrecoverable deformation-models of viscoelasticity-Voigt-kelvin-Maxwell-Burger models-WLF equation-TTS curve-Boltzman superposition principle, stress relaxation-creep and creep recovery-

UNIT IV FLOW BEHAVIOUR 9

Basics of rheology- shear stress-shear strain-strain rate-different types of fluids-Newtonian and Non-Newtonian fluids- flow behaviour of different Non- Newtonian fluids-zero shear viscosity steady shear and oscillatory shear experiments. Methods to measure flow properties-capillary rheometer-parallel plate rheometer-cone and plate rheometer-Cup and cone viscometer. Measurement of normal stresses. Theories of viscosities of dilute and concentrated Solutions.

UNIT V MELT RHEOLOGY AND RHEOMETRY 9

Rheology of dilute and concentrated suspensions, Flow behaviour of polymer melts during Injection moulding-Extrusion: Film extrusion, Sheet extrusion and Blow mouldings. Bubble inflation rheometer, compression rheometer, stress relaxation instruments. Torque rheometers, rotational & sliding surface rheometers and their use in determining processability.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Know the conformational change of polymer chains in solution and melt

CO2 Analyze the various thermoelasticity properties & thermodynamics process

CO3 Relate the polymer rheology to properties of polymeric materials and processing

CO4 Understand and measure the basic flow properties of polymers.

CO5 Apply the concept of rheology & rheometry for industrial application.

REFERENCES:

1. Elements of Physical Chemistry: S. Glasstone and D. Lewis, Macmillan India Press, Madras, 1995.
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MAPPING OF CO'S WITH PO'S

Course outcome Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	2	1	--	1	1	--	1	1	1	2
CO2	1	1	1	2	1	1	1	--	1	1	1	2
CO3	1	1	1	2	1	1	1	--	1	1	1	2
CO4	1	1	1	2	1	1	1	--	1	1	1	2
CO5	2	1	2	2	1	2	1	--	1	2	1	2
AVg.	1.2	1	1.4	1.8	1	1.2	1		1	1.2	1	2

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

PA4002 PLASTICS PACKAGING L T P C
3 0 0 3

COURSE 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 PLASTICS MATERIALS FOR PACKAGING 9

Introduction to Packaging – Functions of packaging –Properties and Applications of major packaging materials viz. Polyolefins, Polystyrene, Polyvinyl Chloride, Polyesters, Polyamides (Nylons), Polycarbonate and Newer materials such as High Nitrile polymers, Polyethylene Naphthalate (PEN), Polyetherimide (PEI) and LCP.

UNIT II PROCESSING OF PACKAGING MATERIALS 9

Adhesives, heat sealing types, sealing method, extrusion blown film and cast film and sheet co extrusion, surface treatment testing and evaluation of films, flexible packaging, pouches, bulk and heavy duty bags, thermoforming, thin sheet thermoforming, blow moulding, extrusion and injection blow moulding, foams, cushioning and distribution packaging.

UNIT III BIO BASED PACKAGING MATERIALS 9

Edible and bio-based food packaging materials, Edible film and coating, Polysaccharide based coatings, Lipid based coatings, Protein based coating, First, Second and Third bio-based packaging materials. Permeability of thermoplastic polymers, Multilayer films, Processing, Deteriorative reaction in foods, Enzyme reactions, Chemical reactions, Physical change, Biological change, shelf life of foods, Factors controlling shelf life.

UNIT IV APPLICATIONS OF PACKAGING 9

Aseptic packaging of foods, Sterilization of packaging materials, Packaging of microwavable foods, Active and intelligent packaging, Modified atmospheric packaging, Packaging of fresh foods, Packaging of horticultural products. Packaging of dairy products, Packaging of cereal, snack foods and confectionery, Packaging of beverages, Comparison of polymer packaging with paper, metal and glass materials, printing processes, Safety and legislative aspect of packaging.

UNIT V TESTING OF PACKAGING MATERIALS 9

Mechanical properties–Tensile properties, Impact properties, Tear strength, Burst strength, Stiffness, Crease or flex resistance, Co-efficient of friction, Blocking, Orientation and shrinkage. Optical Properties–Clarity, Haze and gloss Barrier Properties–Oxygen transmission, Water vapour transmission rate – Migration.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Gain knowledge on the plastic packaging process and materials.
CO2 Familiarize with the testing of plastic packaging.
CO3 Attain knowledge of Biobased packaging
CO4 Understand the concepts of plastics materials used in packaging industries
CO5 Understand the machinery used in packaging field and testing equipments used for packaging products.

REFERENCES:

1. Gordon L. Robertson, Food Packaging Principles and Practice, Marcel Dekker, Inc., New York 1993.
2. Louis T. Manzione, Plastic Packaging of Microelectronic Devices, Van Nostrand Reinhold, New York, 1990
3. Plastics films -Technology and packaging applications-Kenton R, Osborn, Wilmer A Jenkins, Institute of Packaging professionals, CRC Press.2019.
4. Understanding Plastics Packaging Technology (Hanser Understanding Books) , Hanser; First edition (September 1, 1997).
5. Plastic Films in Food Packaging, 1st Edition-Materials, Technology and Applications-SinaEbnesajjad, Elsevier, December 2012,

MAPPING OF CO'S WITH PO'S

Course outcome Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PO1 0	PO11	PO1 2
CO1	1	1	2	2	1	2	2	--	1	1	1	2
CO2	2	1	2	2	1	1	1	--	1	1	1	2
CO3	2	1	2	2	1	1	1	--	1	1	1	2
CO4	2	1	2	2	1	1	1	--	1	1	1	2
CO5	2	2	2	1	1	1	1	--	2	2	2	2
AVg.	1.8	1.2	2	1.8	1	1.2	1.2	1.2	1.2	1.2	=1.2	2

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

PA4003 **ADDITIVES AND COMPOUNDING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To know about various additives like Lubricants, Fillers, Fibres, flame retardants, colourants, anti-oxidants, UV-stabilizers, plasticizers, anti-blocking agents, Nucleating agents, Flow promoters, Anti static agents etc.
- To understand the functions of each of these additives, technical requirements, types & mechanism, and their effective evaluation are dealt with in this subject.
- To select suitable plastics material compounding and mixing techniques like two roll milling, internal blender, single / twin screw extruder, etc.
- To understand the mechanism of degradation of polymers and stabilizing additives.
- To know the various compounding methodologies for plastics materials and learn the maintenance of compounding machinery.

UNIT I INTRODUCTION TO ADDITIVES 9

Introduction-Chemistry and Mechanism- Selection Criteria-Selection of Polymers and Compounding ingredients-General objectives-possibilities and limitations of mixing and compounding. General effect on Properties-Evaluation and functions of additives.

UNIT II ADDITIVES 9

Fillers and Reinforcement– Antioxidants-Thermal Stabilisers, Ultraviolet stabilizer– Impact Modifiers/ toughening agents. Colourants-Fire retardants-Coupling agents-blowingagents Plasticizers- Antistatic agents-Anti blocking agents-Slip and antislip agents-processing aids - Lubricants- mould releasing agents Additives for recycling.

UNIT III COMPOUNDING EQUIPMENTS 9

Methods of incorporation of additives into polymer materials. Mixing and mixing equipment's. Principles- Operating characteristics- Machine construction-Specifications -Process control systems and working details of Batch mixers and continuous mixers–High speed mixer -Two roll mill-Banbury Mixer–Ribbon blender – Planetary mixers-Single Screw extruder-Twin Screw extruder.

UNIT IV FORMULATIONS AND TECHNIQUES 9

Compounding of PVC, Rubber, Polyolefins, Biodegradable plastics, Engineering plastics. Alloys and blend production - color, filler, reinforcement compounding. Reactive extrusion.

UNIT V END USE MARKET FOR PLASTICS 9

Case studies on material suitability (e.g., Plastic Gears, Feeding Bottle, Bowels for microwave ovens). Survey and uses of plastics with reasons for their importance in major industries like Agriculture, Packaging, Building, Transport, Electrical, Electronics and Telecommunications, Medical and Furniture.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the fundamental of additives
CO2 Select the suitable additive as per requirement.
CO3 Identify the suitable compounding techniques to make different grades of Plastics compounds
CO4 Formulate the compound to solve the environmental related problems**.**
CO5 Learn about various applications of Plastics by using different additives.

REFERENCES:

1. Muralisrinivasan, Natamai S. Introduction to Polymer Compounding, Volume 2: Machinery and Technology. , 2015.
2. Murphy, John. Additives for Plastics Handbook. Elsevier Advanced Technology, 2003.

3. Enrique Saldívar-Guerra and Eduardo Vivaldo-Lima,Polymer Additives,2013
4. Zweifel,H.,Maier,R.,Schiller,M.Plastics Additives Handbook,2009
5. Plastics Additives- Geoffrey Pritchard, Springer-1998.

MAPPING OF CO'S WITH PO'S

Course outcome Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	1	1	1	--	1	1	1	2
CO2	2	2	1	1	1	1	2	--	1	1	2	2
CO3	2	1	1	1	1	1	1	--	1	1	2	2
CO4	2	2	1	1	1	1	2	--	1	1	2	2
CO5	2	1	2	2	1	1	1	--	1	1	1	2
AVg.	2	1.4	1.4	1.2	1	1	1.4	--	1	1	1.6	2

PA4004 POLYMER NANOCOMPOSITES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the basics and chemistry of nano size materials. and their
- Explain the different nano material synthesis, characterization.
- To study different manufacturing techniques of dispersion of nano particles such as sonication, high shear mixing, centrifugal mixer, twin-screw extrusion.
- To study different manufacturing techniques to produce real-life component.
- To learn about the flow behavior of nanofiller/polymer systems and their processing and applications.

UNIT I INTRODUCTION TO NANOMATERIALS 9

Nanomaterials, Uniqueness of nanomaterials, classification of nanomaterials based on dimension (0D,1D, 2D, 3D), different types of nanomaterials: carbon based materials (carbon nanotubes, Carbon Nanofibers, fullerenes), metal based materials (quantum dots, nanogold, nanosilver, nanoaluminium oxide, nano titanium oxide) dendrimers, inorganic nanomaterials (Montmorillonitenanoclays,, POSS [polyhedral oligomericsilsesquioxane], Nanosilica) -properties. Polymer Matrices: Thermoplastic based nanocomposites, Thermoset based nanocomposites, Elastomer based nanocomposites, ceramic matrix nanocomposites

UNIT II NANOMATERIAL SYNTHESIS AND CHARACTERIZATION 9

Preparation, Characterization of and functionalization of various nanomaterials such as C60, Carbon nanofiber, Carbon Nanotube, Graphene and Cellulose nanofibers. Characteristics of Polymer nanostructures materials. Processing of nanoparticles, binding mechanisms in nanoparticles, dispersion of nanoparticles, and stabilization of nanoparticles.

UNIT III PREPARATION OF POLYMER NANOCOMPOSITES 9

Processing and fabrication of polymer nanocomposites, Melt blending, solvent casting, In-situ polymerization, solution polymerization, template synthesis, high shear mixing. Homogeneous/heterogeneous nucleation, plasma promoted nucleation. Polymer nanocomposites with structural, gas barrier and flame retardant properties, carbon fibre reinforced polymer nanocomposites, elastomer and thermoplastic elastomer nanocomposites

UNIT IV CHARACTERIZATION OF POLYMER NANOCOMPOSITES 9

Mechanical properties, X-ray diffraction, Small angle X-ray Scattering, Optical Microscopy, Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM), TEM and EDAX analysis, Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM). Electrical properties of polymer nanocomposites. Thermal properties of polymer nanocomposites by using DTA, TGA, DSC.

UNIT V APPLICATION OF POLYMER NANOCOMPOSITES 9

High temperature applications: fire retardant, flame retardant nanocomposite applications, Thermoset nanocomposites for rocket ablative materials, nanomodified carbon-carbon composites, Nanocomposites for carbon fiber reinforced polymer matrix composites, Thermoplastic Elastomer nanocomposites for propulsion systems. Biomedical implants, tissue engineering scaffolds, EMI shielding application,

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Have a clear understanding of nanocomposites.
CO2 Gain knowledge about different structures and properties of nanocomposites
CO3 Have an idea about preparation technologies and applications of nanocomposites.
CO4 Know different characterization and testing techniques and interpretation of results
CO5 Demonstrate the importance of different nano materials used to make polymer nanocomposites for specific applications.

REFERENCES:

1. Pradeep, T., 2007. Nano: the essentials: understanding nanoscience and nanotechnology. McGraw-Hill Education.
2. Ebrahimi, F. ed., 2012. Nanocomposites: new trends and developments. BoD–Books on Demand.
3. Gogotsi, Y., 2006. Nanomaterials handbook. CRC press.
4. Tsakalakos, L., 2010. Nanotechnology for photovoltaics. CRC press.
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MAPPING OF CO'S WITH PO'S

Course outcome Statement	PO1	PO2	PO 3	PO 4	PO 5	PO6	PO 7	PO8	PO9	PO1 0	PO1 1	PO1 2
CO1	2	1	2	2	1	1	1	--	1	1	1	2
CO2	2	1	1	2	1	1	1	--	1	1	1	2
CO3	2	1	1	2	1	1	1	--	1	1	2	2
CO4	2	1	1	2	1	1	1	--	1	1	2	2
CO5	2	2	2	2	1	2	1	--	1	1	2	2
AVg.	2	1.2	1.4	2	1	1.2	1	--	1	1	1.6	2

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

PA4005 SECONDARY PROCESSING OPERATIONS LT P C
3 0 0 3

OBJECTIVES:

- To know about the different secondary processing methods like calendaring, thermoforming, and rotomoulding.
- To gain knowledge about the processing of FRP laminates.

- Acquire knowledge about different types of foaming.
- To understand the various machining and joining methods for plastics products.
- To study about different coating processes

UNIT I CALENDERING, THERMOFORMING AND ROTOMOULDING 9

Calendering: Introduction–type of calendars–roll configuration–Definition of terms such as calendar bank–calendering process–process variable and application. Thermoforming: Introduction–pressure forming–vacuum forming–Techniques of vacuum forming–simple vacuum forming, drape forming, plug assisted forming, snapback vacuum forming– pressure snap-back forming-blowback forming–merits & demerits of vacuum forming – vacuum forming moulds. Pressure forms–Advantages over vacuum forming–material for thermoforming–heating systems. Matched deforming–continuous forming methods – application.

UNIT II FRP LAMINATES 9

Introduction, FRP processing methods – contact moulding – hand layup, spray up method– vacuum bag & pressure bag moulding, filament welding, centrifugal casting, pultrusion, matched die moulding – Laminates, definition of terms – high, pressure laminating process, types of machinery, impregnation systems – decorative and industrial laminates, continuous high pressure laminating process, application.

UNIT III CELLULAR PLASTICS 9

Introduction–process to create foam in resins – mechanical foaming, chemical foaming, physical foaming–processes to shape and solidify foams–low pressure foam moulding, high pressure foam moulding, RIM extrusion foaming, casting foams, steam chest moulding structural foam moulding – applications.

UNIT IV MACHINING & JOINING OF PLASTICS 9

Introduction–Importance of machining–methods viz. cutting, drilling, blending, filling, etc. Joining–principles–cohesion principle, adhesion principle–solvent cementing, Dop cementing, welding of plastics–viz. high frequency welding thermal sealing, spin welding, vibration welding, hot plate welding, ultrasonic welding, Adhesive bonding–examples: Mechanical fasteners. Other Secondary Processes: Printing, painting, hot stamping, in mould decoration, Electroplating and vacuum metallising.

UNIT V CASTING PROCESSES AND ROTATIONAL MOULDING 9

Dip casting, slush casting, continuous casting, cell casting, processes and applications. Introduction–principle–process–machinery used–materials–moulds, process parameters–merits & demerits of roto moulding. Coating Processes: Roller coating, powder coating, fluidised bed coating, electrostatic spray coating, processes and applications.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Gain knowledge of various secondary processing techniques and their importance with industrial relevance
- Select a specific processing technique as per the requirement.
- Learn different FRP processing methods and foaming methods
- Choose suitable machining and joining methods for plastic products.
- Understand different coating processes and applications

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2. Bruins, Paul F., ed. *Basic principles of rotational molding*. CRC Press, 1972.
3. Crawford, Roy James, and James L. Throne. *Rotational molding technology*. William Andrew, 2001.

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MAPPING OF CO'S WITH PO'S

Course outcome Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	3	2	2	1	---	2	---	3
CO2	2	2	1	1	3	2	2	2	1	2	2	3
CO3	2	3	2	3	2	2	2	---	1	3	---	3
CO4	2	1	1	2	3	1	1	---	---	3	1	3
CO5	2	2	2	3	3	2	2	---	1	3	---	3
AVg.	2	2	1.6	2.2	2.8	1.8	1.8	0.6	0.6	2.6	0.6	3

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

PA4006 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 aquire knowledge about various Thermoplastic elastomers and its applications
- To enable the students to learn the basic processing of rubber products like hose conveyor belts etc.
- To learn the basic processing of latex products like latex gloves, latex threads etc

UNIT I NATURAL RUBBER PRODUCTION TECHNOLOGY 9

Various sources of natural rubber, Latex-physical nature and chemical composition, biosynthetic pathway of natural rubber production, Tapping latex, Preservation of latex, Processing of Latex (Centrifuging, creaming, etc), Dry rubber production (Smoked sheet, air dried sheet, ISNR, etc.) Grading of rubbers - Modified forms of natural rubber.

UNIT II SYNTHETIC ELASTOMERS 9

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, EVA,

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 COMPOUNDING OF RUBBERS 9

Principles of rubber compounding. Compounding to meet processing and vulcanisate properties. Introduction to dry rubber and latex compounding ingredients, Sulphur vulcanization and non-sulphur vulcanization, vulcanization systems - accelerators, activators, promoters, antioxidants, antiozonants, processing aids, extenders, fillers and effect of fillers, Blowing agents, etc. Equipments used rubber processing, rubber Processability tests

UNIT V RUBBER PRODUCT MANUFACTURING 9

Manufacturing of Dry rubber Products: Tyres, Belting, Hoses, Footwear, Rubber metal bonded items, sports goods, cellular rubber. Manufacturing of Latex Products: Latex Gloves, Latex threads, Latex foam rubber, latex adhesives

TOTAL: 45 PERIODS

OUTCOMES:

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

- Acquire knowledge of natural rubber and other synthetic elastomers.
- Understand the basics of rubber compounding and vulcanization
- Comprehend various Thermoplastic elastomers and its applications
- Acquire knowledge about the rubber products manufacturing
- Understand the basics of latex products manufacturing

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MAPPING OF CO'S WITH PO'S

Course outcome Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PO1 0	PO11	PO1 2
CO1	2	2	2	1	1	1	1	---	---	2	---	3
CO2	2	3	2	3	2	2	2	1	---	2	1	3
CO3	2	3	1	2	1	1	1	---	---	2	1	3
CO4	3	2	2	3	2	2	2	1	1	1	1	3
CO5	3	2	2	3	2	2	2	1	1	1	1	3
AVg.	.4	2.4	1.8	2.4	1.6	1.6	1.6	0.6	0.4	1.6	0.8	3

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

PA4007 SCIENCE AND TECHNOLOGY OF ADVANCED COATINGS L T P C
3 0 0 3

OBJECTIVES:

- To provide theoretical basis of the process of coatings and characteristics of coatings.
- To make the students aware of the different essential components of paints and coatings.
- To introduce to the different kinds of natural and synthetic resins and their applications.
- To understand various preparation technics and characterization of surface coatings.
- To make the students familiar with the basic and recent advancements in coating technologies.

UNIT I INTRODUCTION 9

Concepts & terminologies, Interfacial tension, Free energy changes, wetting, dispersion, adhesion, Chemistry & Technology of Surfactants.

UNIT II CONCEPT OF DYES & PIGMENTS 9

Theory of Color; Important Physico-Chemical Characteristics of Pigments, Analysis & testing of pigments Inorganic Pigments; Chemistry, Properties and Applications of carbon black, metallic and metal oxide pigments, Resinated pigments, Organic Pigments, High Performance Pigments & Special Effect Pigments (IR Reflective, anticorrosive, thermo chromic, pearlescent etc), driers, additives, solvents, plasticizers.

UNIT III CHEMISTRY AND TECHNOLOGY OF RESINS 9

Natural resins like rosin, shellac, Bitumen, Asphalts and Coal tar–Their modifications & uses Chemistry and Technology of Synthetic resins viz. Alkyds, Polyester, Phenolics, Amino, Acrylic & Vinyl resins: Raw materials for these resins, Chemistry of synthesis of these resins, processing techniques, properties & applications of these resins for surface coatings.

UNIT IV MANUFACTURE OF PAINTS & POWDER COATINGS 9

Powder Coatings, dry distempers, cement paints, oil based distempers and paints, other stiff paints, putties. Marking and labeling of packaged products, Solvent emission, recovery and disposal, environmental, health and safety issues

UNIT V VARIOUS SURFACE COATINGS 9

Preparation and characteristics of Coil Coating, UV cured coating, Waterborne PU Coatings, Non Stick coatings, Smart Coatings, super hydrophobic coatings, electro wetting, Hygienic Coatings, protective coatings, marine coatings, automotive and aerospace coatings Study of important characteristics of surface coating : Rheological properties, Optical Properties, Adhesion and Mechanical properties, Corrosion and Chemical resisting properties, Film thickness, Liquid Paint analysis according to ASTM, BIS and BS Standards, Characterization of Varnishes according to ASTM, BIS and BSS Standards.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Appreciate the economical and societal importance of paints and coatings.
- Familiarize with the components used in paints and will be able to predict the properties with varying compositions of the components.
- Learn about different kinds of natural and synthetic resins and its applications
- Gain knowledge about the manufacturing techniques for paints and coatings and the advancements in coating technologies.
- Understand different characteristics of surface coatings

REFERENCES

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3. Güngör Gündüz, Chemistry, Materials, and Properties of Surface Coatings: Traditional and evolving technologies. DEStech Publications, Inc., 2016.
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MAPPING OF CO'S WITH PO'S

Course outcome Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PO1 0	PO11	PO1 2
CO1	2	2	2	2	3	2	2	1	1	2	---	3
CO2	2	3	2	1	1	2	2	1	1	2	1	3
CO3	2	2	2	1	1	2	2	1	---	1	---	3
CO4	3	3	3	3	3	1	1	1	1	2	1	3
CO5	3	3	3	3	2	1	1	2	---	2	---	2
AVg.	2.4	2.6	2.4	2	2	1.6	1.6	1.2	0.6	1.8	0.4	2.8

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

PA4008 CAD/CAM/CAE APPLICATIONS IN MOULD / DIE DESIGNS L T P C
3 0 0 3

OBJECTIVES:

- To enable the students to provide an overview of how computers are being used in Design of Plastic Component,
- Manufacturing of Tool and Analysis of mould flow.
- To study about different NC machines and its working principle
- To develop the knowledge of computer aided manufacturing.
- To understand various CAM software packages

UNIT I COMPUTER GRAPHICS 9

Output primitives (Points, lines, curves, etc.,) - 2-D and 3D Transformations Homogeneous Coordinates- Windowing, Viewing and clipping transformation
Hidden Line and Surface Removal Algorithms.

UNIT II COMPUTER AIDED DESIGN (CAD) 9

Introduction to curves- Analytical Curves- circle and conics- Synthetic Curves Bezier and B-spline curve. Surface modeling: Bezier and B-Spline surface- Bi- linear surface- Boundary Representation Sweep representation. Solid modeling: Primitives- Boolean set operations- Boundary Representation– Constructive Solid Geometry, User interface for solid modeling. Graphics Standards: Standards for computer graphics-Open Graphics Library (OpenGL) - Data exchange standards IGES, STEP, CALS etc. - Communication standards

UNIT III COMPUTER AIDED MANUFACTURING (CAM) 9

Introduction to NC machines, CNC machines, Direct Numerical Control (DNC), Advantages & Disadvantages, Working principle of CNC machines - Introduction to CAM software packages –G Codes & M Codes – Part programming for CNC Turning Centre and CNC Machining Centre.

UNIT IV FINITE ELEMENT ANALYSIS (FEA) 9

Introduction to Finite Element Analysis (FEA), Types of analysis - Procedure for finite element analysis -Finite Element Analysis packages, and its application; Analysis of One Dimensional Bar elements- Derivation of Shape function and Stiffness matrix and force vector – Assembly of matrix – Field problems.

UNIT V MOLD FLOW ANALYSIS 9

Introduction to Moldflow analysis- Design principles- Product design and Moldflow - Sequence of analysis- Moldflow concepts- Meshes used in Moldflow analysis- Types, Requirement- Geometry Creation- Importing Geometry; Shrinkages and Warpage- injection molding and shrinkage, basic cause of warpage and shrinkages ; Moldflow design procedure- Analysis steps framework, Evaluate an Initial design, optimized the design; Part defects.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Acquire knowledge of computer-aided design and manufacturing of moulds for plastics processing.
- Comprehend various CNC machining processes used in Mould manufacturing.
- Gain knowledge of computer-aided manufacturing
- Attain knowledge of various CAM software packages
- Learn about various types of analysis involved in Mould flow.

REFERENCES

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3. Ibrahim Zeid “Mastering CAD CAM” Tata McGraw-Hill Publishing Co.2007.
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MAPPING OF CO’S WITH PO’S

Course outcome Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PO1 0	PO11	PO1 2
CO1	2	3	3	3	3	1	2	1	1	2	1	3
CO2	2	2	2	2	3	1	1	1	1	2	---	3
CO3	2	2	2	2	1	1	1	1	---	2	---	3
CO4	1	2	3	3	3	1	1	1	---	2	1	3
CO5	1	3	3	3	3	1	2	1	---	2	1	3
AVg.	1.6	2.4	2.6	2.6	2.6	1	1.4	1	0.4	2	0.6	3

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

PA4009 **REVERSE ENGINEERING** **L T P C**
3 0 0 3

OBJECTIVES:

- To Understand basic engineering systems.
- To learn the students to apply the concepts of reverse engineering
- To learn about the Reverse Engineering Process and data analysis
- To learn about acceptance legality of reverse engineering.
- To Understand the terminologies related to re-engineering, forward engineering, and reverse engineering.

UNIT I INTRODUCTION **9**

Historical Background, Industrial Evolution- Reinvention of Engineering Marvels from Nature-Reverse Engineering in Modern Industries-Reverse Engineering vs. Machine Design-Motivation and Challenge-Analysis and Verification-Accreditation-Part Criticality-Applications of Reverse Engineering.

UNIT II GEOMETRICAL FORM **9**

Surface and Solid Model Reconstruction-Scanning Instruments and Technology-Principles of Imaging-Cross-Sectional Scanning-Digital Data-Computational Graphics and Modeling-Data Refinement and Exchangeability-Dimensional Measurement-Case Studies-Part Tolerance-Prototyping-Additive Prototyping Technologies-Subtractive Prototyping Processes-Rapid Injection Molding-Steps of Geometric Modeling

UNIT III MATERIAL CHARACTERISTICS AND ANALYSIS **9**

Alloy Structure Equivalency-Phase Formation and Identification-Mechanical Strength-Hardness

Part Durability and Life Limitation

Part Failure Analysis-Fatigue-Creep and Stress Rupture-Environmentally Induced Failure

UNIT IV MATERIAL IDENTIFICATION & DATA PROCESS ANALYSIS **9**

Material Specification-Composition-Determination-Microstructure Analysis-Manufacturing Process Verification

Data Process and Analysis

Statistical Analysis-Data Analysis-Reliability and the Theory of Interference-Weibull Analysis-Data Conformity and Acceptance,-Data Report

UNIT V PART PERFORMANCE AND ACCEPTANCE LEGALITY **9**

Performance Criteria-Methodology of Performance Evaluation-System Compatibility

Acceptance and Legality

Legality of Reverse Engineering-Legal Definition of Reverse Engineering-Legal Precedents on Reverse Engineering-Patent-Copyrights-Copyright Codes-Legal Precedents on Copyrights-Trade Secret-Case Study of Reverse Engineering Trade Secret-Third-Party Materials

TOTAL: 45 PERIODS

OUTCOMES:

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

- Understand the reverse engineering methodologies and apply for product development
- Determine the functional requirements and working principles of reverse engineering
- Understand the principles behind the design of the product, ways to redesign and improve the performance of the system
- Understand the legality of reverse engineering
- Gain expertise in depth analysis of the products and extraction of real time data

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MAPPING OF CO’S WITH PO’S

Course outcome Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	-	3	-	-	-	-	-	-	1
CO2	3	2	3	3	3	-	-	-	1	-	-	1
CO3	3	2	3	3	3	-	-	-	-	-	-	1
CO4	3	3	3	3	3	-	-	-	-	-	-	3
CO5	3	3	3	3	3	-	-	-	-	-	-	1
AVg.	3	2.4	3	3	3	-	-	-	1	-	-	1.4

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

PA4010 MECHANICAL BEHAVIOR OF MATERIALS L T P C
3 0 0 3

OBJECTIVES:

- To know the mechanical behavior of both metallic and non-metallic materials under different loading and temperature conditions.
- To evaluate the failure analysis and Justify the safe use of materials for engineering applications
- To gain knowledge about selection of suitable materials for different applictations & conduct cost analysis
- To understand the concepts & properties of metallic materials
- To understand the concepts & properties of non-metallic materials

UNIT I BASIC CONCEPTS OF MATERIAL BEHAVIOR 10

Elasticity in metals and polymers– Strengthening mechanisms, work hardening, solid solutioning, grain boundary strengthening, poly phase mixture, precipitation, particle, fibre and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behavior–Super plasticity–Griffith’s theory,– Ductile, brittle transition in steel – High temperature fracture, creep – Larson Miller parameter– Deformation and fracture mechanism maps.

UNIT II BEHAVIOUR UNDER DYNAMIC LOADS AND DESIGN APPROACHES 10

Stress intensity factor and fracture toughness – Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law.- Safe life, Stress life, strain-life and fail - safe design approaches -Effect of surface and metallurgical parameters on fatigue – Fracture of non metallic materials – Failure analysis, sources of failure, procedure of failure analysis.

UNIT III SELECTION OF MATERIALS 10

Motivation for selection, cost basis and service requirements–Selection for mechanical properties, strength, toughness, fatigue and creep – Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing – Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications – Computer aided materials selection**.**

UNIT IV MODERN METALLIC MATERIALS 8

Dual phase steels, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) Steel, Maraging steel, Nitrogen steel–Intermetallics, Ni and Ti aluminides – smart materials, shape memory alloys – Metallic glass and nano crystalline materials.

UNIT V NON METALLIC MATERIALS 7

Polymeric materials – Formation of polymer structure – Production techniques of fibers, foams, adhesives and coating – structure, properties and applications of engineering polymers – Advanced structural ceramics, WC, TIC, TaC, Al2O3, SiC, Si3N4 CBN and diamond – properties, processing and applications**.**

TOTAL: 45 PERIODS

OUTCOMES:

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

Familiarize the students in the area of material behavior under different loading and selection of materials for the design of engineering structures

- Understand the mechanism involved in the elastic and plastic behavior of metals
- Apply their knowledge in mechanisms of metallic and nonmetallic systems
- Understand the fundamental of fracture mechanics
- Apply their knowledge of cost analysis & selection of materials

REFERENCES:

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MAPPING OF CO'S WITH PO'S

Course outcome Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO12
CO1	2	3	1	1	2	2	-	-	-	-	-	-
CO2	2	3	1	1	2	2	-	-	-	-	-	-
CO3	2	3	1	1	2	2	-	-	-	-	-	-
CO4	2	3	1	1	2	2	-	-	-	-	-	-
CO5	2	3	1	1	2	2	-	-	-	-	-	-
AVg.	2	3	1	1	2	2	-	-	-	-	-	-

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

PA4011 ADVANCED PLASTICS PROCESSING L T P C
3 0 0 3

OBJECTIVES:

- To understand the specialized injection moulding process viz., Co-injection moulding, Two colour injection moulding process, Gas assisted Injection Moulding, Reaction Injection Moulding, Liquid injection moulding, structural foam moulding and to understand the effect of shrinkage, merit & demerits of the process.
- To understand advanced blow moulding process.
- To expertise the student with sufficient background for selection of processing techniques.
- To understand advanced Extrusion process
- To gain knowledge on the applications of advanced injection moulding & Extrusion processes.

UNIT I SPECIALIZED INJECTION MOULDING PROCESS – I 9

Introduction–Injection Moulding Process–Principle –Machinery–Process variables. Co-injection moulding, Two-colour Injection Moulding Process–applications, Gas Assisted Injection Moulding (GAIM)–Basic processes and procedures–Moulding aspects–shrinkage and summary. Reaction Injection Moulding (RIM)–Process – Mould–Process Controls–Merits.

UNIT II SPECIALIZED INJECTION MOULDING PROCESS – II 9

Multi-layer Moulding, Counter Flow Moulding, Liquid Injection Moulding processes. Structural Foam Moulding – Low pressure and high pressure processes–Merits & demerits.

UNIT III ADVANCED BLOW MOULDING – I 9

Introduction to Blow Moulding Process–Extrusion Blow Moulding–Injection Blow Moulding – Stretch Blow Moulding–ESBM and ISBM–Merits & Demerits, Applications. Multi-layer Blow Moulding–Process–Applications.

UNIT IV ADVANCED BLOW MOULDING – II 9

Introduction – Classification of Advanced Blow moulding processes–Deep Draw Blow Moulding - Double Wall Blow Moulding Technology–Split moulds – Versatility – Applications - Press Blow Moulding Technology Process – Applications, Three Dimensional Blow Moulding Process – Applications.

UNIT V ADVANCED EXTRUSION PROCESSES 9

Introduction–Extrusion Process–Principle–Single Screw Extruder–Various Extrusion Methods for Film, Pipe, Sheet, Monofilaments–Process, Dies, Downstream equipments and Applications Multilayer Extrusion–Profile Extrusion–Co-Extruded Sheets–Corrugated Pipes–Process, Dies, Downstream equipments and Applications.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Select the advanced processing technique as per the requirement.
- Acquire knowledge of processing plastic materials by advanced injection moulding processes.
- Apply the knowledge of processing plastic materials by advanced extrusion moulding processes.
- Acquire knowledge of advanced processing techniques, end product application & it's importance with industrial relevance.
- Evaluate the applications of various processing techniques.

REFERENCES

1. Charles A Harper Handbook of plastics Processes.
2. Crawford, R.J., Plastics Engineering, 3rd Ed., Elsevier India Pvt. Ltd., New Delhi 2006.
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14. Strong, Brent A., Plastics – Materials & Processing, 3rd Ed., Pearson Education Ltd., Newyork, 2006.

MAPPING OF CO'S WITH PO'S

Course outcome Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	3	1	1	1	3	1	-	-	-	-	-	-
CO2	3	1	1	1	3	1	-	-	-	-	-	-
CO3	3	1	1	1	3	1	-	-	-	-	-	-
CO4	3	1	1	1	3	1	-	-	-	-	-	3
CO5	3	1	1	1	3	1	-	-	-	-	-	3
AVg.	3	1	1	1	3	1	-	-	-	-	-	3

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

PA4012 FRACTURE MECHANISM & ANALYSIS IN POLYMERS L T P C
3 0 0 3

OBJECTIVES:

- To impart knowledge on mechanics of cracked components of different modes by which these components fail under static load conditions.
- To identify the role of deformation of materials in fracture.
- To understand about crack growth curve
- To evaluate various crack arrest mechanisms.
- To evaluate various applications of fracture mechanics

UNIT I ELEMENTS OF SOLID MECHANICS 9

The geometry of stress and strain, elastic deformation, plastic and elasto-plastic deformation – limit analysis–Airy's function – field equation for stress intensity factor.

UNIT II STATIONARY CRACK UNDER STATIC LOADING 9

Two dimensional elastic fields–Analytical solutions yielding near a crack front–Irwin's approximation - plastic zone size–Dugdaale model–determination of J integral and its relation to crack opening displacement.

UNIT III ENERGY BALANCE AND CRACK GROWTH 9

Griffith analysis–stable and unstable crack growth–Dynamic energy balance–crack arrest mechanism–K1c test methods - R curves - determination of collapse load.

UNIT IV FATIGUE CRACK GROWTH CURVE 9

Empirical relation describing crack growth law–life calculations for a given load amplitude – effects of changing the load spectrum--rain flow method– external factors affecting the K1c values.- leak before break analysis.

UNIT V APPLICATIONS OF FRACTURE MECHANICS 9

Crack Initiation under large scale yielding – thickness as a design parameter – mixed mode fractures - crack instability in thermal and residual stress fields - numerical methods.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Familiarize with the design of components that contain cracks under static load conditions
- Understand cracking under various loading conditions.
- Acquire knowledge about energy balance in crack growth.
- Conduct various analysis on crack growth
- Acquire knowledge of applications of fracture mechanics

REFERENCES:

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MAPPING OF CO'S WITH PO'S

Course outcome Statement	PO1	PO 2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	3	2	3	3	2	1	-	-	-	-	-	3
CO2	3	2	3	3	2	1	-	-	-	-	-	3
CO3	3	2	3	3	2	1	-	-	-	-	-	3
CO4	3	2	3	3	2	1	-	-	-	-	-	3
CO5	3	2	3	3	2	1	-	-	-	-	-	3
AVg.	3	2	3	3	2	1	-	-	-	-	-	3

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

PA4013 BIOMEDICAL PLASTICS L T P C

3 0 0 3

OBJECTIVES:

- To learn about various types of biopolymers produced from starch and microbes.
- To understand various natural and synthetic polymers used for biomedical applications.
- To learn about the plastics that are used as implants in cardiovascular, dental, ophthalmology, and other artificial organs.
- To be familiarized with evaluation methods of biomedical polymers and their interaction with human system in in-vivo and in-vitro environments.
- To understand various natural and synthetic polymers used for biomedical applications and their compatibility with biological system

UNIT I MATERIALS USED IN MEDICINE 9

Introduction, Polymers, Silicone Biomaterials: History and Chemistry, Medical Fibers and Biotextiles, Hydrogels, Bioresorbable and Bioerodible Materials, Natural Materials, Metals, Ceramics, Glasses, and Glass-Ceramics, Composites, Textured and Porous Materials, Surface-Immobilized Biomolecules

UNIT II BIOLOGICAL TESTING OF BIOMATERIALS 9

Introduction to Testing Biomaterials, In Vitro Assessment of Tissue Compatibility, In Vivo Assessment of Tissue Compatibility, Evaluation of Blood-Materials Interactions, Microscopy for Biomaterials Science

UNIT III DEGRADATION OF MATERIALS IN BIOLOGICAL ENVIRONMENT 9

Introduction: Degradation of Materials in the Biological Environment, Chemical and Biochemical Degradation of Polymers, Degradative Effects of the Biological Environment on Metals and Ceramics, Pathological Calcification of Biomaterials,

UNIT IV APPLICATION OF MATERIALS IN MEDICINE, BIOLOGY, AND ARTIFICIAL ORGANS 9

Introduction, Nonthrombogenic Treatments and Strategies, Cardiovascular Medical Devices, Implantable Cardiac Assist Devices, Extracorporeal Artificial Organs, Orthopedic Applications, Dental Implantation, Adhesives and Sealants, Ophthalmological Applications, Intraocular Lens Implants, Burn Dressings and Skin Substitutes, Sutures, Drug Delivery Systems, Cochlear Prostheses, Biomedical Sensors and Biosensors, Overview of Tissue Engineering, Synthetic Bioresorbable Polymer Scaffolds.

UNIT V PRACTICAL ASPECTS OF BIOMATERIALS 9

Introduction, Sterilization of Implants and Devices, Implant and Device Failure, Correlation, Surfaces and Biomaterials Science, Development and Regulation of Medical Products Using Biomaterials, Ethical Issues in the Development of New Biomaterials, Legal Aspects of Biomaterials

TOTAL: 45 PERIODS

OUTCOMES:

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

- Understand the production of bio-plastics from bio-based feed stocks.
- Know about various plastics that are used for biomedical applications such as cardiovascular, dental, ophthalmology, and other artificial organs.
- Understand the methods and standards used for the evaluation of biomedical polymers.
- Describe the criteria for the selection of biomedical polymers
- Explain the biomedical applications of polymers

REFERENCES

1. Ratner, B.D., Hoffman, A.S., Schoen, F.J. and Lemons, J.E., 2004. Biomaterials science: an introduction to materials in medicine. Elsevier.
2. Park, J.B., 2012. Biomaterials science and engineering. Springer Science & Business Media.
3. Williams, D., 2014. Essential biomaterials science. Cambridge University Press.
4. Pignatello, R. ed., 2011. Biomaterials science and engineering

MAPPING OF CO'S WITH PO'S

Course outcome Statement	PO1	PO 2	PO3	PO 4	PO5	PO6	PO7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	3	1	2	1	3	2	3	-	-	-	-	-
CO2	3	1	2	1	3	2	3	-	-	-	-	-
CO3	3	1	2	1	3	2	3	-	-	-	-	-
CO4	3	1	2	1	3	2	3	-	-	-	-	-
CO5	3	1	2	1	3	2	3	-	-	-	-	-
AVg.	3	1	2	1	3	2	3	-	-	-	-	-

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

PA4014 **SHAPE MEMORY POLYMERS** **L T P C**
3 0 0 3

OBJECTIVES:

- To gain all the information about current status of the materials.
- To know all the advance direction for the materials.
- To understand about processing of advanced materials.
- To acquire knowledge about super alloys
- To learn about plasma synthesis techniques & their applications

UNIT I SMART MATERIALS **9**

Smart system, Piezoelectric materials, Shape memory alloys and shape memory polymers, Magnetostrictive materials, pH-sensitive polymers, Halochromic materials, Chromogenic-systems, Ferrofluid, Rehological fluid, applications of different smart materials. Nanotechnology: Micro-to-nano history, nanoscience, nanotechnology, Nano particle, nanostructured materials, Nanocomposites.

UNIT II SUPER ALLOYS **9**

Classification of Nanomaterials, fabrication of nanomaterials, Applications of Nanomaterials. Classification of super alloys, Development of different phases in super alloys, Ni-based super alloys, commercially available pure nickel alloys, Co-based super alloys, Fe-based super alloys, Ti alloys, Al-Li alloys.

UNIT III BIOMATERIALS **9**

Functional and Engineering Ceramics: Ceramics and their classifications, cutting tool materials, diverse applications of cutting tool, Cermets, Cubic Boron Nitride, polycrystalline diamond. Metallic biomaterials like 316L stainless steel, Co-Cr Alloys, Titanium Ti6Al4V, Ceramic biomaterials like Alumina, Zirconia, Carbon Hydroxyapatite, Polymeric biomaterials like Ultra high molecular weight polyethylene, Polyurethane.

UNIT IV ULTRA-LIGHT MATERIALS **9**

Bulk metallic glasses (BMG): Various methods for BMG production, Classification of BMG, Properties and behaviors of BMG, Thermodynamic aspects of stability, Potential applications of BMG. Aerogels, Aerographite, Metallic Foams, Polymeric Foams, Metallic Microlattices, their synthesis, properties and applications.

UNIT V PLASMA SURFACE ENGINEERING **9**

Plasma, plasma synthesis techniques, Energy associated with plasma, Kinetics in plasma, different types of plasma spraying, cold plasma, applications of plasma. Energy generation and energy storage: battery cell, Self-charging battery, Battery both generates and stores energy, Flow battery.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Know the current-development/advances-in-materials in the metallurgical field.
- Be aware of the advances in materials related to interdisciplinary areas.
- Understand the different types of crystal structures in biomaterials
- Gain knowledge about different ultralight engineering materials and their applications
- Apply the concept of plasma surface engineering and their applications

REFERENCES

1. R E Smallman, A.H.W., Butterworth-Heinemann, *Physical Metallurgy and Advanced Materials*, Elsevier, ISBN: 0750669063.
2. Mark J. Hampden-Smith Wiley-VCH, *Chemistry of Advanced Materials: An Overview*, Wiley, ISBN-10: 0471185906 ISBN-13: 978-0471185901.
3. M. Meyers, M Sarikaya, R. Ritchie, *Nano and Microstructural Design of Advanced Materials*, Elsevier , ISBN-13: 978-0-08-044373-7, ISBN-10: 0-08-044373-7

4. Feiyu Kang, Hidetaka Konno, Masahiro Toyoda, and Michio Inagaki, *Advanced Materials Science and Engineering of Carbon*, Elsevier , eBook ISBN: 9780124078383

MAPPING OF CO'S WITH PO'S

Course outcome Statement	PO1	PO 2	PO 3	PO 4	PO5	PO6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO12
CO1	3	1	1	1	3	1	-	-	-	-	-	3
CO2	3	1	1	1	3	1	-	-	-	-	-	3
CO3	3	1	1	1	3	1	-	-	-	-	-	3
CO4	3	1	1	1	3	1	-	-	-	-	-	3
CO5	3	1	1	1	3	1	-	-	-	-	-	3
AVg.	3	1	1	1	3	1	-	-	-	-	-	3

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

PA4015 CONDUCTING POLYMERS L T P C
3 0 0 3

OBJECTIVES:

- To enable the students to understand the basic concepts on conducting polymers
- To impart knowledge about synthesis mechanism and applications of conducting polymers
- To learn about various types of characterization methods
- To gain knowledge about doping concepts
- To elucidate various applications of conducting polymers

UNIT I ELECTROCHEMISTRY OF CONDUCTING POLYMERS 9

Introduction to conducting polymers-discovery of polyacetylene-concept of doing and n-type -polarons and bipolarons-conduction mechanism-redox type polymers (electro - active polymers). Important properties of conjugated polymers-electrical conductivity, photoconductivity, charge storage capacity, photoluminescence, and electroluminescence.

UNIT II GENERAL SYNTHESIS OF CONDUCTING POLYMERS 9

Electrically conducting polymers-Chain growth polymerisation, step growth polymerization, electrochemical polymerization, Metathesis polymerization (Ring opening metathesis polymer (ROMP). Advantages and disadvantages of conducting polymers, methods to enhance the processability of conducting polymers

UNIT III SYNTHESIS OF DIFFERENT CONDUCTING POLYMERS 9

Synthesis and properties of conducting polymers-Polyacetylene, Poly p-phenylene, Polyheterocyclic and polyaromatic conducting polymers like polythiophene, poly vinyl carbazole, polypyrene, polyaniline, Polypyrrole, Poly phenylene vinylene, Polypyridine.

UNIT IV CHARACTERIZATION AND PROCESSABILITY OF CONDUCTING POLYMERS 9

Characterization methods - elemental analysis for dopants - IR - UV (electro chemical) scanning electron microscopy (SEM)-electrochemical characterization-cyclic voltammetry- electrochemical quartz crystal microbalance (EQCM) - probe beam deflection (PBD) -Langmuir - blodgett technique. Concept of doping- Charge carriers: polarons, bipolarons and solitons. Types of dopants, oxidative

dopants and reductive dopants, mechanism of doping, p-type doping and n-type doping, inorganic and organic dopants, effect of doping on the dielectric properties of conducting polymers

UNIT V APPLICATIONS OF CONDUCTING POLYMERS 9

Applications of conducting polymers- electro active applications Polymer rechargeable batteries, sensors, electrochemical actuators, electro luminescent applications. Conductivity applications - antistatic coatings, conducting adhesives, artificial nerves. Electronic applications- EMI shielding, Frequency selective surfaces, satellite communication links, Dielectric properties of conducting polymers in the high and very high frequency fields (a.c field), ultra high frequency field (Microwave field). Recent trends in conducting polymer and conducting polymer nanocomposites

TOTAL: 45 PERIODS

OUTCOMES:

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

- Understand the basic concepts and the mechanism of conduction in polymers
- Synthesise conducting polymers by various methods.
- Characterize the conduction in polymers
- Understand the application of conductive polymers in various devices.
- Familiarize with the recent and future trend of conducting polymers.

REFERENCES

1. Reynolds, J.R., Thompson, B.C. and Skotheim, T.A. eds., 2019. *Conjugated Polymers: Properties, Processing, and Applications*. CRC press.
2. J. Margolis, Conducting Polymers and Plastics, Chapman and Hal, London 1993.
3. Baeriswyl, D., Campbell, D.K., Clark, G.C., Harbeke, G., Kahol, P.K., Kiess, H., Mazumdar, S., Mehring, M. and Rehwald, W., 2012. *Conjugated conducting polymers* (Vol. 102). Springer Science & Business Media.
4. Linford, R.G. ed., 1990. *Electrochemical science and technology of polymers* (Vol. 2). Elsevier Applied Science.
5. Di Bari, G.A., Schlesinger, M. and Paunovic, M., 2000. Modern electroplating. *New York), M. Schlesinger and M. Paunovic, Eds., John Wiley & Sons, Inc*.
6. Barford, W., 2013. Electronic and optical properties of conjugated polymers (Vol. 159). Oxford University Press.
7. Mullen, K., Reynolds, J.R. and Masuda, T. eds., 2014. *Conjugated polymers* (No. 9). Royal Society of Chemistry.

MAPPING OF CO'S WITH PO'S

Course outcome Statement	PO 1	PO2	PO 3	PO4	PO 5	PO6	PO 7	PO 8	PO9	PO1 0	PO1 1	PO1 2
CO1	3	1	3	1	3	1	-	-	-	-	-	3
CO2	3	1	3	1	3	1	-	-	-	-	-	3
CO3	3	1	3	1	3	1	-	-	-	-	-	3
CO4	3	1	3	1	3	1	-	-	-	-	-	3
CO5	3	1	3	1	3	1	-	-	-	-	-	3
AVg.	3	1	3	1	3	1	-	-	-	-	-	3

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

PA4016 **LIQUID CRYSTALLINE POLYMERS** **L T P C**
3 0 0 3

OBJECTIVES:

- To make the student to acquire knowledge in liquid crystalline polymers for special application.
- To provide exposure to the students about advanced polymeric materials.
- To acquire knowledge about various theories of LCP
- To learn about processing & identification of LCP
- To elucidate various applications of LCP

UNIT I INTRODUCTION **9**

Definition of LCP, Types of liquid crystalline polymer, Local order and classification, Chemistry and physics of liquid crystalline polymer, Synthesis of liquid crystalline polymer, Properties of liquid crystalline polymer.

UNIT II STABILITY OF LIQUID CRYSTALLINE POLYMERS **9**

Thermotropic liquid crystals-Rigid-rods to main-chain polymers, development of side chain liquid crystalline polymers, Stability of liquid crystalline polymers, Factors limiting liquid crystallinity in rigid rod-like molecules, Control of mesophase stability in main chain thermotropic liquid, crystalline polymers, Lyotropic rigid-rod polymers, Polymers with mesogenic side-chains, Liquid crystalline polymers with more complex molecular architectures.

UNIT III THEORIES OF LIQUID CRYSTALLINITY IN POLYMERS **9**

Theories of liquid crystallinity in polymers: Steric theory of rod-like liquid crystals, Virial theories: the Onsager approach Flory's lattice model, Orientation dependent interactions: the Maier–Saupe theory, Theories for main-chain polymers with semi-rigid chains, Theories of side-chain liquid crystalline polymers, Phenomenological theories of phase transitions.

UNIT IV PROCESSING OF STRUCTURAL LIQUID CRYSTALLINE POLYMERS **9**

Processing of structural liquid crystalline polymers: Rheology, Processing and the consequences of flow alignment, Liquid crystalline polymers as structural materials, Liquid crystalline polymers in blends and composites, Identification of LCP by DSC, Microscopy and XRD.

UNIT V APPLICATIONS OF FUNCTIONAL LIQUID CRYSTALLINE POLYMERS **9**

Applications of functional liquid crystalline polymers: Liquid crystalline polymers as Optoelectronic materials, Liquid crystalline polymers in displays, Semiconducting liquid crystalline polymers, Laser writeable devices, nonlinear optical applications, Sensors and actuators. Applications and uses Electrical/ Electronic Applications, Automotive Applications, Engineering Parts, Appliances, Food Containers, Industrial Applications etc.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Know about preparation and properties of liquid crystalline polymers.
- Methodically discuss application of liquid crystalline polymers.
- Appreciate the uses of polymers for specialty applications
- Evaluate various applications of liquid crystalline polymers
- Identify different LCP

REFERENCES

1. Raynes, Peter. "LIQUID CRYSTALS—Second Edition, by S Chandrasekhar, Cambridge University Press,(1992),
2. Dierking, I., 2017. Handbook of liquid crystals.
3. Chanda, M. and Roy, S.K., 2008. Industrial polymers, specialty polymers, and their applications. CRC press.

4. Ciferri, A. ed., 2012. Polymer liquid crystals. Elsevier.
5. Martellucci, S. and Chester, A.N. eds., 1992. Phase Transitions in Liquid Crystals (p. 439). New York: Plenum Press.

MAPPING OF CO'S WITH PO'S

Course outcome Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	3	1	3	1	3	1	-	-	-	-	-	3
CO2	3	1	3	1	3	1	-	-	-	-	-	3
CO3	3	1	3	1	3	1	-	-	-	-	-	3
CO4	3	1	3	1	3	1	-	-	-	-	-	3
CO5	3	1	3	1	3	1	-	-	-	-	-	3
AVg.	3	1	3	1	3	1	-	-	-	-	-	3

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

AUDIT COURSES

AX4091 ENGLISH FOR RESEARCH PAPER WRITING L T P C
2 0 0 0

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6
Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6
Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission

TOTAL: 30 PERIODS

REFERENCES:

1. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

AX4092 DISASTER MANAGEMENT LT P C

2 0 0 0

COURSE OBJECTIVES:

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION 6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA 6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT 6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1 Ability to summarize basics of disaster

CO2 Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3 Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4 Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5 Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES:

1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company, 2007.
3. Sahni, PardeepEt.Al . ," Disaster Mitigation Experiences And Reflections", Prentice Hall of India, New Delhi,2001.

AX4093 CONSTITUTION OF INDIA L T P C
2 0 0 0

COURSE OBJECTIVES:

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: ZilaPachayat. Elected officials and their roles, CEO ZilaPachayat: Position and role. Block level: Organizational

Hierarchy(Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr.S.N.Busi, Dr. B. R. Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7thEdn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AX4094 நற்றமிழ்இலக்கியம் L T P C

2 0 0 0

UNIT I சங்க இலக்கியம் 6

1. தமிழின்துவக்கநூல்தொல்காப்பியம்
– எழுத்து, சொல், பொருள்
2. அகநானூறு(82)
- இயற்கைஇன்னிசைஅரங்கம்
3. குறிஞ்சிப்பாட்டின்மலர்க்காட்சி
4. புறநானூறு(95,195)
- போரைநிறுத்தியஔளவையார்

UNIT II அறநெறித்தமிழ் 6

1. அறநெறிவகுத்ததிருவள்ளுவர்
- அறம்வலியுறுத்தல், அன்புடைமை, ஒப்புரவறிதல், ஈகை, புகழ்
2. பிறஅறநூல்கள்- இலக்கியமருந்து
– ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை
(தூய்மையைவலியுறுத்தும்நூல்)

UNIT III **இரட்டைக்காப்பியங்கள்** **6**

1.கண்ணகியின்புரட்சி
- சிலப்பதிகாரவழக்குரைகாதை
2. சமூகசேவைஇலக்கியம்மணிமேகலை
- சிறைக்கோட்டம்அறக்கோட்டமாகியகாதை

UNIT IV **அருள்நெறித்தமிழ்** **6**

1. சிறுபாணாற்றுப்படை
- பாரிமுல்லைக்குத்தேர்கொடுத்தது,
பேகன்மயிலுக்குப்போர்வைகொடுத்தது,
அதியமான்ஔவைக்குநெல்லிக்கனிகொடுத்தது, அரசர் பண்புகள்
2. நற்றிணை
- அன்னைக்குரியபுன்னைசிறப்பு
3. திருமந்திரம் (617, 618)
- இயமம்நியமம்விதிகள்
4. தர்மச்சாலையை நிறுவிய வள்ளலார்
5. புறநானூறு
- சிறுவனேவள்ளலானான்
6. அகநானூறு (4) - வண்டு
நற்றிணை (11) - நண்டு
கலித்தொகை (11) - யானை, புறா
ஐந்திணை 50 (27) - மான்
ஆகியவைபற்றியசெய்திகள்

UNIT V **நவீனதமிழ்இலக்கியம்** **6**

1. உரைநடைத்தமிழ்,
- தமிழின்முதல்புதினம்,
- தமிழின்முதல்சிறுகதை,
- கட்டுரைஇலக்கியம்,
- பயணஇலக்கியம்,
- நாடகம்,
2. நாட்டுவிடுதலைபோராட்டமும்தமிழ்இலக்கியமும்,
3. சமுதாயவிடுதலையும்தமிழ்இலக்கியமும்,
4. பெண் விடுதலையும்விளிம்புநிலையினரின்மேம்பாட்டில்தமிழ் இலக்கியமும்,
5. அறிவியல்தமிழ்,
6. இணையத்தில்தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில்தமிழ்இலக்கியம்.

TOTAL: 30 PERIODS

<u>தமிழ்இலக்கியவெளியீடுகள் / புத்தகங்கள்</u>

1. தமிழ்இணையகல்விக்கழகம் (Tamil Virtual University) - www.tamilvu.org
2. தமிழ்விக்கிப்பீடியா (Tamil Wikipedia) -https://ta.wikipedia.org
3. தர்மபுர ஆதீன வெளியீடு
4. வாழ்வியல்களஞ்சியம்- தமிழ்ப்பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக்களஞ்சியம்- தமிழ்வளர்ச்சித்துறை (thamilvalarchithurai.com)
6. அறிவியல்களஞ்சியம்- தமிழ்ப்பல்கலைக்கழகம், தஞ்சாவூர்

OCE431 INTEGRATED WATER RESOURCES MANAGEMENT L T P C
3 0 0 3

OBJECTIVE

- Students will be introduced to the concepts and principles of IWRM, which is inclusive of the economics, public-private partnership, water & health, water & food security and legal & regulatory settings.

UNIT I CONTEXT FOR IWRM 9

Water as a global issue: key challenges – Definition of IWRM within the broader context of development – Key elements of IWRM - Principles – Paradigm shift in water management - Complexity of the IWRM process – UN World Water Assessment - SDGs.

UNIT II WATER ECONOMICS 9

Economic view of water issues: economic characteristics of water good and services – Non-market monetary valuation methods – Water economic instruments – Private sector involvement in water resources management: PPP objectives, PPP models, PPP processes, PPP experiences through case studies.

UNIT III LEGAL AND REGULATORY SETTINGS 9

Basic notion of law and governance: principles of international and national law in the area of water management - Understanding UN law on non-navigable uses of international water courses – International law for groundwater management – World Water Forums – Global Water Partnerships - Development of IWRM in line with legal and regulatory framework.

UNIT IV WATER AND HEALTH WITHIN THE IWRM CONTEXT 9

Links between water and health: options to include water management interventions for health – Health protection and promotion in the context of IWRM – Global burden of Diseases - Health impact assessment of water resources development projects – Case studies.

UNIT V AGRICULTURE IN THE CONCEPT OF IWRM 9

Water for food production: 'blue' versus 'green' water debate – Water foot print - Virtual water trade for achieving global water and food security –- Irrigation efficiencies, irrigation methods - current water pricing policy– scope to relook pricing.

TOTAL: 45 PERIODS

OUTCOMES

- On completion of the course, the student is expected to be able to

CO1	Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management.
CO2	Select the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies.
CO3	Apply law and governance in the context of IWRM.
CO4	Discuss the linkages between water-health; develop a HIA framework.
CO5	Analyse how the virtual water concept pave way to alternate policy options.

REFERENCES:

1. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.
2. Mollinga .P. etal " Integrated Water Resources Management", Water in South Asia Volume I, Sage Publications, 2006.
3. Technical Advisory Committee, Integrated Water Resources management, Technical Advisory Committee Background Paper No: 4. Global water partnership, Stockholm, Sweden. 2002.
4. Technical Advisory Committee, Dublin principles for water as reflected in comparative assessment of institutional and legal arrangements for Integrated Water Resources

Management, Technical Advisory Committee Background paper No: 3. Global water partnership, Stockholm, Sweden. 1999.
5. Technical Advisory Committee, Effective Water Governance". Technical Advisory Committee Background paper No: 7. Global water partnership, Stockholm, Sweden, 2003.

OCE432 WATER, SANITATION AND HEALTH L T P C
3 0 0 3

OBJECTIVES:

- Understand the accelerating health impacts due to the present managerial aspects and initiatives in water and sanitation and health sectors in the developing scenario

UNIT I FUNDAMENTALS WASH 9

Meanings and Definition: Safe Water- Health, Nexus: Water- Sanitation - Health and Hygiene – Equity issues-Water security - Food Security. Sanitation And Hygiene (WASH) and Integrated Water Resources Management (IWRM) - Need and Importance of WASH

UNIT II MANAGERIAL IMPLICATIONS AND IMPACT 9

Third World Scenario – Poor and Multidimensional Deprivation--Health Burden in Developing Scenario -Factors contribute to water, sanitation and hygiene related diseases-Social: Social Stratification and Literacy Demography: Population and Migration- Fertility - Mortality- Environment: Water Borne-Water Washed and Water Based Diseases - Economic: Wage - Water and Health Budgeting -Psychological: Non-compliance - Disease Relapse - Political: Political Will.

UNIT III CHALLENGES IN MANAGEMENT AND DEVELOPMENT 9

Common Challenges in WASH - Bureaucracy and Users- Water Utilities -Sectoral Allocation:- Infrastructure- Service Delivery: Health services: Macro and Micro- level: Community and Gender Issues- Equity Issues - Paradigm Shift: Democratization of Reforms and Initiatives.

UNIT IV GOVERNANCE 9

Public health -Community Health Assessment and Improvement Planning (CHA/CHIP)-Infrastructure and Investments on Water, (WASH) - Cost Benefit Analysis – Institutional Intervention-Public Private Partnership - Policy Directives - Social Insurance -Political Will vs Participatory Governance -

UNIT V INITIATIVES 9

Management vs Development -Accelerating Development- Development Indicators -Inclusive Development-Global and Local- Millennium Development Goal (MDG) and Targets - Five Year Plans - Implementation - Capacity Building - Case studies on WASH.

TOTAL: 45 PERIODS

OUTCOMES:

CO1	Capture to fundamental concepts and terms which are to be applied and understood all through the study.
CO2	Comprehend the various factors affecting water sanitation and health through the lens of third world scenario.
CO3	Critically analyse and articulate the underlying common challenges in water, sanitation and health.
CO4	Acquire knowledge on the attributes of governance and its say on water sanitation and health.
CO5	Gain an overarching insight in to the aspects of sustainable resource management in the absence of a clear level playing field in the developmental aspects.

REFERENCES

1. Bonitha R., Beaglehole R.,Kjellstorm, 2006, "Basic Epidemiology", 2nd Edition, World Health Organization.
2. Van Note Chism, N. and Bickford, D. J. (2002), Improving the environment for learning: An expanded agenda. New Directions for Teaching and Learning, 2002: 91–98. doi: 10.1002/tl.83Improving the Environment for learning: An Expanded Agenda
3. National Research Council. Global Issues in Water, Sanitation, and Health: Workshop Summary**.** Washington, DC: The National Academies Press, 2009.
4. Sen, Amartya 1997. On Economic Inequality. Enlarged edition, with annex by JamesFoster and Amartya Sen, Oxford: Claredon Press, 1997.
5. Intersectoral Water Allocation Planning and Management, 2000, World Bank Publishers www. Amazon.com
6. Third World Network.org (www.twn.org).

OCE433 PRINCIPLES OF SUSTAINABLE DEVELOPMENT L T P C
3 0 0 3

OBJECTIVES:

- To impart knowledge on environmental, social and economic dimensions of sustainability and the principles evolved through landmark events so as to develop an action mindset for sustainable development.

UNIT I SUSTAINABILITY AND DEVELOPMENT CHALLEGES 9

Definition of sustainability – environmental, economical and social dimensions of sustainability - sustainable development models – strong and weak sustainability – defining development- millennium development goals – mindsets for sustainability: earthly, analytical, precautionary, action and collaborative– syndromes of global change: utilisation syndromes, development syndromes, and sink syndromes – core problems and cross cutting Issues of the 21 century - global, regional and local environmental issues – social insecurity - resource degradation –climate change – desertification.

UNIT II PRINCIPLES AND FRAME WORK 9

History and emergence of the concept of sustainable development - our common future - Stockholm to Rio plus 20– Rio Principles of sustainable development – Agenda 21 natural step- peoples earth charter – business charter for sustainable development –UN Global Compact - Role of civil society, business and government – United Nations' 2030 Agenda for sustainable development – 17 sustainable development goals and targets, indicators and intervention areas

UNIT III SUSTAINABLE DEVELOPMENT AND WELLBEING 9

The Unjust World and inequities - Quality of Life - Poverty, Population and Pollution - Combating Poverty - - Demographic dynamics of sustainability - Strategies to end Rural and Urban Poverty and Hunger – Sustainable Livelihood Framework- Health, Education and Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities and Industry for Prevention, Precaution , Preservation and Public participation.

UNIT IV SUSTAINABLE SOCIO-ECONOMIC SYSTEMS 10

Sustainable Development Goals and Linkage to Sustainable Consumption and Production – Investing in Natural Capital- Agriculture, Forests, Fisheries - Food security and nutrition and sustainable agriculture- Water and sanitation - Biodiversity conservation and Ecosystem integrity –Ecotourism - Sustainable Cities – Sustainable Habitats- Green Buildings - Sustainable Transportation — Sustainable Mining - Sustainable Energy– Climate Change –Mitigation and Adaptation - Safeguarding Marine Resources - Financial Resources and Mechanisms

UNIT V ASSESSING PROGRESS AND WAY FORWARD 8

Nature of sustainable development strategies and current practice**-** Sustainability in global, regional and national context –Approaches to measuring and analysing sustainability– limitations of GDP- Ecological Footprint- Human Development Index- Human Development Report – National initiatives for Sustainable Development - Hurdles to Sustainability - Science and Technology for sustainable development –Performance indicators of sustainability and Assessment mechanism – Inclusive Green Growth and Green Economy – National Sustainable Development Strategy Planning and National Status of Sustainable Development Goals

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1	Explain and evaluate current challenges to sustainability, including modern world social, environmental, and economic structures and crises.
CO2	Identify and critically analyze the social environmental, and economic dimensions of sustainability in terms of UN Sustainable development goals
CO3	Develop a fair understanding of the social, economic and ecological linkage of Human well being, production and consumption
CO4	Evaluate sustainability issues and solutions using a holistic approach that focuses on connections between complex human and natural systems.
CO5	Integrate knowledge from multiple sources and perspectives to understand environmental limits governing human societies and economies and social justice dimensions of sustainability.

REFERENCES:

1. Tom Theis and Jonathan Tomkin, Sustainability: A Comprehensive Foundation, Rice University, Houston, Texas, 2012
2. A guide to SDG interactions:from science to implementation, International Council for Science, Paris,2017
3. Karel Mulder, Sustainable Development for Engineers - A Handbook and Resource Guide, Rouledge Taylor and Francis, 2017.
4. The New Global Frontier - Urbanization, Poverty and Environmentin the 21st Century - *George Martine,Gordon McGranahan,Mark Montgomery and Rogelio Fernández-Castilla,* IIED and UNFPA, Earthscan, UK, 2008
5. Nolberto Munier, Introduction to Sustainability: Road to a Better Future, Springer, 2006
6. Barry Dalal Clayton and Stephen Bass, Sustainable Development Strategies- a resource book", Earthscan Publications Ltd, London, 2002.

OCE434 ENVIRONMENTAL IMPACT ASSESSMENT L T P C

3 0 0 3

OBJECTIVES:

- To make the students to understand environmental clearance, its legal requirements and to provide knowledge on overall methodology of EIA, prediction tools and models, environmental management plan and case studies.

UNIT I INTRODUCTION 9

Historical development of Environmental Impact Assessment (EIA). Environmental Clearance- EIA in project cycle. legal and regulatory aspects in India – types and limitations of EIA –EIA process- screening – scoping - terms of reference in EIA- setting – analysis – mitigation. Cross sectoral issues –public hearing in EIA- EIA consultant accreditation.

UNIT II IMPACT INDENTIFICATION AND PREDICTION 10

Matrices – networks – checklists – cost benefit analysis – analysis of alternatives – expert systems in EIA. prediction tools for EIA – mathematical modeling for impact prediction – assessment of impacts – air – water – soil – noise – biological —- cumulative impact assessment

UNIT III SOCIO-ECONOMIC IMPACT ASSESSMENT 8

Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. factors and methodologies- individual and family level impacts. communities in transition-rehabilitation

UNIT IV EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN 9

Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment

UNIT V CASE STUDIES 9

Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, CETPs, CMSWMF, building and construction projects

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1	Understand need for environmental clearance, its legal procedure, need of EIA, its types, stakeholders and their roles
CO2	Understand various impact identification methodologies, prediction techniques and model of impacts on various environments
CO3	Understand relationship between social impacts and change in community due to development activities and rehabilitation methods
CO4	Document the EIA findings and prepare environmental management and monitoring plan
CO5	Identify, predict and assess impacts of similar projects based on case studies

REFERENCES:

1. EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of India
2. Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest and Climate Change, Government of India
3. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996
4. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey. 2003
5. Lee N. and George C. 2000. Environmental Assessment in Developing and Transitional Countries. Chichester: Willey
6. World Bank –Source book on EIA ,1999
7. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification Assessment and Control, 4th Edition, Butterworth Heineman, 2012.

OIC431 **BLOCKCHAIN TECHNOLOGIES** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- This course is intended to study the basics of Blockchain technology.
- During this course the learner will explore various aspects of Blockchain technology like application in various domains.
- By implementing, learners will have idea about private and public Blockchain, and smart contract.

UNIT I INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN 9

Introduction to Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.

UNIT II BITCOIN AND CRYPTOCURRENCY 9

Introduction to Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency.

UNIT III INTRODUCTION TO ETHEREUM 9

Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, , Transactions, Receiving Ethers, Smart Contracts.

UNIT-IV INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING 10

Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types.

UNIT V BLOCKCHAIN APPLICATIONS 8

Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After the completion of this course, student will be able to

CO1: Understand and explore the working of Blockchain technology
CO2: Analyze the working of Smart Contracts
CO3: Understand and analyze the working of Hyperledger
CO4: Apply the learning of solidity to build de-centralized apps on Ethereum
CO5: Develop applications on Blockchain

REFERENCES:

1. Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained”, Second Edition, Packt Publishing, 2018.
2. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, “Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction” Princeton University Press, 2016
3. Antonopoulos, Mastering Bitcoin, O’Reilly Publishing, 2014. .
4. Antonopoulos and G. Wood, “Mastering Ethereum: Building Smart Contracts and Dapps”, O’Reilly Publishing, 2018.
5. D. Drescher, Blockchain Basics. Apress, 2017.

OIC432 **DEEP LEARNING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- Develop and Train Deep Neural Networks.
- Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection and recognition
- Build and train RNNs, work with NLP and Word Embeddings
- The internal structure of LSTM and GRU and the differences between them
- The Auto Encoders for Image Processing

UNIT I DEEP LEARNING CONCEPTS **6**

Fundamentals about Deep Learning. Perception Learning Algorithms. Probabilistic modelling. Early Neural Networks. How Deep Learning different from Machine Learning. Scalars. Vectors. Matrixes, Higher Dimensional Tensors. Manipulating Tensors. Vector Data. Time Series Data. Image Data. Video Data.

UNIT II NEURAL NETWORKS **9**

About Neural Network. Building Blocks of Neural Network. Optimizers. Activation Functions. Loss Functions. Data Pre-processing for neural networks, Feature Engineering. Overfitting and Underfitting. Hyperparameters.

UNIT III CONVOLUTIONAL NEURAL NETWORK **10**

About CNN. Linear Time Invariant. Image Processing Filtering. Building a convolutional neural network. Input Layers, Convolution Layers. Pooling Layers. Dense Layers. Backpropagation Through the Convolutional Layer. Filters and Feature Maps. Backpropagation Through the Pooling Layers. Dropout Layers and Regularization. Batch Normalization. Various Activation Functions. Various Optimizers. LeNet, AlexNet, VGG16, ResNet. Transfer Learning with Image Data. Transfer Learning using Inception Oxford VGG Model, Google Inception Model, Microsoft ResNet Model. R-CNN, Fast R-CNN, Faster R-CNN, Mask-RCNN, YOLO

UNIT IV NATURAL LANGUAGE PROCESSING USING RNN **10**

About NLP & its Toolkits. Language Modeling . Vector Space Model (VSM). Continuous Bag of Words (CBOW). Skip-Gram Model for Word Embedding. Part of Speech (PoS) Global Co-occurrence Statistics–based Word Vectors. Transfer Learning. Word2Vec. Global Vectors for Word Representation GloVe. Backpropagation Through Time. Bidirectional RNNs (BRNN) . Long Short Term Memory (LSTM). Bi-directional LSTM. Sequence-to-Sequence Models (Seq2Seq). Gated recurrent unit GRU.

UNIT V DEEP REINFORCEMENT & UNSUPERVISED LEARNING **10**

About Deep Reinforcement Learning. Q-Learning. Deep Q-Network (DQN). Policy Gradient Methods. Actor-Critic Algorithm. About Autoencoding. Convolutional Auto Encoding. Variational Auto Encoding. Generative Adversarial Networks. Autoencoders for Feature Extraction. Auto Encoders for Classification. Denoising Autoencoders. Sparse Autoencoders

COURSE OUTCOMES:

CO1: Feature Extraction from Image and Video Data
CO2: Implement Image Segmentation and Instance Segmentation in Images
CO3: Implement image recognition and image classification using a pretrained network (Transfer Learning)
CO4: Traffic Information analysis using Twitter Data
CO5: Autoencoder for Classification & Feature Extraction

TOTAL : 45 PERIODS

REFERENCES

1. Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc.2017
2. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018
3. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020
4. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017
5. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress,2017

OME431 VIBRATION AND NOISE CONTROL STRATEGIES L T P C
3 0 0 3

OBJECTIVES

- To appreciate the basic concepts of vibration in damped and undamped systems
- To appreciate the basic concepts of noise, its effect on hearing and related terminology
- To use the instruments for measuring and analyzing the vibration levels in a body
- To use the instruments for measuring and analyzing the noise levels in a system
- To learn the standards of vibration and noise levels and their control techniques

UNIT- I BASICS OF VIBRATION 9

Introduction – Sources and causes of Vibration-Mathematical Models - Displacement, velocity and Acceleration - Classification of vibration: free and forced vibration, undamped and damped vibration, linear and non-linear vibration - Single Degree Freedom Systems - Vibration isolation - Determination of natural frequencies

UNIT- II BASICS OF NOISE 9

Introduction - Anatomy of human ear - Mechanism of hearing - Amplitude, frequency, wavelength and sound pressure level - Relationship between sound power, sound intensity and sound pressure level - Addition, subtraction and averaging decibel levels - sound spectra -Types of sound fields - Octave band analysis - Loudness.

UNIT- III INSTRUMENTATION FOR VIBRATION MEASUREMENT 9

Experimental Methods in Vibration Analysis.- Vibration Measuring Instruments - Selection of Sensors - Accelerometer Mountings - Vibration Exciters - Mechanical, Hydraulic, Electromagnetic and Electrodynamics – Frequency Measuring Instruments -. System Identification from Frequency Response -Testing for resonance and mode shapes

UNIT- IV INSTRUMENTATION FOR NOISE MEASUREMENT AND ANALYSIS 9

Microphones - Weighting networks - Sound Level meters, its classes and calibration - Noise measurements using sound level meters - Data Loggers - Sound exposure meters - Recording of noise - Spectrum analyser - Intensity meters - Energy density sensors - Sound source localization.

UNIT- V METHODS OF VIBRATION CONTROL, SOURCES OF NOISE AND ITS CONTROL 9

Specification of Vibration Limits – Vibration severity standards - Vibration as condition Monitoring Tool – Case Studies - Vibration Isolation methods - Dynamic Vibration Absorber – Need for Balancing - Static and Dynamic Balancing machines – Field balancing - Major sources of noise - Noise survey techniques – Measurement technique for vehicular noise - Road vehicles Noise standard – Noise due to construction equipment and domestic appliances – Industrial noise sources and its strategies – Noise control at the source – Noise control along the path – Acoustic Barriers – Noise control at the receiver -- Sound transmission through barriers – Noise reduction Vs Transmission loss - Enclosures

TOTAL: 45 PERIODS

OUTCOMES:

On Completion of the course the student will be able to

1. apply the basic concepts of vibration in damped and undamped systems
2. apply the basic concepts of noise and to understand its effects on systems
3. select the instruments required for vibration measurement and its analysis
4. select the instruments required for noise measurement and its analysis.
5. recognize the noise sources and to control the vibration levels in a body and to control noise under different strategies.

REFERENCES:

1. Singiresu S. Rao, “Mechanical Vibrations”, Pearson Education Incorporated, 2017.
2. Graham Kelly. Sand Shashidhar K. Kudari, “Mechanical Vibrations”, Tata McGraw –Hill Publishing Com. Ltd., 2007.
3. Ramamurti. V, “Mechanical Vibration Practice with Basic Theory”, Narosa Publishing House, 2000.
4. William T. Thomson, “Theory of Vibration with Applications”, Taylor & Francis, 2003.
5. G.K. Grover, “Mechanical Vibrations”, Nem Chand and Bros.,Roorkee, 2014.
6. A.G. Ambekar, “Mechanical Vibrations and Noise Engineering”, PHI Learning Pvt. Ltd., 2014.
7. David A. Bies and Colin H. Hansen, “Engineering Noise Control – Theory and Practice”, Spon Press, London and New York, 2009.

OME432 ENERGY CONSERVATION AND MANAGEMENT IN DOMESTIC SECTORS **L T P C**
3 0 0 3

COURSE OBJECTIVES:

1. To learn the present energy scenario and the need for energy conservation.
2. To understand the different measures for energy conservation in utilities.
3. Acquaint students with principle theories, materials, and construction techniques to create energy efficient buildings.
4. To identify the energy demand and bridge the gap with suitable technology for sustainable habitat
5. To get familiar with the energy technology, current status of research and find the ways to optimize a system as per the user requirement

UNIT I ENERGY SCENARIO **9**

Primary energy resources - Sectorial energy consumption (domestic, industrial and other sectors), Energy pricing, Energy conservation and its importance, Energy Conservation Act-2001 and its features – Energy star rating.

UNIT II HEATING, VENTILLATION & AIR CONDITIONING **9**

Basics of Refrigeration and Air Conditioning – COP / EER / SEC Evaluation – SPV system design & optimization for Solar Refrigeration.

UNIT III LIGHTING, COMPUTER, TV **9**

Specification of Luminaries – Types – Efficacy – Selection & Application – Time Sensors – Occupancy Sensors – Energy conservation measures in computer – Television – Electronic devices.

UNIT IV ENERGY EFFICIENT BUILDINGS **9**

Conventional versus Energy efficient buildings – Landscape design – Envelope heat loss and heat gain – Passive cooling and heating – Renewable sources integration.

UNIT V ENERGY STORAGE TECHNOLOGIES 9

Necessity & types of energy storage – Thermal energy storage – Battery energy storage, charging and discharging– Hydrogen energy storage & Super capacitors – energy density and safety issues – Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Understand technical aspects of energy conservation scenario.
2. Energy audit in any type for domestic buildings and suggest the conservation measures.
3. Perform building load estimates and design the energy efficient landscape system.
4. Gain knowledge to utilize an appliance/device sustainably.
5. Understand the status and current technological advancement in energy storage field.

REFERENCES:

1. Yogi Goswami, Frank Kreith, Energy Efficiency and Renewable energy Handbook, CRC Press, 2016
2. ASHRAE Handbook 2020 – HVAC Systems & Equipment
3. Paolo Bertoldi, Andrea Ricci, Anibal de Almeida, Energy Efficiency in Household Appliances and Lighting, Conference proceedings, Springer, 2001
4. David A. Bainbridge, Ken Haggard, Kenneth L. Haggard, Passive Solar Architecture: Heating, Cooling, Ventilation, Daylighting, and More Using Natural Flows, Chelsea Green Publishing, 2011.
5. Guide book for National Certification Examination for Energy Managers and Energy Auditors
6. (Could be downloaded from www.energymanagertraining.com)
7. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002.
8. Robert Huggins, Energy Storage: Fundamentals, Materials and Applications, 2nd edition, Springer, 2015
9. Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion, Wiley publications, 2012.

OME433 ADDITIVE MANUFACTURING L T P C

3 0 0 3

UNIT I INTRODUCTION 9

Need - Development - Rapid Prototyping Rapid Tooling – Rapid Manufacturing – Additive Manufacturing. AM Process Chain- Classification – Benefits.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING 9

CAD Model Preparation - Part Orientation and Support Structure Generation -Model Slicing - Tool Path Generation Customized Design and Fabrication - Case Studies.

UNIT III VAT POLYMERIZATION 9

Stereolithography Apparatus (SLA)- Materials -Process -Advantages Limitations- Applications. Digital Light Processing (DLP) - Materials – Process - Advantages - Applications. Multi Jet Modelling (MJM) - Principles - Process - Materials - Advantages and Limitations.

UNIT IV MATERIAL EXTRUSION AND SHEET LAMINATION 9

Fused Deposition Modeling (FDM)- Process-Materials - Applications and Limitations. Sheet Lamination Process: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or

Adhesive Bonding – Thermal Bonding- Materials- Application and Limitation - Bio-Additive Manufacturing Computer Aided Tissue Engineering (CATE) – Case studies

POWDER BASED PROCESS

Selective Laser Sintering (SLS): Process –Mechanism– Typical Materials and Application- Multi Jet Fusion - Basic Principle-– Materials- Application and Limitation - Three Dimensional Printing - Materials -Process - Benefits and Limitations. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Materials – Process - Advantages and Applications. Beam Deposition Process: Laser Engineered Net Shaping (LENS)- Process -Material Delivery - Process Parameters -Materials - Benefits -Applications.

UNIT V CASE STUDIES AND OPPORTUNITIES ADDITIVE MANUFACTURING PROCESSES 9

Education and training - Automobile- pattern and mould - tooling - Building Printing-Bio Printing - medical implants -development of surgical tools Food Printing -Printing Electronics. Business Opportunities and Future Directions - Intellectual Property.

TOTAL: 45 PERIODS

REFERENCES:

1. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015, ISBN: 978-1- 56990-582-1.
2. Ian Gibson, David W. Rosen and Brent Stucker “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, 2nd edition, Springer., United States, 2015, ISBN13: 978-1493921126.
3. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590
4. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
5. Chua C.K., Leong K.F., and Lim C.S., “Rapid prototyping: Principles and applications”, Third edition, World Scientific Publishers, 2010.

OME434 ELECTRIC VEHICLE TECHNOLOGY L T P C

3 0 0 3

UNIT I NEED FOR ELECTRIC VEHICLES 9

History and need for electric and hybrid vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies, comparison of diesel, petrol, electric and hybrid vehicles, limitations, technical challenges

UNIT II ELECTRIC VEHICLE ARCHITECHTURE 9

Electric vehicle types, layout and power delivery, performance – traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, Concepts of hybrid electric drive train, architecture of series and parallel hybrid electric drive train, merits and demerits, mild and full hybrids, plug-in hybrid electric vehicles and range extended hybrid electric vehicles, Fuel cell vehicles.

UNIT III ENERGY STORAGE 9

Batteries – types – lead acid batteries, nickel based batteries, and lithium based batteries, electrochemical reactions, thermodynamic voltage, specific energy, specific power, energy efficiency, Battery modeling and equivalent circuit, battery charging and types, battery cooling, Ultra-capacitors, Flywheel technology, Hydrogen fuel cell, Thermal Management of the PEM fuel cell

UNIT IV ELECTRIC DRIVES AND CONTROL 9

Types of electric motors – working principle of AC and DC motors, advantages and limitations, DC motor drives and control, Induction motor drives and control, PMSM and brushless DC motor -drives and control , AC and Switch reluctance motor drives and control – Drive system efficiency – Inverters – DC and AC motor speed controllers

UNIT V DESIGN OF ELECTRIC VEHICLES 9

Materials and types of production, Chassis skate board design, motor sizing, power pack sizing, component matching, Ideal gear box – Gear ratio, torque–speed characteristics, Dynamic equation of vehicle motion, Maximum tractive effort – Power train tractive effort Acceleration performance, rated vehicle velocity – maximum gradability, Brake performance, Electronic control system, safety and challenges in electric vehicles. Case study of Nissan leaf, Toyota Prius, tesla model 3, and Renault Zoe cars.

TOTAL: 45 PERIODS

REFERENCES:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, 2nd edition CRC Press, 2011.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained - Wiley, 2003.
4. Ehsani, M, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2005

OME435	NEW PRODUCT DEVELOPMENT	L	T	P	C
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COURSE OBJECTIVES:

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

1. Applying the principles of generic development process; and understanding the organization structure for new product design and development.
2. Identfying opportunity and planning for new product design and development.
3. Conducting customer need analysis; and setting product specification for new product design and development.
4. Generating, selecting, and testing the concepts for new product design and development.
5. Appling the principles of Industrial design and prototype for new product design and development.

UNIT I INTRODUCTION TO PRODUCTDESIGN & DEVELOPMENT 9

Introduction – Characteristics of Successful Product Development – People involved in Product Design and Development – Duration and Cost of Product Development – The Challenges of Product Development – The Product Development Process – Concept Development: The Front-End Process – Adapting the Generic Product Development Process – Product Development Process Flows – Product Development Organizations.

UNIT II OPPORTUNITY DENTIFICATION & PRODUCT PLANNING 9

Opportunity Identification: Definition – Types of Opportunities – Tournament Structure of Opportunity Identification – Effective Opportunity Tournaments – Opportunity Identification Process – Product Planning: Four types of Product Development Projects – The Process of Product Planning.

UNIT III IDENTIFYING CUSTOMER NEEDS & PRODUCT SPECIFICATIONS 9

Identifying Customer Needs: The Importance of Latent Needs – The Process of Identifying Customer Needs. Product Specifications: Definition – Time of Specifications Establishment – Establishing Target Specifications – Setting the Final Specifications

UNIT IV CONCEPT GENERATION, SELECTION & TESTING 9

Concept Generation: Activity of Concept Generation – Structured Approach – Five step method of Concept Generation. Concept Selection: Methodology – Concept Screening and Concepts Scoring. Concept testing: Seven Step activities of concept testing.

UNITV INDUSTRIAL DESIGN & PROTOTYPING 9

Industrial Design: Need and Impact–Industrial Design Process. Prototyping – Principles of Prototyping – Prototyping Technologies – Planning for Prototypes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Apply the principles of generic development process; and understand the organization structure for new product design and development.
2. Identify opportunity and plan for new product design and development.
3. Conduct customer need analysis; and set product specification for new product design and development.
4. Generate, select, and test the concepts for new product design and development.
5. Apply the principles of Industrial design and prototype for design and develop new products.

TEXT BOOK:

1. Ulrich K.T., Eppinger S. D. and Anita Goyal, "Product Design and Development "McGraw-Hill Education; 7 edition, 2020.

REFERENCES:

1. Belz A., 36-Hour Course: "Product Development" McGraw-Hill, 2010.
2. Rosenthal S.,"Effective Product Design and Development", Business One Orwin,Homewood, 1992,ISBN1-55623-603-4.

OBA431 SUSTAINABLE MANAGEMENT L T P C

3 0 0 3

COURSE OBJECTIVES:

- To provide students with fundamental knowledge of the notion of corporate sustainability.
- To determine how organizations impacts on the environment and socio-technical systems, the relationship between social and environmental performance and competitiveness, the approaches and methods.

UNIT I MANAGEMENT OF SUSTAINABILITY 9

Management of sustainability -rationale and political trends: An introduction to sustainability management, International and European policies on sustainable development, theoretical pillars in sustainability management studies.

UNIT II CORPORATE SUSTAINABILITY AND RESPONSIBILITY 9

Corporate sustainability parameter, corporate sustainability institutional framework, integration of sustainability into strategic planning and regular business practices, fundamentals of stakeholder engagement.

UNIT III SUSTAINABILITY MANAGEMENT: STRATEGIES AND APPROACHES 9

Corporate sustainability management and competitiveness: Sustainability-oriented corporate strategies, markets and competitiveness, Green Management between theory and practice, Sustainable Consumption and Green Marketing strategies, Environmental regulation and strategic

postures; Green Management approaches and tools; Green engineering: clean technologies and innovation processes; Sustainable Supply Chain Management and Procurement.

UNIT IV SUSTAINABILITY AND INNOVATION 9

Socio-technical transitions and sustainability, Sustainable entrepreneurship, Sustainable pioneers in green market niches, Smart communities and smart specializations.

UNIT V SUSTAINABLE MANAGEMENT OF RESOURCES, COMMODITIES AND COMMONS 9

Energy management, Water management, Waste management, Wild Life Conservation, Emerging trends in sustainable management, Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: An understanding of sustainability management as an approach to aid in evaluating and minimizing environmental impacts while achieving the expected social impact.
CO2: An understanding of corporate sustainability and responsible Business Practices
CO3: Knowledge and skills to understand, to measure and interpret sustainabilityperformances.
CO4: Knowledge of innovative practices in sustainable business and community management
CO5: Deep understanding of sustainable management of resources and commodities

REFERENCES:

1. Daddi, T., Iraldo, F., Testa, Environmental Certification for Organizations and Products: Management, 2015
2. Christian N. Madu, Handbook of Sustainability Management 2012
3. Petra Molthan-Hill, The Business Student's Guide to Sustainable Management: Principles and Practice, 2014
4. Margaret Robertson, Sustainability Principles and Practice, 2014
5. Peter Rogers, An Introduction to Sustainable Development, 2006

OBA432 MICRO AND SMALL BUSINESS MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVES

- To familiarize students with the theory and practice of small business management.
- To learn the legal issues faced by small business and how they impact operations.

UNIT I INTRODUCTION TO SMALL BUSINESS 9

Creation, Innovation, entrepreneurship and small business - Defining Small Business –Role of Owner – Manager – government policy towards small business sector –elements of entrepreneurship – evolution of entrepreneurship –Types of Entrepreneurship – social, civic, corporate - Business life cycle - barriers and triggers to new venture creation – process to assist start ups – small business and family business.

UNIT II SCREENING THE BUSINESS OPPORTUNITY AND FORMULATING THE BUSINESS PLAN 9

Concepts of opportunity recognition; Key factors leading to new venture failure; New venture screening process; Applying new venture screening process to the early stage small firm Role planning in small business – importance of strategy formulation – management skills for small business creation and development.

UNIT III BUILDING THE RIGHT TEAM AND MARKETING STRATEGY 9

Management and Leadership – employee assessments – Tuckman's stages of group development - The entrepreneurial process model - Delegation and team building - Comparison of HR management in small and large firms - Importance of coaching and how to apply a coaching model.

Marketing within the small business - success strategies for small business marketing - customer delight and business generating systems, - market research, - assessing market performance- sales management and strategy - the marketing mix and marketing strategy.

UNIT IV FINANCING SMALL BUSINESS 9

Main sources of entrepreneurial capital; Nature of 'bootstrap' financing - Difference between cash and profit - Nature of bank financing and equity financing - Funding-equity gap for small firms. Importance of working capital cycle - Calculation of break-even point - Power of gross profit margin- Pricing for profit - Credit policy issues and relating these to cash flow management and profitability.

UNIT V VALUING SMALL BUSINESS AND CRISIS MANAGEMENT 9

Causes of small business failure - Danger signals of impending trouble - Characteristics of poorly performing firms - Turnaround strategies - Concept of business valuation - Different valuation measurements - Nature of goodwill and how to measure it - Advantages and disadvantages of buying an established small firm - Process of preparing a business for sale.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1. Familiarise the students with the concept of small business
CO2. In depth knowledge on small business opportunities and challenges
CO3. Ability to devise plans for small business by building the right skills and marketing strategies
CO4. Identify the funding source for small start ups
CO5. Business evaluation for buying and selling of small firms

REFERENCES

1. Hankinson,A.(2000). "The key factors in the profile of small firm owner-managers that influence business performance. The South Coast Small Firms Survey, 1997-2000." Industrial and Commercial Training 32(3):94-98.
2. Parker,R.(2000). "Small is not necessarily beautiful: An evaluation of policy support for small and medium-sized enterprise in Australia." Australian Journal of Political Science 35(2):239-253.
3. Journal articles on SME's.

OBA433 INTELLECTUAL PROPERTY RIGHTS L T P C
3 0 0 3

COURSE OBJECTIVE

- To understand intellectual property rights and its valuation.

UNIT I INTRODUCTION 9

Intellectual property rights - Introduction, Basic concepts, Patents, Copyrights, Trademarks, Trade Secrets, Geographic Indicators; Nature of Intellectual Property, Technological Research, Inventions and Innovations, History - the way from WTO to WIPO, TRIPS.

UNIT II PROCESS 9

New Developments in IPR, Procedure for grant of Patents, TM, GIs, Patenting under Patent Cooperation Treaty, Administration of Patent system in India, Patenting in foreign countries.

UNIT III STATUTES **9**

International Treaties and conventions on IPRs, The TRIPs Agreement, PCT Agreement, The Patent Act of India, Patent Amendment Act (2005), Design Act, Trademark Act, Geographical Indication Act, Bayh- Dole Act and Issues of Academic Entrepreneurship.

UNIT IV STRATEGIES IN INTELLECTUAL PROPERTY **9**

Strategies for investing in R&D, Patent Information and databases, IPR strength in India, Traditional Knowledge, Case studies.

UNIT V MODELS **9**

The technologies Know-how, concept of ownership, Significance of IP in Value Creation, IP Valuation and IP Valuation Models, Application of Real Option Model in Strategic Decision Making, Transfer and Licensing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1: Understanding of intellectual property and appreciation of the need to protect it
CO2: Awareness about the process of patenting
CO3: Understanding of the statutes related to IPR
CO4: Ability to apply strategies to protect intellectual property
CO5: Ability to apply models for making strategic decisions related to IPR

REFERENCES

1. Sople Vinod, Managing Intellectual Property by (Prentice hall of India Pvt.Ltd), 2006.
2. Intellectual Property rights and copyrights, EssEss Publications.
3. Primer, R. Anita Rao and Bhanoji Rao, Intellectual Property Rights, Lastain Book company.
4. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2006.
5. WIPO Intellectual Property Hand book.

OBA434 ETHICAL MANAGEMENT **L T P C**
3 0 0 3

COURSE OBJECTIVE

- To help students develop knowledge and competence in ethical management and decision making in organizational contexts.

UNIT I ETHICS AND SOCIETY **9**

Ethical Management- Definition, Motivation, Advantages-Practical implications of ethical management. Managerial ethics, professional ethics, and social Responsibility-Role of culture and society's expectations- Individual and organizational responsibility to society and the community.

UNIT II ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS **9**

Managing in an ethical crisis, the nature of a crisis, ethics in crisis management, discuss case studies, analyze real-world scenarios, develop ethical management skills, knowledge, and competencies. Proactive crisis management.

UNIT III STAKEHOLDERS IN ETHICAL MANAGEMENT 9

Stakeholders in ethical management, identifying internal and external stakeholders, nature of stakeholders, ethical management of various kinds of stakeholders: customers (product and service issues), employees (leadership, fairness, justice, diversity) suppliers, collaborators, business, community, the natural environment (the sustainability imperative, green management, Contemporary issues).

UNIT IV INDIVIDUAL VARIABLES IN ETHICAL MANJAGEMENT 9

Understanding individual variables in ethics, managerial ethics, concepts in ethical psychology- ethical awareness, ethical courage, ethical judgment, ethical foundations, ethical emotions/intuitions/intensity. Utilization of these concepts and competencies for ethical decision-making and management.

UNIT V PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS 9

Ethical management in practice, development of techniques and skills, navigating challenges and dilemmas, resolving issues and preventing unethical management proactively. Role modelling and creating a culture of ethical management and human flourishing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1: Role modelling and influencing the ethical and cultural context.
CO2: Respond to ethical crises and proactively address potential crises situations.
CO3: Understand and implement stakeholder management decisions.
CO4: Develop the ability, knowledge, and skills for ethical management.
CO5: Develop practical skills to navigate, resolve and thrive in management situations

REFERENCES

1. Brad Agle, Aaron Miller, Bill O' Rourke, The Business Ethics Field Guide: the essential companion to leading your career and your company, 2016.
2. Steiner & Steiner, Business, Government & Society: A managerial Perspective, 2011.
3. Lawrence & Weber, Business and Society: Stakeholders, Ethics, Public Policy, 2020.

ET4251 IoT FOR SMART SYSTEMS LT P C

3 0 0 3

COURSE OBJECTIVES:

1. To study about **Internet of Things** technologies and its role in real time applications.
2. To introduce the infrastructure required for IoT
3. To familiarize the accessories and communication techniques for IoT.
4. To provide insight about the embedded processor and sensors required for IoT
5. To familiarize the different platforms and Attributes for IoT

UNIT I INTRODUCTION TO INTERNET OF THINGS 9

Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Typical IoT applications, Trends and implications.

UNIT II IOT ARCHITECTURE 9

IoT reference model and architecture -Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture**,** IoT standards, Cloud computing for IoT, Bluetooth, Bluetooth Low Energy beacons.

UNIT III PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT 9

PROTOCOLS:

NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA, LTE, GPRS, small cell.

Wireless technologies for IoT: WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems-Recent trends.

UNIT IV IOT PROCESSORS 9

Services/Attributes: Big-Data Analytics for IOT, Dependability,Interoperability, Security, Maintainability.

Embedded processors for IOT :Introduction to Python programming -Building IOT with RASPERRY PI and Arduino.

UNIT V CASE STUDIES 9

Industrial IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Analyze the concepts of IoT and its present developments.
CO2: Compare and contrast different platforms and infrastructures available for IoT
CO3: Explain different protocols and communication technologies used in IoT
CO4: Analyze the big data analytic and programming of IoT
CO5: Implement IoT solutions for smart applications

REFERENCES:

1. ArshdeepBahga and VijaiMadisetti : A Hands-on Approach “Internet of Things”,Universities Press 2015.
2. Oliver Hersent , David Boswarthick and Omar Elloumi “ The Internet of Things”, Wiley,2016.
3. Samuel Greengard, “ The Internet of Things”, The MIT press, 2015.
4. Adrian McEwen and Hakim Cassimally“Designing the Internet of Things “Wiley,2014.
5. Jean- Philippe Vasseur, Adam Dunkels, “Interconnecting Smart Objects with IP: The Next Internet” Morgan Kuffmann Publishers, 2010.
6. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley and sons, 2014.
7. Lingyang Song/DusitNiyato/ Zhu Han/ Ekram Hossain,” Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.
8. OvidiuVermesan and Peter Friess (Editors), “Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems”, River Publishers Series in Communication, 2013.
9. Vijay Madisetti , ArshdeepBahga, “Internet of Things (A Hands on-Approach)”, 2014.
10. Zach Shelby, Carsten Bormann, “6LoWPAN: The Wireless Embedded Internet”, John Wiley and sons, 2009.
11. Lars T.Berger and Krzysztof Iniewski, “Smart Grid applications, communications and security”, Wiley, 2015.
12. JanakaEkanayake, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins, “ Smart Grid Technology and Applications”, Wiley, 2015.
13. UpenaDalal,”Wireless Communications & Networks,Oxford,2015.

ET4072 MACHINE LEARNING AND DEEP LEARNING L T P C
3 0 0 3

COURSE OBJECTIVES:

The course is aimed at

1. Understanding about the learning problem and algorithms
2. Providing insight about neural networks
3. Introducing the machine learning fundamentals and significance
4. Enabling the students to acquire knowledge about pattern recognition.
5. Motivating the students to apply deep learning algorithms for solving real life problems.

UNIT I LEARNING PROBLEMS AND ALGORITHMS 9

Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms

UNIT II NEURAL NETWORKS 9

Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning.

UNIT III MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS 9

Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering.

UNIT IV DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS 9

Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.

UNIT V DEEP LEARNING: RNNS, AUTOENCODERS AND GANS 9

State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs

TOTAL : 45 PERIODS

COURSE OUTCOMES (CO):

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

CO1 : Illustrate the categorization of machine learning algorithms.
CO2: Compare and contrast the types of neural network architectures, activation functions
CO3: Acquaint with the pattern association using neural networks
CO4: Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks
CO5: Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs.

REFERENCES:

1. J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning
2. Deep Learning, Ian Good fellow, YoshuaBengio and Aaron Courville, MIT Press, ISBN:
3. 9780262035613, 2016.

4. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.
5. Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
6. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

PX4012 RENEWABLE ENERGY TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:
To impart knowledge on
- Different types of renewable energy technologies
- Standalone operation, grid connected operation of renewable energy systems

UNIT I INTRODUCTION 9
Classification of energy sources – Co2 Emission - Features of Renewable energy - Renewable energy scenario in India -Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment Per Capital Consumption - CO_2 Emission - importance of renewable energy sources, Potentials – Achievements– Applications.

UNIT II SOLAR PHOTOVOLTAICS 9
Solar Energy: Sun and Earth-Basic Characteristics of solar radiation- angle of sunrays on solar collector-Estimating Solar Radiation Empirically - Equivalent circuit of PV Cell- Photovoltaic cell-characteristics: P-V and I-V curve of cell-Impact of Temperature and Insolation on I-V characteristics-Shading Impacts on I-V characteristics-Bypass diode -Blocking diode.

UNIT III PHOTOVOLTAIC SYSTEM DESIGN 9
Block diagram of solar photo voltaic system : Line commutated converters (inversion mode) - Boost and buck-boost converters - selection of inverter, battery sizing, array sizing - PV systems classification- standalone PV systems - Grid tied and grid interactive inverters- grid connection issues.

UNIT IV WIND ENERGY CONVERSION SYSTEMS 9
Origin of Winds: Global and Local Winds- Aerodynamics of Wind turbine-Derivation of Betz's limit-Power available in wind-Classification of wind turbine: Horizontal Axis wind turbine and Vertical axis wind turbine- Aerodynamic Efficiency-Tip Speed-Tip Speed Ratio-Solidity-Blade Count-Power curve of wind turbine - Configurations of wind energy conversion systems: Type A, Type B, Type C and Type D Configurations- Grid connection Issues - Grid integrated SCIG and PMSG based WECS.

UNIT V OTHER RENEWABLE ENERGY SOURCES 9
Qualitative study of different renewable energy resources: ocean, Biomass, Hydrogen energy systems, Fuel cells, Ocean Thermal Energy Conversion (OTEC), Tidal and wave energy, Geothermal Energy Resources.

TOTAL : 45 PERIODS

OUTCOMES:
After completion of this course, the student will be able to:
CO1: Demonstrate the need for renewable energy sources.
CO2: Develop a stand-alone photo voltaic system and implement a maximum power point

tracking in the PV system.

CO3: Design a stand-alone and Grid connected PV system.
CO4: Analyze the different configurations of the wind energy conversion systems.
CO5: Realize the basic of various available renewable energy sources

REFERENCES:

1. S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electrical Systems”, Oxford UniversityPress, 2009.
2. Rai. G.D, “Non conventional energy sources”, Khanna publishes, 1993.
3. Rai. G.D,” Solar energy utilization”, Khanna publishes, 1993.
4. Chetan Singh Solanki, “Solar Photovoltaics: Fundamentals, Technologies and Applications”, PHI Learning Private Limited, 2012.
5. John Twideu and Tony Weir, “Renewal Energy Resources” BSP Publications, 2006
6. Gray, L. Johnson, “Wind energy system”, prentice hall of India, 1995.
7. B.H.Khan, " Non-conventional Energy sources", , McGraw-hill, 2nd Edition, 2009.
8. Fang Lin Luo Hong Ye, " Renewable Energy systems", Taylor & Francis Group,2013.

PS4093 SMART GRID L T P C
3 0 0 3

COURSE OBJECTIVES

- To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To know about the function of smart grid.
- To familiarize the power quality management issues in Smart Grid.
- To familiarize the high performance computing for Smart Grid applications
- To get familiarized with the communication networks for Smart Grid applications

UNIT I INTRODUCTION TO SMART GRID 9

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Comparison of Micro grid and Smart grid, Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India – Case Study.

UNIT II SMART GRID TECHNOLOGIES 9

Technology Drivers, Smart Integration of energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV) – Grid to Vehicle and Vehicle to Grid charging concepts.

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU) & their application for monitoring & protection. Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID 9

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

UNIT V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Architecture and Standards -Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols, Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

TOTAL : 45 PERIODS

COURSE OUTCOME:

Students able to

CO1: Relate with the smart resources, smart meters and other smart devices.
CO2: Explain the function of Smart Grid.
CO3: Experiment the issues of Power Quality in Smart Grid.
CO4: Analyze the performance of Smart Grid.
CO5**:** Recommend suitable communication networks for smart grid applications

REFERENCES

1. Stuart Borlase 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press 2012.
2. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, 'Smart Grid: Technology and Applications', Wiley, 2012.
3. Mini S. Thomas, John D McDonald, 'Power System SCADA and Smart Grids', CRC Press, 2015
4. Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, 'Communication Networks for Smart Grids', Springer, 2014
5. SMART GRID Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication.

CP4391 SECURITY PRACTICES L T P C

3 0 0 3

COURSE OBJECTIVES:

- To learn the core fundamentals of system and web security concepts
- To have through understanding in the security concepts related to networks
- To deploy the security essentials in IT Sector
- To be exposed to the concepts of Cyber Security and cloud security
- To perform a detailed study of Privacy and Storage security and related Issues

UNIT I SYSTEM SECURITY 9

Model of network security – Security attacks, services and mechanisms – OSI security architecture -A Cryptography primer- Intrusion detection system- Intrusion Prevention system - Security web applications- Case study: OWASP - Top 10 Web Application Security Risks.

UNIT II NETWORK SECURITY 9

Internet Security - Intranet security- Local Area Network Security - Wireless Network Security - Wireless Sensor Network Security- Cellular Network Security - Mobile security - IOT security - Case Study - Kali Linux.

UNIT III SECURITY MANAGEMENT 9

Information security essentials for IT Managers- Security Management System - Policy Driven System Management- IT Security - Online Identity and User Management System. Case study: Metasploit

UNIT IV CYBER SECURITY AND CLOUD SECURITY 9

Cyber Forensics- Disk Forensics – Network Forensics – Wireless Forensics – Database Forensics – Malware Forensics – Mobile Forensics – Email Forensics- Best security practices for automate Cloud infrastructure management – Establishing trust in IaaS, PaaS, and SaaS Cloud types. Case study: DVWA

UNIT V PRIVACY AND STORAGE SECURITY 9

Privacy on the Internet - Privacy Enhancing Technologies - Personal privacy Policies - Detection of Conflicts in security policies- privacy and security in environment monitoring systems. Storage Area Network Security - Storage Area Network Security Devices - Risk management - Physical Security Essentials.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Understand the core fundamentals of system security
CO2: Apply the security concepts to wired and wireless networks
CO3: Implement and Manage the security essentials in IT Sector
CO4: Explain the concepts of Cyber Security and Cyber forensics
CO5: Be aware of Privacy and Storage security Issues.

REFERENCES

1. John R. Vacca, Computer and Information Security Handbook, Third Edition, Elsevier 2017
2. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Seventh Edition, Cengage Learning, 2022
3. Richard E. Smith, Elementary Information Security, Third Edition, Jones and Bartlett Learning, 2019
4. Mayor, K.K.Mookhey, Jacopo Cervini, Fairuzan Roslan, Kevin Beaver, Metasploit Toolkit for Penetration Testing, Exploit Development and Vulnerability Research, Syngress publications, Elsevier, 2007. ISBN : 978-1-59749-074-0
5. John Sammons, “The Basics of Digital Forensics- The Primer for Getting Started in Digital Forensics”, Syngress, 2012
6. Cory Altheide and Harlan Carvey, “Digital Forensics with Open Source Tools”,2011 Syngress, ISBN: 9781597495875.
7. Siani Pearson, George Yee "Privacy and Security for Cloud Computing" Computer Communications and Networks, Springer, 2013.

MP4251 CLOUD COMPUTING TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To gain expertise in Virtualization, Virtual Machines and deploy practical virtualization solution
- To understand the architecture, infrastructure and delivery models of cloud computing.
- To explore the roster of AWS services and illustrate the way to make applications in AWS
- To gain knowledge in the working of Windows Azure and Storage services offered by Windows Azure
- To develop the cloud application using various programming model of Hadoop and Aneka

UNIT I VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE 6

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines –Emulation – Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization –Management Virtualization –— Hardware Maximization – Architectures – Virtualization Management – Storage Virtualization – Network Virtualization- Implementation levels of virtualization – virtualization structure – virtualization of CPU, Memory and I/O devices – virtual clusters and Resource Management –

Virtualization for data center automation

UNIT II CLOUD PLATFORM ARCHITECTURE 12

Cloud Computing: Definition, Characteristics - Cloud deployment models: public, private, hybrid, community – Categories of cloud computing: Everything as a service: Infrastructure, platform, software- A Generic Cloud Architecture Design – Layered cloud Architectural Development – Architectural Design Challenges

UNIT III AWS CLOUD PLATFORM - IAAS 9

Amazon Web Services: AWS Infrastructure- AWS API- AWS Management Console - Setting up AWS Storage - Stretching out with Elastic Compute Cloud - Elastic Container Service for Kubernetes- AWS Developer Tools: AWS Code Commit, AWS Code Build, AWS Code Deploy, AWS Code Pipeline, AWS code Star - AWS Management Tools: Cloud Watch, AWS Auto Scaling, AWS control Tower, Cloud Formation, Cloud Trail, AWS License Manager

UNIT IV PAAS CLOUD PLATFORM 9

Windows Azure: Origin of Windows Azure, Features, The Fabric Controller – First Cloud APP in Windows Azure- Service Model and Managing Services: Definition and Configuration, Service runtime API- Windows Azure Developer Portal- Service Management API- Windows Azure Storage Characteristics-Storage Services- REST API- Blops

UNIT V PROGRAMMING MODEL 9

Introduction to Hadoop Framework - Mapreduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job –Developing Map Reduce Applications - Design of Hadoop file system –Setting up Hadoop Cluster- Aneka: Cloud Application Platform, Thread Programming, Task Programming and Map-Reduce Programming in Aneka

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Employ the concepts of virtualization in the cloud computing
CO2: Identify the architecture, infrastructure and delivery models of cloud computing
CO3: Develop the Cloud Application in AWS platform
CO4: Apply the concepts of Windows Azure to design Cloud Application
CO5: Develop services using various Cloud computing programming models.

REFERENCES

1. Bernard Golden, Amazon Web Service for Dummies, John Wiley & Sons, 2013.
2. Raoul Alongi, AWS: The Most Complete Guide to Amazon Web Service from Beginner to Advanced Level, Amazon Asia- Pacific Holdings Private Limited, 2019.
3. Sriram Krishnan, Programming: Windows Azure, O'Reilly,2010.
4. Rajkumar Buyya, Christian Vacchiola, S.Thamarai Selvi, Mastering Cloud Computing , MCGraw Hill Education (India) Pvt. Ltd., 2013.
5. Danielle Ruest, Nelson Ruest, —Virtualization: A Beginner"s Guide‖, McGraw-Hill Osborne Media, 2009.
6. Jim Smith, Ravi Nair , "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.
7. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.
8. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009.
9. Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012.

IF4072 **DESIGN THINKING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To provide a sound knowledge in UI & UX
- To understand the need for UI and UX
- Research Methods used in Design
- Tools used in UI & UX
- Creating a wireframe and prototype

UNIT I **UX LIFECYCLE TEMPLATE** **8**

Introduction. A UX process lifecycle template. Choosing a process instance for your project. The system complexity space. Meet the user interface team. Scope of UX presence within the team. More about UX lifecycles. Business Strategy. Value Innovation. Validated User Research. Killer UX Design. The Blockbuster Value Proposition. What Is a Value Proposition?.

UNIT II **CONTEXTUAL INQUIRY** **10**

The system concept statement. User work activity data gathering. Look for emotional aspects of work practice. Abridged contextual inquiry process. Data-driven vs. model-driven inquiry. Organizing concepts: work roles and flow model. Creating and managing work activity notes. Constructing your work activity affinity diagram (WAAD). Abridged contextual analysis process. History of affinity diagrams.

UNIT III **DESIGN THINKING, IDEATION, AND SKETCHING** **9**

Design-informing models: second span of the bridge . Some general “how to” suggestions. A New example domain: slideshow presentations. User models. Usage models. Work environment models. Barrier summaries. Model consolidation. Protecting your sources. Abridged methods for design-informing models extraction. Design paradigms. Design thinking. Design perspectives. User personas. Ideation. Sketching

UNIT IV **UX GOALS, METRICS, AND TARGETS** **8**

Introduction. UX goals. UX target tables. Work roles, user classes, and UX goals. UX measures. Measuring instruments. UX metrics. Baseline level. Target level. Setting levels. Observed results. Practical tips and cautions for creating UX targets. How UX targets help manage the user experience engineering process.

UNIT V **ANALYSING USER EXPERIENCE** **10**

Sharpening Your Thinking Tools. UX Research and Strength of Evidence. Agile Personas. How to Prioritize Usability Problems. Creating Insights, Hypotheses and Testable Design Ideas. How to Manage Design Projects with User Experience Metrics. Two Measures that Will Justify Any Design Change. Evangelizing UX Research. How to Create a User Journey Map. Generating Solutions to Usability Problems. Building UX Research Into the Design Studio Methodology. Dealing with Common objections to UX Research. The User Experience Debrief Meeting. Creating a User Experience Dashboard.

SUGGESTED ACTIVITIES:

1: Hands on Design Thinking process for a product
2: Defining the Look and Feel of any new Project
3: Create a Sample Pattern Library for that product (Mood board, Fonts, Colors based on UI principles)
4: Identify a customer problem to solve.
5: Conduct end-to-end user research - User research, creating personas, Ideation process (User stories, Scenarios), Flow diagrams, Flow Mapping

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Build UI for user Applications
CO2: Use the UI Interaction behaviors and principles
CO3: Evaluate UX design of any product or application
CO4: Demonstrate UX Skills in product development
CO5: Implement Sketching principles

REFERENCES

1. UX for Developers: How to Integrate User-Centered Design Principles Into Your Day-to-Day Development Work, Westley Knight. Apress, 2018
2. The UX Book: Process and Guidelines for Ensuring a Quality User Experience, Rex Hartson, Pardha Pyla. Morgan Kaufmann, 2012
3. UX Fundamentals for Non-UX Professionals: User Experience Principles for Managers, Writers, Designers, and Developers, Edward Stull. Apress, 2018
4. Lean UX: Designing Great Products with Agile Teams, Gothelf, Jeff, Seiden, and Josh. O'Reilly Media, 2016
5. Designing UX: Prototyping: Because Modern Design is Never Static, Ben Coleman, and Dan Goodwin. SitePoint, 2017

MU4153 PRINCIPLES OF MULTIMEDIA L T P C
3 0 0 3

COURSE OBJECTIVES:

- To get familiarity with gamut of multimedia and its significance
- To acquire knowledge in multimedia components.
- To acquire knowledge about multimedia tools and authoring.
- To acquire knowledge in the development of multimedia applications.
- To explore the latest trends and technologies in multimedia

UNIT I INTRODUCTION 9

Introduction to Multimedia – Characteristics of Multimedia Presentation – Multimedia Components – Promotion of Multimedia Based Components – Digital Representation – Media and Data Streams – Multimedia Architecture – Multimedia Documents, Multimedia Tasks and Concerns, Production, sharing and distribution, Hypermedia, WWW and Internet, Authoring, Multimedia over wireless and mobile networks.

Suggested Activities:

1. Flipped classroom on media Components.
2. External learning – Interactive presentation.

Suggested Evaluation Methods:

1. Tutorial – Handling media components
2. Quizzes on different types of data presentation.

UNIT II ELEMENTS OF MULTIMEDIA 9

Text-Types, Font, Unicode Standard, File Formats, Graphics and Image data representations – data types, file formats, color models; video – color models in video, analog video, digital video, file formats, video display interfaces, 3D video and TV: Audio – Digitization, SNR, SQNR, quantization, audio quality, file formats, MIDI; Animation- Key Frames and Tweening, other Techniques, 2D and 3D Animation.

Suggested Activities:
1. Flipped classroom on different file formats of various media elements.
2. External learning – Adobe after effects, Adobe Media Encoder, Adobe Audition.

Suggested Evaluation Methods:
1. Demonstration on after effects animations.
2. Quizzes on file formats and color models.

UNIT III MULTIMEDIA TOOLS 9

Authoring Tools – Features and Types – Card and Page Based Tools – Icon and Object Based Tools – Time Based Tools – Cross Platform Authoring Tools – Editing Tools – Painting and Drawing Tools – 3D Modeling and Animation Tools – Image Editing Tools – Sound Editing Tools – Digital Movie Tools.

Suggested Activities:
1. Flipped classroom on multimedia tools.
2. External learning – Comparison of various authoring tools.

Suggested Evaluation Methods:
1. Tutorial – Audio editing tool.
2. Quizzes on animation tools.

UNIT IV MULTIMEDIA SYSTEMS 9

Compression Types and Techniques: CODEC, Text Compression: GIF Coding Standards, JPEG standard – JPEG 2000, basic audio compression – ADPCM, MPEG Psychoacoustics, basic Video compression techniques – MPEG, H.26X – Multimedia Database System – User Interfaces – OS Multimedia Support – Hardware Support – Real Time Protocols – Play Back Architectures – Synchronization – Document Architecture – Hypermedia Concepts: Hypermedia Design – Digital Copyrights, Content analysis.

Suggested Activities:
1. Flipped classroom on concepts of multimedia hardware architectures.
2. External learning – Digital repositories and hypermedia design.

Suggested Evaluation Methods:
1. Quizzes on multimedia hardware and compression techniques.
2. Tutorial – Hypermedia design.

UNIT V MULTIMEDIA APPLICATIONS FOR THE WEB AND MOBILE PLATFORMS 9

ADDIE Model – Conceptualization – Content Collection – Storyboard–Script Authoring Metaphors – Testing – Report Writing – Documentation. Multimedia for the web and mobile platforms. Virtual Reality, Internet multimedia content distribution, Multimedia Information sharing – social media sharing, cloud computing for multimedia services, interactive cloud gaming. Multimedia information retrieval.

Suggested Activities:
1. External learning – Game consoles.
2. External learning – VRML scripting languages.

Suggested Evaluation Methods:
1. Demonstration of simple interactive games.
2. Tutorial – Simple VRML program.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Handle the multimedia elements effectively.
CO2: Articulate the concepts and techniques used in multimedia applications.
CO3: Develop effective strategies to deliver Quality of Experience in multimedia applications.

CO4: Design and implement algorithms and techniques applied to multimedia objects.
CO5: Design and develop multimedia applications following software engineering models.

REFERENCES:

1. Li, Ze-Nian, Drew, Mark, Liu, Jiangchuan, “Fundamentals of Multimedia”, Springer, Third Edition, 2021.
2. Prabhat K.Andleigh, Kiran Thakrar, “MULTIMEDIA SYSTEMS DESIGN”, Pearson Education, 2015.
3. Gerald Friedland, Ramesh Jain, “Multimedia Computing”, Cambridge University Press, 2018. (digital book)
4. Ranjan Parekh, “Principles of Multimedia”, Second Edition, McGraw-Hill Education, 2017

DS4015 BIG DATA ANALYTICS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the basics of big data analytics
- To understand the search methods and visualization
- To learn mining data streams
- To learn frameworks
- To gain knowledge on R language

UNIT I INTRODUCTION TO BIG DATA 9

Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis – Nature of Data - Analytic Processes and Tools - Analysis Vs Reporting - Modern Data Analytic Tools- Statistical Concepts: Sampling Distributions - Re-Sampling - Statistical Inference - Prediction Error.

UNIT II SEARCH METHODS AND VISUALIZATION 9

Search by simulated Annealing – Stochastic, Adaptive search by Evaluation – Evaluation Strategies – Genetic Algorithm – Genetic Programming – Visualization – Classification of Visual Data Analysis Techniques – Data Types – Visualization Techniques – Interaction techniques – Specific Visual data analysis Techniques

UNIT III MINING DATA STREAMS 9

Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions

UNIT IV FRAMEWORKS 9

MapReduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases - S3 - Hadoop Distributed File Systems – Case Study- Preventing Private Information Inference Attacks on Social Networks- Grand Challenge: Applying Regulatory Science and Big Data to Improve Medical Device Innovation

UNIT V R LANGUAGE 9

Overview, Programming structures: Control statements -Operators -Functions -Environment and scope issues -Recursion -Replacement functions, R data structures: Vectors -Matrices and arrays -Lists -Data frames -Classes, Input/output, String manipulations

COURSE OUTCOMES:

CO1:understand the basics of big data analytics

CO2: Ability to use Hadoop, Map Reduce Framework.

CO3: Ability to identify the areas for applying big data analytics for increasing the business outcome.

CO4:gain knowledge on R language

CO5: Contextually integrate and correlate large amounts of information to gain faster insights.

TOTAL:45 PERIODS

REFERENCE:

1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
2. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 3rd edition 2020.
3. Norman Matloff, The Art of R Programming: A Tour of Statistical Software Design, No Starch Press, USA, 2011.
4. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, John Wiley & sons, 2012.
5. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007.

NC4201 INTERNET OF THINGS AND CLOUD L T P C

3 0 0 3

COURSE OBJECTIVES:

- To understand Smart Objects and IoT Architectures
- To learn about various IOT-related protocols
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT
- To develop IoT infrastructure for popular applications

UNIT I FUNDAMENTALS OF IoT 9

Introduction to IoT – IoT definition – Characteristics – IoT Complete Architectural Stack – IoT enabling Technologies – IoT Challenges. Sensors and Hardware for IoT – Hardware Platforms – Arduino, Raspberry Pi, Node MCU. A Case study with any one of the boards and data acquisition from sensors.

UNIT II PROTOCOLS FOR IoT 9

Infrastructure protocol (IPV4/V6/RPL), Identification (URIs), Transport (Wifi, Lifi, BLE), Discovery, Data Protocols, Device Management Protocols. – A Case Study with MQTT/CoAP usage-IoT privacy, security and vulnerability solutions.

UNIT III CASE STUDIES/INDUSTRIAL APPLICATIONS 9

Case studies with architectural analysis: IoT applications – Smart City – Smart Water – Smart Agriculture – Smart Energy – Smart Healthcare – Smart Transportation – Smart Retail – Smart waste management.

UNIT IV CLOUD COMPUTING INTRODUCTION 9

Introduction to Cloud Computing - Service Model – Deployment Model- Virtualization Concepts – Cloud Platforms – Amazon AWS – Microsoft Azure – Google APIs.

UNIT V IoT AND CLOUD 9

IoT and the Cloud - Role of Cloud Computing in IoT - AWS Components - S3 – Lambda - AWS IoT Core -Connecting a web application to AWS IoT using MQTT- AWS IoT Examples. Security Concerns, Risk Issues, and Legal Aspects of Cloud Computing- Cloud Data Security

TOTAL:45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1: Understand the various concept of the IoT and their technologies..
CO2: Develop IoT application using different hardware platforms
CO3: Implement the various IoT Protocols
CO4: Understand the basic principles of cloud computing.
CO5: Develop and deploy the IoT application into cloud environment

REFERENCES

1. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman ,CRC Press, 2017
2. Adrian McEwen, Designing the Internet of Things, Wiley,2013.
3. EMC Education Services, “Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data”, Wiley publishers, 2015.
4. Simon Walkowiak, “Big Data Analytics with R” PackT Publishers, 2016
5. Bart Baesens, “Analytics in a Big Data World: The Essential Guide to Data Science and its Applications”, Wiley Publishers, 2015.

MX4073 MEDICAL ROBOTICS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To explain the basic concepts of robots and types of robots
- To discuss the designing procedure of manipulators, actuators and grippers
- To impart knowledge on various types of sensors and power sources
- To explore various applications of Robots in Medicine
- To impart knowledge on wearable robots

UNIT I INTRODUCTION TO ROBOTICS 9

Introduction to Robotics, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Dynamic Stabilization

Sensors and Actuators

Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors, force sensors Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, Various types of Grippers, PD and PID feedback actuator models

UNIT II MANIPULATORS & BASIC KINEMATICS 9

Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse Kinematic problems

Navigation and Treatment Planning

Variable speed arrangements, Path determination – Machinery vision, Ranging – Laser – Acoustic, Magnetic, fiber optic and Tactile sensor

UNIT III SURGICAL ROBOTS 9

Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump, CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric and General Surgery, Gynecologic Surgery, General Surgery and Nanorobotics. Case Study

UNIT IV REHABILITATION AND ASSISTIVE ROBOTS 9

Pediatric Rehabilitation, Robotic Therapy for the Upper Extremity and Walking, Clinical-Based Gait Rehabilitation Robots, Motion Correlation and Tracking, Motion Prediction, Motion Replication. Portable Robot for Tele rehabilitation, Robotic Exoskeletons – Design considerations, Hybrid assistive limb. Case Study

UNIT V WEARABLE ROBOTS 9

Augmented Reality, Kinematics and Dynamics for Wearable Robots, Wearable Robot technology, Sensors, Actuators, Portable Energy Storage, Human–robot cognitive interaction (cHRI), Human–robot physical interaction (pHRI), Wearable Robotic Communication - case study

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1: Describe the configuration, applications of robots and the concept of grippers and actuators
CO2: Explain the functions of manipulators and basic kinematics
CO3: Describe the application of robots in various surgeries
CO4: Design and analyze the robotic systems for rehabilitation
CO5: Design the wearable robots

REFERENCES

1. Nagrath and Mittal, “Robotics and Control”, Tata McGraw Hill, First edition, 2003
2. Spong and Vidhyasagar, “Robot Dynamics and Control”, John Wiley and Sons, First edition, 2008
3. Fu.K.S, Gonzalez. R.C., Lee, C.S.G, “Robotics, control”, sensing, Vision and Intelligence, Tata McGraw Hill International, First edition, 2008
4. Bruno Siciliano, Oussama Khatib, Springer Handbook of Robotics, 1st Edition, Springer, 2008
5. Shane (S.Q.) Xie, Advanced Robotics for Medical Rehabilitation - Current State of the Art and Recent Advances, Springer, 2016
6. Sashi S Kommu, Rehabilitation Robotics, I-Tech Education and Publishing, 2007
7. Jose L. Pons, Wearable Robots: Biomechatronic Exoskeletons, John Wiley & Sons Ltd, England, 2008
8. Howie Choset, Kevin Lynch, Seth Hutchinson, “Principles of Robot Motion: Theory, Algorithms, and Implementations”, Prentice Hall of India, First edition, 2005
9. Philippe Coiffet, Michel Chirouze, “An Introduction to Robot Technology”, Tata McGraw Hill, First Edition, 1983
10. Jacob Rosen, Blake Hannaford & Richard M Satava, “Surgical Robotics: System Applications & Visions”, Springer 2011
11. Jocelyn Troccaz, Medical Robotics, Wiley, 2012
12. Achim Schweikard, Floris Ernst, Medical Robotics, Springer, 2015

VE4202 EMBEDDED AUTOMATION L T P C
3 0 0 3

COURSE OBJECTIVES:

- To learn about the process involved in the design and development of real-time embedded system
- To develop the embedded C programming skills on 8-bit microcontroller
- To study about the interfacing mechanism of peripheral devices with 8-bit microcontrollers
- To learn about the tools, firmware related to microcontroller programming
- To build a home automation system

UNIT - I INTRODUCTION TO EMBEDDED C PROGRAMMING 9

C Overview and Program Structure - C Types, Operators and Expressions - C Control Flow - C Functions and Program Structures - C Pointers And Arrays - FIFO and LIFO - C Structures - Development Tools

UNIT - II AVR MICROCONTROLLER 9

ATMEGA 16 Architecture - Nonvolatile and Data Memories - Port System - Peripheral Features : Time Base, Timing Subsystem, Pulse Width Modulation, USART, SPI, Two Wire Serial Interface, ADC, Interrupts - Physical and Operating Parameters

UNIT – III HARDWARE AND SOFTWARE INTERFACING WITH 8-BIT SERIES CONTROLLERS 9

Lights and Switches - Stack Operation - Implementing Combinational Logic - Expanding I/O - Interfacing Analog To Digital Convertors - Interfacing Digital To Analog Convertors - LED Displays : Seven Segment Displays, Dot Matrix Displays - LCD Displays - Driving Relays - Stepper Motor Interface - Serial EEPROM - Real Time Clock - Accessing Constants Table - Arbitrary Waveform Generation - Communication Links - System Development Tools

UNIT – IV VISION SYSTEM 9

Fundamentals of Image Processing - Filtering - Morphological Operations - Feature Detection and Matching - Blurring and Sharpening - Segmentation - Thresholding - Contours - Advanced Contour Properties - Gradient - Canny Edge Detector - Object Detection - Background Subtraction

UNIT – V HOME AUTOMATION 9

Home Automation - Requirements - Water Level Notifier - Electric Guard Dog - Tweeting Bird Feeder - Package Delivery Detector - Web Enabled Light Switch - Curtain Automation - Android Door Lock - Voice Controlled Home Automation - Smart Lighting - Smart Mailbox - Electricity Usage Monitor - Proximity Garage Door Opener - Vision Based Authentic Entry System

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, students will be able to

CO1: analyze the 8-bit series microcontroller architecture, features and pin details
CO2: write embedded C programs for embedded system application
CO3: design and develop real time systems using AVR microcontrollers
CO4: design and develop the systems based on vision mechanism
CO5: design and develop a real time home automation system

REFERENCES:

1. Dhananjay V. Gadre, "Programming and Customizing the AVR Microcontroller", McGraw-Hill, 2001.
2. Joe Pardue, "C Programming for Microcontrollers ", Smiley Micros, 2005.
3. Steven F. Barrett, Daniel J. Pack, "ATMEL AVR Microcontroller Primer : Programming and Interfacing", Morgan & Claypool Publishers, 2012
4. Mike Riley, "Programming Your Home - Automate With Arduino, Android and Your Computer", the Pragmatic Programmers, Llc, 2012.
5. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2011.
6. Kevin P. Murphy, "Machine Learning - a Probabilistic Perspective", the MIT Press Cambridge, Massachusetts, London, 2012.