ANNA UNIVERSITY, CHENNAI
NON- AUTONOMOUS COLLEGES AFFILIATED ANNA UNIVERSITY
M.E.COMPUTER AIDED DESIGN
REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA & SYLLABI

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I.	To become effective and excellent collaborators and innovators, participating in efforts to address and provide fast and efficient solutions
II.	To provide creative and innovative solutions to industrial design problems using computer aided tools.
III.	To pursue advanced education, research and development and other creative/ innovative efforts in their professional career.

2. PROGRAMME OUTCOMES (POs):

PO#	Programme Outcomes
1	An ability to independently carry out research/investigation and development work to solve practical problems.
2	An ability to write and present a substantial technical report/document.
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
4	Graduate will develop confidence for self-education and creativity knowledge in their field of Engineering.
5	Graduate will show the understanding of impact of engineering solutions on the society and also will be aware of contemporary issues.
6	Responsibility of understanding ethically and professionally and develop confidence for self-education and ability for life-long learning.

3. PEO / PO Mapping:

PEO	PO					
	1	**2**	**3**	**4**	**5**	**6**
I.	√		√	√		√
II.		√		√	√	
III.		√	√	√		√
IV.		√	√		√	√
V.	√	√		√	√	√

Every programme objectives must be mapped with 1,2,3,-, scale against the correlation PO's

		COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6
YEAR I	SEMESTER I	Advanced Mechanics of Materials	√		√			
		Computer Applications in Design		√		√	√	
		Concepts of Engineering Design			√			
		Design for Sustainability		√		√	√	
		Research Methodology and IPR	√		√		√	√
		Program Elective - I		√		√	√	
		Audit Course-I*	√	√		√		√
		Computer Aided Design Laboratory	√		√	√		√
		Technical Seminar		√	√	√		√
	SEMESTER II	Product Lifecycle Management	√		√	√		√
		Finite Element Methods in Mechanical Design	√		√			
		Vibration Analysis and Control	√				√	
		Solid Freeform Manufacturing						
		Professional Elective - II	√		√		√	
		Professional Elective - III					√	
		Audit Course - II			√		√	
		Vibration Laboratory		√	√			
		Simulation and Analysis Laboratory	√			√	√	
	SEMESTER III	Professional Elective - IV	√		√			
		Professional Elective - V		√				
		Open Elective				√		
		Project Work-I	√			√		√
YEAR II	SEMESTER IV	Project Work-II						

ANNA UNIVERSITY, CHENNAI
NON- AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY
M.E. COMPUTER AIDED DESIGN
REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA & SYLLABUS

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	ED4151	Advanced Mechanics of Materials	PCC	3	1	0	4	4
2.	ED4153	Computer Applications in Design	PCC	3	0	0	3	3
3.	CD4151	Concepts of Engineering Design	PCC	3	0	0	3	3
4.	CD4152	Design for Sustainability	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
PRACTICAL								
8.	CD4161	Computer Aided Design Laboratory	PCC	0	0	4	4	2
9.	CD4111	Technical Seminar	EEC	0	0	2	2	1
			TOTAL	**19**	**1**	**6**	**26**	**21**

* Audit Course is optional

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PD4391	Product Lifecycle Management	PCC	3	0	0	3	3
2.	ED4251	Finite Element Methods in Mechanical Design	PCC	3	1	0	4	4
3.	ED4154	Vibration Analysis and Control	PCC	3	0	0	3	3
4.	CM4152	Solid Freeform Manufacturing	PCC	3	0	0	3	3
5.		Professional Elective - II	PEC	3	0	0	3	3
6.		Professional Elective - III	PEC	3	0	0	3	3
7.		Audit Course - II		2	0	0	2	0
PRACTICAL								
8.	ED4161	Vibration Laboratory	PCC	0	0	4	4	2
9.	ED4261	Simulation and Analysis Laboratory	PCC	0	0	4	4	2
			TOTAL	**20**	**1**	**8**	**29**	**23**

* Audit Course is optional

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Professional Elective - IV	PEC	3	0	0	3	3
2.		Professional Elective - V	PEC	3	0	0	3	3
3.		Open Elective	OEC	3	0	0	3	3
PRACTICAL								
4.	CD4311	Project Work I	EEC	0	0	12	12	6
			TOTAL	**9**	**0**	**12**	**21**	**15**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICAL								
1.	CD4411	Project Work II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE: 71

PROFESSIONAL CORE COURSES (PCC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	ED4151	Advanced Mechanics of Materials	PCC	3	1	0	4	4
2.	ED4153	Computer Applications in Design	PCC	3	0	0	3	3
3.	CD4151	Concepts of Engineering Design	PCC	3	0	0	3	3
4.	CD4152	Design for Sustainability	PCC	3	0	0	3	3
5.	CD4161	Computer Aided Design Laboratory	PCC	0	0	4	4	2
6.	PD4391	Product Lifecycle Management	PCC	3	0	0	3	3
7.	ED4251	Finite Element Methods in Mechanical Design	PCC	3	1	0	4	4
8.	ED4154	Vibration Analysis and Control	PCC	3	0	0	3	3
9.	CM4152	Solid Freeform Manufacturing	PCC	3	0	0	3	3
10.	ED4161	Vibration Laboratory	PCC	0	0	4	4	2
11.	ED4261	Simulation and Analysis Laboratory	PCC	0	0	4	4	2

RESEARCH METHODOLOGY AND IPR COURSE (RMC)

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	RM4151	Research Methodology and IPR	2	0	0	2	1

PROFESSIONAL ELECTIVE COURSES

SEMESTER I, ELECTIVES – I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	PD4152	Integrated Product Development	PEC	3	0	0	3	3
2	ED4072	Composite Materials and Mechanics	PEC	3	0	0	3	3
3	ED4074	Design of Hydraulic and Pneumatic Systems	PEC	3	0	0	3	3
4	ED4079	Quality Concepts in Design	PEC	3	0	0	3	3
5	MA4071	Applied Probability and Statistics for Design Engineers	PEC	3	0	0	3	3

SEMESTER II, ELECTIVES – II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	ED4080	Tribology in Design	PEC	3	0	0	3	3
2	ED4091	Advanced Finite Element Analysis	PEC	3	0	0	3	3
3	ED4152	Advanced Mechanisms in Design	PEC	3	0	0	3	3
4	AO4091	Artificial Intelligence and Machine Learning	PEC	3	0	0	3	3
5	CD4001	Advanced Computer Manufacturing	PEC	3	0	0	3	3

SEMESTER II, ELECTIVES – III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	ED4093	Optimization Techniques in Design	PEC	3	0	0	3	3
2.	CD4091	Bio Materials	PEC	3	0	0	3	3
3.	ED4075	Mechanical Measurements and Analysis	PEC	3	0	0	3	3
4.	BM4074	Wearable Technologies	PEC	3	0	0	3	3
5.	AP4251	Industrial Internet of Things	PEC	3	0	0	3	3

SEMESTER III, ELECTIVES – IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	ED4094	Vehicle Dynamics	PEC	3	0	0	3	3
2.	PD4151	Creativity and Innovation	PEC	3	0	0	3	3
3.	CD4092	Industrial Robotics and Expert systems	PEC	3	0	0	3	3
4	PD4291	Designing with Advanced Materials	PEC	3	0	0	3	3
5	IC4291	Computational Fluid Dynamics	PEC	3	0	0	3	3

SEMESTER III, ELECTIVES-V

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	ED4092	Engineering Fracture Mechanics	PEC	3	0	0	3	3
2	ED4071	Design of Hybrid and Electric Vehicles	PEC	3	0	0	3	3
3	IL4093	Supply Chain Management	PEC	3	0	0	3	3
4	II4091	Industry 4.0	PEC	3	0	0	3	3
5	ED4073	Material Handling Systems and Design	PEC	3	0	0	3	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CD4111	Technical Seminar	EEC	0	0	2	2	1
2.	CD4311	Project Work I	EEC	0	0	12	12	6
3.	CD4411	Project Work II	EEC	0	0	24	24	12

AUDIT COURSES (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	நற்றமிழ் இலக்கியம்	2	0	0	0

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.	OBA431	Sustainable Management	3	0	0	3
8.	OBA432	Micro and Small Business Management	3	0	0	3
9.	OBA433	Intellectual Property Rights	3	0	0	3

10.	OBA434	Ethical Management	3	0	0	3
11.	ET4251	IoT for Smart Systems	3	0	0	3
12.	ET4072	Machine Learning and Deep Learning	3	0	0	3
13.	PX4012	Renewable Energy Technology	3	0	0	3
14.	PS4093	Smart Grid	3	0	0	3
15.	CP4391	Security Practices	3	0	0	3
16.	MP4251	Cloud Computing Technologies	3	0	0	3
17.	IF4072	Design Thinking	3	0	0	3
18.	MU4153	Principles of Multimedia	3	0	0	3
19.	DS4015	Big Data Analytics	3	0	0	3
20.	NC4201	Internet of Things and Cloud	3	0	0	3
21.	MX4073	Medical Robotics	3	0	0	3
22.	VE4202	Embedded Automation	3	0	0	3
23.	CX4016	Environmental Sustainability	3	0	0	3
24.	TX4092	Textile Reinforced Composites	3	0	0	3
25.	NT4002	Nanocomposite Materials	3	0	0	3
26.	BY4016	IPR, Biosafety and Entrepreneurship	3	0	0	3

ED4151	ADVANCED MECHANICS OF MATERIALS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES

1. To learn the concepts of theory of elasticity in three-dimensional stress system.
2. To study the shear centre of various cross-sections and deflections in beams subjected to unsymmetrical bending.
3. To learn the stresses in flat plates and curved members.
4. To study torsional stress of non-circular sections.
5. To learn the stresses in rotating members, contact stresses in point and line contact applications.

UNIT-I ELASTICITY 9+3

Stress-Strain relations and general equations of elasticity in Cartesian, Polar and curvilinear coordinates, differential equations of equilibrium-compatibility-boundary conditions-representation of three-dimensional stress of a tension generalized hook's law - St. Venant's principle - planestress - Airy's stress function. Energy methods.

UNIT-II SHEAR CENTRE AND UNSYMMETRICAL BENDING 9+3

Location of shear centre for various thin sections - shear flows. Stresses and Deflections in beams subjected to unsymmetrical loading-kern of a section.

UNIT-III STRESSES IN FLAT PLATES AND CURVED MEMBERS 9+3

Circumference and radial stresses – deflections - curved beam with restrained ends - closed ring subjected to concentrated load and uniform load - chain links and crane hooks. Solution of rectangular plates – pure bending of plates – deflection – uniformly distributed load – various end conditions

UNIT-IV TORSION OF NON-CIRCULAR SECTIONS 9+3

Torsion of rectangular cross section - St.Venants theory - elastic membrane analogy - Prandtl'sstress function - torsional stress in hollow thin walled tubes.

UNIT-V STRESSES IN ROTATING MEMBERS AND CONTACT STRESSES 9+3

Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness allowable speeds. Methods of computing contact stress-deflection of bodies in point and line contact applications.

TOTAL = 60 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

CO1 Apply the concepts of theory of elasticity in three-dimensional stress system.

CO2 Determine the shear centre of various cross-sections and deflections in beams subjected tounsymmetrical bending.

CO3 Evaluate the stresses in flat plates and curved members.

CO4 Calculate torsional stress of non-circular sections.

CO5 Determine the stresses in rotating members, contact stresses in point and line contactapplications.

REFERENCES:

1. Arthur P Boresi, Richard J.Schmidt, “Advanced Mechanics of Materials”, Wiley India Pvt.Ltd., 2009.
2. Hibbeler. R.C., “Mechanics of Materials”, Prentice-Hall, 2018.
3. Robert D.Cook, Warren C.Young, "Advanced Mechanics of Materials", Prentice Hall, 1999.
4. Srinath. L.S., “Advanced Mechanics of Solids”, Tata McGraw Hill, 2009.
5. Timoshenko and Goodier, "Theory of Elasticity", Tata McGraw Hill, 2010.

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	2	2	1	3	3	1
2	2	3	1	3	2	1
3	2	2	1	3	2	1
4	2	2	1	3	2	1
5	2	3	1	3	3	1
AVg.	2	2.4	1	3	2.4	1

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

ED4153	**COMPUTER APPLICATIONS IN DESIGN**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand fundamental concepts of computer graphics and its tools in a generic framework.
- To impart the parametric fundamentals to create and manipulate geometric models using curves, surfaces and solids.
- To impart the parametric fundamentals to create and manipulate geometric models using NURBS and solids.
- To provide clear understanding of CAD systems for 3D modeling and viewing.
- To create strong skills of assembly modeling and prepare the student to be an effective user of a standards in CAD system.

UNIT – I INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS 9

Overview of Graphics systems: Video Display Devices, Raster-Scan System, Random-Scan Systems, Graphics Monitors and Workstations, Input Devices, Hard-Copy Devices, Graphics Software.

Output primitives: Line Drawing Algorithm - DDA, Bresenham’s and Parallel Line Algorithm. Circle generating algorithm – Midpoint Circle Algorithm.

Geometric Transformations: Coordinate Transformations, Windowing and Clipping, 2D Geometric transformations-Translation, Scaling, Shearing, Rotation and Reflection, Composite transformation, 3D transformations.

UNIT – II CURVES AND SURFACES MODELLING 9

Introduction to curves - Analytical curves: line, circle and conics – synthetic curves: Hermite cubic spline- Bezier curve and B-Spline curve – curve manipulations.

Introduction to surfaces - Analytical surfaces: Plane surface, ruled surface, surface of revolution and tabulated cylinder – synthetic surfaces: Hermitebicubic surface- Bezier surface and B-Spline surface- surface manipulations.

UNIT – III NURBS AND SOLID MODELING 9

NURBS- Basics- curves, lines, arcs, circle and bi linear surface. Regularized Boolean set operations - primitive instancing - sweep representations - boundary representations - constructive solid Geometry - comparison of representations - user interface for solid modeling.

UNIT – IV VISUAL REALISM 9

Hidden Line removal, Hidden Surface removal, – Hidden Solid Removal algorithms - Shading – Coloring. Animation - Conventional, Computer animation, Engineering animation - types and techniques.

UNIT – V ASSEMBLY OF PARTS AND PRODUCT LIFE CYCLE MANAGEMENT 9

Assembly modeling – Design for manufacture – Design for assembly – computer aided DFMA - inferences of positions and orientation - tolerances analysis –Center of Gravity and mass property calculations - mechanism simulation. Graphics and computing standards - Data Exchange standards. Product development and management – new product development –models utilized in various phases of new product development – managing product life cycle.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Solve 2D and 3D transformations for the basic entities like line and circle.
2. Formulate the basic mathematics fundamental to CAD system.
3. Use the different geometric modeling techniques like feature based modeling, surface modeling and solid modeling.
4. Create geometric models through animation and transform them into real world systems
5. Simulate assembly of parts using Computer-Aided Design software.

REFERENCES:

1. Boothroyd, G, “Assembly Automation and Product Design” Marcel Dekker, New York, 1997.
2. Chitale A.K and Gupta R.C “ Product design and manufacturing “ PHI learning private limited, 6th Edition, 2015.
3. David Rogers, James Alan Adams “Mathematical Elements for Computer Graphics” 2nd Edition, Tata McGraw-Hill edition.2003
4. Donald D Hearn and M. Pauline Baker “Computer Graphics C Version”, Prentice Hall, Inc., 2nd Edition, 1996.
5. Ibrahim Zeid, "Mastering CAD/CAM", McGraw Hill, 2nd Edition, 2006
6. William M Newman and Robert F.Sproull “Principles of Interactive Computer Graphics”, McGraw Hill Book Co. 1stEdition, 2001.

MAPPING OF CO WITH PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	1	2	1	3	3	2
2	1	2	1	3	3	2
3	1	2	1	3	3	2
4	1	2	1	3	3	2
5	1	2	1	3	3	2
AVg.	1	2	1	3	3	2

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

CD4151	CONCEPTS OF ENGINEERING DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To impart knowledge on basic concepts in engineering design.
- To develop a product catering to the need sofa customer and considering quality and societal aspects in design
- To incorporate various design methods to develop a creative product.
- To gain knowledge on the selection of materials and manufacturing techniques for product design.
- To develop a robust and reliable product.

UNIT-I DESIGN FUNDAMENTALS 9

Importance of design- The design process-Considerations of Good Design – Morphology of design–Organization for design–Computer-Aided Engineering–Designing to codes and standards–Concurrent Engineering–Product and process cycles–Technological Forecasting – Market Identification –Competition Benchmarking

UNIT-II CUSTOMER-ORIENTED DESIGN&SOCIETAL CONSIDERATIONS 9

Identification of customer needs- customer requirements- Quality Function Deployment- Product Design Specifications-Human Factors in Design–Ergonomics, and Aesthetics, Societal consideration - Contracts – Product liability – Protecting intellectual property – Legal and ethical domains – Codes of ethics - Ethical conflicts – Environment responsible design-future trends in interaction of engineering with society

UNIT-III DESIGN METHODS 9

Creativity and problem solving–Creativity methods-Theory of Inventive Problem Solving (TRIZ)–Conceptual decomposition-Generating design concepts-Axiomatic Design–Evaluation methods-Embodiment Design-Product Architecture-Configuration Design- Parametric Design. Role of models in design-Mathematical Modeling – Simulation – Geometric Modeling –Rapid prototyping-Finite Element Analysis– Optimization–Search Methods

UNIT-IV MATERIAL SELECTION PROCESSING AND DESIGN 9

Material Selection Process–Economics–Cost Vs Performance–Weighted property Index–Value Analysis–Role of Processing in Design–Classification of Manufacturing Process–Design for Manufacture – Design for Assembly –Designing for castings, Forging, Metal Forming, Machining and Welding– Residual Stresses–Fatigue, Fracture, and Failure.

UNIT-V PROBABILITY CONCEPTS IN DESIGN FOR RELIABILITY 9

Probability–Distributions–Test of Hypothesis–Design of Experiments–Reliability Theory–Design for Reliability–Reliability centered Maintenance-Robust Design-Failure mode Effect Analysis

TOTAL= 45 PERIODS

OUTCOMES:

On Completion of the course, the student will be able to

- Appreciate the aspects of the need for design, design process used for designing various components.
- Get familiarized with concepts related to legal, human, and marketing factors during the design of products.
- Get acquainted with the knowledge of designing creative components.
- Gain knowledge on the material selection process and various design procedures.
- Get equipped with tools for improving quality, reliability, and performance of a product.

REFERENCES:

1. George E. Dieter, Linda C. Schmidt, “Engineering Design”, McGraw Hill Education Pvt.Ltd.,2013
2. Pahl.G,Beitz.W,“Engineering Design- A systematic approach”, Springer–Verlag,2005
3. Ray,M.S.,“Elements of Engineering Design”, Prentice HallInc.1985
4. Nam P. Suh, Ralph & Eloise F. Cross, “The Principles of Design”, Oxford University Press,1990
5. Karl T. Ulrich, Steven D. Eppinger, “Product Design And Development, Tata Mcgraw-Hill Education,2015

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	3	2	2	-	-	-
2	3	2	2	-	-	1
3	3	2	2	-	1	-
4	3	2	2	-	-	-
5	3	2	2	2	1	-
AVg.	15/5=3	10/5=2	10/5=2	2/1 = 2	2/2=1	1/1=1

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

CD4152 DESIGN FOR SUSTAINABILITY

L	**T**	**P**	**C**
3	**0**	**0**	**3**

COURSE OBJECTIVES

1. Selecting the relevant process; applying the general design principles for manufacturability;GD &T.
2. Applying the design considerations while designing the cast and welded components.
3. Applying the design considerations while designing the formed and machined components.
4. Apply design considerations for assembled systems.
5. Apply design considerations for environmental issues.

UNIT-I INTRODUCTION 9

Introduction - Economics of process selection - General design principles for manufacturability; Geometric Dimensioning & Tolerance (GD&T)– Formtolerancing: straightness, flatness, circularity, cylindricity – Profile tolerancing: profile of a line, and surface – Orientation tolerancing: angularity, perpendicularity, parallelism – Location tolerancing: position, concentricity, symmetry – runout tolerancing: circular and total–Supplementary symbols.

UNIT-II CAST & WELDED COMPONENTS DESIGN 9

Design considerations for: Sand cast – Die cast – Permanent mold parts. Arc welding – Design considerations for: Cost reduction – Minimizing distortion – Weld strength – Weldment. Resistance welding–Design considerations for:Spot–Seam–Projection–Flash &Upset weldment

UNIT-III FORMED &MACHINED COMPONENTS DESIGN 9

Design considerations for: Metal extruded parts – Impact/Cold extruded parts – Stamped parts – Forged parts. Design considerations for: Turned parts– Drilled parts – Milled, planned, shaped and slotted parts–Ground parts.

UNIT-IV DESIGN FOR ASSEMBLY 9

Design for assembly – General assembly recommendations – Minimizing the no. of parts – Design considerations for: Rivets – Screw fasteners – Gasket & Seals – Press fits – Snap fits – Automatic assembly– Computer Application for DFMA.

UNIT-V DESIGN FOR ENVIRONMENT 9

Introduction– Environmental objectives–Global issues–Regional and local issues–Basic DFE methods–Design guide lines–Example application–Life cycle assessment–Basic method–AT&T's environmentally responsible product assessment-Weighted sum assessment method–Life cycle assessment method–Techniques to reduce environmental impact–Design to minimize material usage–Design for disassembly–Design for recyclability–Design for manufacture–Design for energy efficiency –Design to regulations and standards.

TOTAL= 45 PERIODS

COURSE OUTCOMES:

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

1. Select relevant process; apply the general design principles for manufacturability; GD&T.
2. Apply design considerations while designing the cast and welded components.
3. Apply design considerations while designing the formed and machined components.
4. Apply design considerations for assembled systems.
5. Apply design considerations for environmental issues.

REFERENCES:

1. Boothroyd, G, 2nd Edition 2002, Design for Assembly Automation and Product Design. New York, Marcel Dekker.
2. Bralla, Design for Manufacture handbook, McGrawhill,1999
3. Boothroyd,G,Heartz and Nike,Product Design for Manufacture,MarcelDekker,1994
4. Dickson, John.R, and Corroda Poly, Engineering Design and Design for Manufacture and Structural Approach,Field Stone Publisher,USA,1995
5. Fixel, J. Design for the Environment McGraw Hill., 2nd Edition 2009
6. Graedel T.Allen By.B, Design for the Environment Angle Wood Cliff, Prentice Hall.ReasonPub.,1996
7. Kevin Otto and Kristin Wood, Product Design. Pearson Publication,(Fourth Impression) 2009
8. Harry Peck, Designing for manufacture, Pitman–1973

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	1	1	2	2	1	1
1	1	1	2	2	1	1
1	1	1	2	2	1	1
1	1	1	2	2	1	1
1	1	1	2	2	1	1
1	1	1	2	2	1	1

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

Patents – 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.

CD4161 COMPUTER AIDED DESIGN LABORATORY

L	T	P	C
0	0	4	2

COURSE OBJECTIVES:

- To impart knowledge on how to prepare drawings for various mechanical components using any commercially available 3D modeling software's

- **CAD Introduction.**
- **Sketcher**
- **Solid modeling**–Extrude, Revolve, Sweep and variational sweep, Loft
- **Surface modeling**–Extrude, Sweep, Trim and Mesh of curves, Freeform.
- **Feature manipulation**–Copy, Edit, Pattern, Suppress, History operations etc.
- **Assembly**-Constraints, Exploded Views, Interference check
- **Drafting**-Layouts, Standard & Sectional Views, Detailing & Plotting.

Exercises in modeling and drafting of mechanical components-assembly using parametric and feature-based packages like PRO-E/SOLIDWORKS /CATIA/NX

TOTAL: 60 PERIODS

OUTCOMES:

On completion of the course the student will be able to

- Use the modern engineering tools necessary for engineering practice
- Draw 2D part drawings, sectional views, and assembly drawings as per standards.
- Create 3D Model on any CAD software.
- Convert 3D solid models into 2D drawings and prepare different views, sections, and dimensioning of part models.
- Examine interference to ensure that parts will not interfere.

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	1	3	3	2	2	
2	1	3	3	2	2	
3	1	3	3	2	2	
4	1	3	3	2	2	
AVg.	1	3	3	2	2	

CD4111 TECHNICAL SEMINAR

L	T	P	C
0	0	2	1

OBJECTIVES:

- To work on a specific technical topic in Engineering design related topics to acquire the skills of oral presentation.
- To acquire technical writing abilities for seminars and conferences.

The students will work for two hours per week guided by a group of staff members. They will be asked to talk on any topic of their choice related to Engineering design topics and to engage in dialogue with the audience. A brief copy of their talk also should be submitted. Similarly, the students will have to present a seminar of not less than fifteen minutes and not more than thirty minutes on the technical topic. They will also answer the queries on the topic. The students as the audience also should interact. Evaluation will be based on the technical presentation and their port and also on the interaction during the seminar.

TOTAL:30 PERIODS

OUTCOMES:

On Completion of the course the student will be able to

- Students comprehend concepts and methods adequate to understand inductive and deductive reasoning, and increase their general problem-solving skills.
- Students develop communicative skills (e.g. speaking, listening, reading, and/ or writing).

PD4391 PRODUCT LIFE CYCLE MANAGEMENT L T P C

3 0 0 3

OBJECTIVES:

1. To understand history, concepts and terminology of PLM
2. To understand functions and features of PLM/PDM
3. To understand different modules offered in commercial PLM/PDM tools
4. To demonstrate PLM/PDM approaches for industrial applications
5. To Use PLM/PDM with legacy data bases, CAx & ERP systems

UNIT I HISTORY, CONCEPTS AND TERMINOLOGY OF PLM 9

Introduction to PLM, Need for PLM, opportunities of PLM, Different views of PLM - Engineering Data Management (EDM), Product Data Management (PDM), Collaborative Product Definition Management (cPDm), Collaborative Product Commerce (CPC), Product Lifecycle Management (PLM).PLM/PDM Infrastructure – Network and Communications, Data Management, Heterogeneous data sources and applications.

UNIT II PLM/PDM FUNCTIONS AND FEATURES 9

User Functions – Data Vault and Document Management, Workflow and Process Management, Product Structure Management, Product Classification and Programme Management. Utility Functions – Communication and Notification, data transport, data translation, image services, system administration and application integration.

UNIT III DETAILS OF MODULES IN APDM/PLM SOFTWARE 9

Case studies based on top few commercial PLM/PDM tools

UNIT IV ROLE OF PLM ININDUSTRIES 9

Case studies on PLM selection and implementation (like auto, aero, electronic) - other possible sectors, PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten step approach to PLM, benefits of PLM for–business, organization, users, product or service, process performance.

UNIT V BASICS ON CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE 9

PLM Customization, use of EAI technology (Middleware), Integration with legacy data base, CAD, SLM and ERP

TOTAL:45 PERIODS

OUTCOMES:

The students will be able to

1. Summarize the history, concepts and terminology of PLM
2. Use the functions and features of PLM/PDM
3. Use different modules offered in commercial PLM/PDM tools.
4. Implement PLM/PDM approaches for industrial applications.
5. Integrate PLM/PDM with legacy data bases, CAx& ERP systems.

CO	PO					
	1	2	3	4	5	6
1	1	2	2	1	-	-
2	2	2	2	1	-	-
3	2	1	2	1	-	-
4	1	1	3	1	-	-
5	1	1	1	1	-	-
Avg	1.4	1.4	2	1	-	-

REFERENCES

1. Antti Saaksvuori and Anselmi Immonen, “Product Lifecycle Management”, Springer Publisher, 2008 (3rd Edition).
2. International Journal of Product Lifecycle Management, Inderscience Publishers
3. Ivica Crnkovic, Ulf Asklund and Annita Persson Dahlqvist, “Implementing and Integrating Product Data Management and Software Configuration Management”, Artech House Publishers, 2003.
4. John Stark, “Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question”, Springer Publisher, 2007.
5. John Stark, “Product Lifecycle Management: 21st Century Paradigm for Product Realisation”, Springer Publisher, 2011 (2nd Edition).
6. Michael Grieves, “Product Life Cycle Management”, Tata McGraw Hill, 2006.

ED4251 FINITE ELEMENT METHODS IN MECHANICAL DESIGN

L	T	P	C
3	1	0	4

COURSE OBJECTIVES

1. To learn mathematical models for one dimensional problems and their numerical solutions
2. To learn two dimensional scalar and vector variable problems to determine field variables
3. To learn Iso parametric transformation and numerical integration for evaluation of element matrices
4. To study various solution techniques to solve Eigen value problems
5. To learn solution techniques to solve non-linear problems

UNIT-I FINITE ELEMENT ANALYSIS OF ONEDIMENSIONAL PROBLEMS **9+3**

Historical Background – Weighted Residual Methods - Basic Concept of FEM – Variational Formulation of B.V.P. – Ritz Method – Finite Element Modelling – Element Equations – Linear and Higher order Shape functions – Bar, Beam Elements –Applications to Heat Transfer problems.

UNIT-II FINITE ELEMENT ANALYSIS OF TWO DIMENSIONAL PROBLEMS **9+3**

Basic Boundary Value Problems in two-dimensions – Linear and higher order Triangular, quadrilateral elements – Poisson’s and Laplace’s Equation – Weak Formulation – Element Matrices and Vectors – Application to scalar variable problems - Introduction to Theory of Elasticity – Plane Stress – Plane Strain and Axisymmetric Formulation – Principle of virtual work – Element matrices using energy approach

UNIT-III ISO-PARAMETRIC FORMULATION 9+3

Natural Co-ordinate Systems – Lagrangian Interpolation Polynomials – Iso parametric Elements –Formulation – Shape functions -one dimensional , two dimensional triangular and quadrilateral elements -Serendipity elements- Jacobian transformation - Numerical Integration – Gauss quadrature – one, two and three point integration

UNIT-IV EIGEN VALUE PROBLEMS 9+3

Dynamic Analysis – Equations of Motion – Consistent and lumped mass matrices – Free Vibration analysis – Natural frequencies of Longitudinal, Transverse and torsional vibration – Solution of Eigenvalue problems - Introduction to transient field problems

UNIT-V NON-LINEAR ANALYSIS 9+3

Introduction to Non-linear problems - some solution techniques- computational procedure-material non-linearity-Plasticity and viscoplasticity, stress stiffening, contact interfaces- problems of gaps and contact - geometric non-linearity - modeling considerations - Free and Mapped meshing -Mesh quality- Error estimate

TOTAL = 60 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

- **CO1** Develop mathematical models for one dimensional problems and their numerical solutions
- **CO2** Determine field variables for two dimensional scalar and vector variable problems
- **CO3** Apply Isoparametric transformation and numerical integration for evaluation of element matrices
- **CO4** Apply various solution techniques to solve Eigen value problems
- **CO5** Formulate solution techniques to solve non-linear problems

REFERENCES:

1. Bathe K.J., “Finite Element Procedures in Engineering Analysis”, Prentice Hall, 1990
2. David Hutton, “Fundamentals of Finite Element Analysis”, Tata McGrawHill, 2005
3. Rao, S.S., “The Finite Element Method in Engineering”, 6th Edition, Butterworth-Heinemann,2018.
4. Reddy,J.N. “Introduction to the Finite Element Method”, 4 thEdition, Tata McGrawHill,2018
5. Seshu.P, “Text Book of Finite Element Analysis”, PHI Learning Pvt. Ltd., New Delhi, 2012.
6. Tirupathi R. Chandrupatla and Ashok D.Belegundu, “Introduction to Finite Elements inEngineering”, International Edition, Pearson Education Limited, 2014.

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	3	2	2	2	3	-
2	3	2	2	2	3	-
3	3	2	2	2	3	-
4	3	2	2	2	3	-
5	3	2	2	2	3	-
AVg.	3	2	2	2	3	-

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

ED4154	VIBRATION ANALYSIS AND CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To appreciate the basic concepts of vibration in damped and undamped systems
2. To calculate the natural frequencies and mode shapes of the two degree freedom systems
3. To determine the natural frequencies and mode shapes of the multi degree freedom and continuous systems
4. To learn the fundamentals of control techniques of vibration and noise levels
5. To use the instruments for the measuring and analyzing the vibration levels in a body

UNIT-I FUNDAMENTALS OF VIBRATION 9+3

Introduction -Sources of Vibration-Mathematical Models- Displacement, velocity and Acceleration-Review Of Single Degree Freedom Systems -Vibration isolation Vibrometers and accelerometers - Response To Arbitrary and non- harmonic Excitations – Transient Vibration –Impulse loads-Critical Speed Of Shaft-Rotor systems

UNIT-II TWO DEGREE FREEDOM SYSTEM 9+3

Introduction-Free Vibration Of Undamped And Damped - Forced Vibration With Harmonic Excitation System –Coordinate Couplings And Principal Coordinates.

UNIT-III MULTI-DEGREE FREEDOM SYSTEM AND CONTINUOUS SYSTEM 9+3

Multi Degree Freedom System –Influence Coefficients and stiffness coefficients- Flexibility Matrix and Stiffness Matrix – Eigen Values and Eigen Vectors-Matrix Iteration Method –Approximate Methods: Dunkerley, Rayleigh's, and Holzer Method -Geared Systems-Eigen Values & Eigenvectors for large system of equations using sub space, Lanczos method - Continuous System: Vibration of String, Shafts and Beams

UNIT-IV VIBRATION AND NOISE CONTROL 9+3

Specification of Vibration Limits – Vibration severity standards- Vibration as condition Monitoring Tool-Vibration Isolation methods - Dynamic Vibration Absorber - Static and Dynamic Balancing machines – Field balancing - Major sources of noise – Noise survey techniques – Measurement technique for vehicular noise – Road vehicle noise standards – Industrial noise sources – Control Strategies – Noise control at the source and along the path – use of acoustic barriers – Noise control at the receiver.

UNIT-V EXPERIMENTAL METHODS IN VIBRATION ANALYSIS 9+3

Vibration Analysis Overview - 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

TOTAL = 60 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

- **CO1** Apply the basic concepts of vibration in damped and undamped systems
- **CO2** Determine the natural frequencies and mode shapes of the two degree freedom systems.
- **CO3** Calculate the natural frequencies and mode shapes of the multi degree freedom andcontinuous systems
- **CO4** Control the vibration and noise levels in a body
- **CO5** Measure and analyze the vibration levels in a body

REFERENCES:

1. Graham Kelly, Sand Shashidhar K. Kudari, “Mechanical Vibrations”, Tata McGraw – Hill Publishing Com. Ltd., 2007
2. Singiresu S. Rao,”Mechanical Vibrations,”Pearson Education Incorporated, 2017
3. Ramamurti.V,“MechanicalVibrationPracticewithBasicTheory”,NarosaPublishingHouse, 2010
4. WilliamT.Thomson,“TheoryofVibrationwithApplications”,Taylor&Francis,2018

CO	PO					
	1	2	3	4	5	6
1	3	3	2	-	-	1
2	3	2	2	-	2	-
3	3	2	3	-	2	-
4	3	3	3	-	2	-
5	3	3	3	3	2	-
AVG	3	2.6	2.6	3	2	1

CM4152 SOLID FREEFORM MANUFACTURING L T P C
3 0 0 3

COURSE OBJECTIVES:

- To acquaint the students with evolution of Solid Freeform Manufacturing (SFM) / Additive Manufacturing (AM), proliferation into various fields and its effects on supply chain.
- To gain knowledge on Design for Additive Manufacturing (DFAM) and its importance in quality improvement of fabricated parts.
- To acquaint with polymerization and sheet lamination processes and their applications.
- To acquaint with material extrusion and powder bed fusion processes.
- To gain knowledge on jetting and direct energy deposition processes and their applications.

UNIT I INTRODUCTION 9

Need - Development of SFM systems – Hierarchical structure of SFM - SFM process chain – Classification – Applications. Case studies: Bio printing- Food Printing- Electronics printing – Rapid Tooling - Building printing. AM Supply chain. Economics aspect: Strategic aspect- Operative aspect.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING 9

Concepts and Objectives - AM Unique Capabilities - Part Consolidation - Topology Optimization - Lightweight Structures - DFAM for Part Quality Improvement - CAD Modeling - Model Reconstruction - Data Processing for AM - Data Formats - Data Interfacing - Part Orientation - Support Structure Design and Support Structure Generation - Model Slicing - Tool Path Generation. Design Requirements of Additive Manufacturing: For Part Production, For Mass Production, For Series Production. Case Studies.

UNIT III VAT POLYMERIZATION AND SHEET LAMINATION PROCESSES 9

Stereolithography Apparatus (SLA): Principles – Photo Polymerization of SL Resins - Pre Build Process – Part-Building and Post-Build Processes - Part Quality and Process Planning, Recoating Issues - Materials - Advantages - Limitations and Applications. Digital Light Processing (DLP) - Materials - Process - Advantages and Applications.

Laminated Object Manufacturing (LOM): Working Principles - Process - Materials, Advantages, Limitations and Applications. Ultrasonic Additive Manufacturing (UAM) - Process - Parameters - Applications. Case Studies.

UNIT IV MATERIAL EXTRUSION AND POWDER BED FUSION PROCESSES 9

Fused deposition Modeling (FDM): Working Principles - Process - Materials and Applications. Design Rules for FDM.

Selective Laser Sintering (SLS): Principles - Process - Indirect and Direct SLS - Powder Structure – Materials - Surface Deviation and Accuracy - Applications. Multijet Fusion.

Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Principles – Processes – Materials – Advantages - Limitations and Applications. Case Studies.

UNIT V JETTING AND DIRECT ENERGY DEPOSITION PROCESSES 9

Binder Jetting: Three dimensional Printing (3DP): Principles – Process - Physics of 3DP - Types of printing: Continuous mode – Drop on Demand mode - Process – Materials - Advantages - Limitations - Applications.

Material Jetting: Multi Jet Modelling (MJM) - Principles - Process - Materials - Advantages and Limitations.

Laser Engineered Net Shaping (LENS): Processes- Materials- Advantages - Limitations and Applications. Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Relate the importance in the evolution of SFM/AM, proliferation into the various fields and its effects on supply chain.

CO2: Analyze the design for AM and its importance in the quality of fabricated parts.

CO3: Build knowledge on principles and applications of polymerization and sheet lamination processes with case studies.

CO4: Explain the principles of material extrusion and powder bed fusion processes and design guidelines.

CO5: Elaborate jetting and direct energy deposition processes and their applications.

REFERENCES:

1. Andreas Gebhardt and Jan-Steffen Hotter, “Additive Manufacturing:3D Printing for Prototyping and Manufacturing”, Hanser publications Munchen, Germany, 2016. ISBN:978-1-56990-582-1.
2. Ben Redwood, Brian Garret, FilemonSchöffer, and Tony Fadel, “The 3D Printing Handbook: Technologies, Design and Applications”, 3D Hubs B.V., Netherland, 2017. ISBN-13: 978-9082748505.
3. Ian Gibson, David W. Rosen and Brent Stucker, “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing” Springer - New York, USA, 2nd Edition, 2015. ISBN-13: 978-1493921126.
4. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press, 1st Edition, 2007 FL, USA. ISBN- 9780849334092.
5. Milan Brandt., “Laser Additive Manufacturing 1st Edition Materials, Design, Technologies, and Applications”, Woodhead Publishing, UK, 2016. ISBN- 9780081004333.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2	3	1	3	3	2
CO2	3	2	3	3	3	2
CO3	3	3	2	3	2	1
CO4	3	3	2	3	2`	1
CO5	3	3	2	3	2	1
Avg	(14/5)=2.8	(14/5)=2.8	(10/5)=2	(15/5)=3	(10/4)=2.5	(7/5)=1.4

ED4161	VIBRATION LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE:

1. To evaluate the stiffness and natural frequency of spring-mass systems.
2. To determine the natural frequencies of damped and undamped torsional vibrations of single rotor systems and obtain the radius of gyration of a body through torsional oscillations.
3. To acquire the critical speed of shaft supported at its ends.
4. To assess the natural frequency, damping coefficient, mode shapes of specimens under free vibrations.
5. To determine the natural frequency of specimens under forced vibrations

LIST OF EXPERIMENTS: 30

1) Determination of stiffness and natural frequency of undamped spring-mass systems arranged in series, parallel and series-parallel fashions
2) Determination of effective radius of gyration of an irregular body through torsional oscillation of tri filar suspension
3) Determination of natural frequency a single rotor un damped shaft system
4) Determination of natural frequency a single rotor damped shaft system
5) Determination of critical speed of shaft
6) Determination of natural frequency and mode shapes of specimens supported at its ends through modal analysis
7) Determination of damping coefficient of specimens supported at its ends
8) Forced vibration of specimens supported under simply supported and cantilever boundary conditions – Determination of natural frequency

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

CO 1 Evaluate the stiffness and natural frequency of spring-mass systems.

CO 2 Determine the natural frequencies of damped and undamped torsional vibrations of single rotor systems

CO 3 Acquire the critical speed of shaft supported at its ends.

CO 4 Assess the natural frequency, damping coefficient, mode shapes of specimens under free vibrations.

CO 5 Determine the natural frequency of specimens under forced vibrations.

CO	PO					
	1	2	3	4	5	6
1	1	1	2	1	1	1
2	1	1	2	1	1	1
3	1	1	2	1	1	1
4	1	1	2	1	1	1
5	1	1	2	1	1	1
AVg.	1	1	2	1	1	1

		L	T	P	C
ED4261	**SIMULATION AND ANALYSIS LABORATORY**	**0**	**0**	**4**	**2**

OBJECTIVES:

• To give exposure to software tools needed to analyze engineering problems.

LIST OF EXPERIMENTS

1. Force and Stress analysis using link elements in Trusses.
2. Stress and deflection analysis in beams with different support conditions.
3. Stress analysis of flat plates.
4. Stress analysis of axi–symmetric components.
5. Thermal stress and heat transfer analysis of plates.
6. Thermal stress analysis of cylindrical shells.
7. Vibration analysis of spring-mass systems.
8. Modal analysis of Beams.
9. Harmonic, transient and spectrum analysis of simple systems.
10. Analysis of machine elements under dynamic loads
11. Analysis of non-linear systems

TOTAL:60 PERIODS

LIST OF EQUIPMENTS/SOFTWARE:

Finite Element Analysis packages

COURSE OUTCOMES:

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

CO1 Solve engineering problems numerically using Computer Aided Finite Element Analysis packages

CO2 Analyze the force, stress, deflection in mechanical components.

CO3 Analyze thermal stress and heat transfer in mechanical components.

CO4 Analyze the vibration of mechanical components.

CO5 Analyze the modal, harmonic, transient and spectrum concepts in mechanical components.

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	2	3	3	2	3	3
2	2	3	3	2	3	3
3	2	3	3	3	3	3
4	2	3	3	1	2	3
5	2	3	3	3	3	3
AVg.	2	3	3	2.2	2.8	3

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

CD4311 **PROJECT WORK I** **L T P C**
0 0 12 6

COUSE OBJECTIVES:

- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
- To develop the methodology to solve the identified problem.
- To train the students in preparing project reports and to face reviews and viva-voce examination.

SYLLABUS: The student individually works on a specific topic approved by the head of the division under the guidance of a faculty member who is familiar in this area of interest. The student can select any topic which is relevant to the area of engineering design. The topic may be theoretical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

TOTAL: 180 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to
CO1 Demonstrate a sound technical knowledge of their selected project topic.
CO2 Undertake problem identification, formulation and solution.
CO3 Design engineering solutions to complex problems utilising a systems approach

The students will have a clear idea of their area of work and they will be in a position to carry out the remaining phase II work in a systematic way.

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	2	2	3	2	2	2
2	2	2	3	2	2	2
3	2	2	3	2	2	2
AVg.	2	2	3	2	2	2

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

CD4411 **PROJECT WORK II** **L T P C**
0 0 24 12

OBJECTIVES:

- To solve the identified problem based on the formulated methodology.
- To develop skills to analyze and discuss the test results, and make conclusions.

SYLLABUS:

The student should continue the phase I work on the selected topic as per the formulated methodology under the same supervisor. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated based on the report submitted and the viva-voce examination by a panel of examiners including one external examiner

TOTAL: 360 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

CO1 Demonstrate a sound technical knowledge of their selected project topic.

CO2 Undertake problem identification, formulation and solution.

CO3 Design engineering solutions to complex problems utilising a systems approach

CO4 Demonstrate the knowledge, skills and attitudes of a professional engineer to take up any challenging practical problem in the field of engineering design and find better solutions to it.

CO	PO					
	1	2	3	4	5	6
1	2	3	3	2	3	2
2	2	3	3	2	3	2
3	2	3	3	2	3	2
4	2	3	3	2	3	2
AVg.	2	3	3	2	3	2

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

PD4152 INTEGRATED PRODUCT DEVELOPMENT L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To Understand the principles of generic development process; product planning; customer need analysis for new product design and development.
2. To enhance the understanding of setting product specifications and generate, select, screen, and test concepts for new product design and development.
3. To apply the principles of product architecture and the importance of industrial design principles and DFM principles for new product development.
4. To expose the different Prototyping techniques, Design of Experiment principles to develop a robust design and importance to patent a developed new product.
5. Applying the concepts of economics principles; project management practices in development of new product.

UNIT– I INTRODUCTION TO PRODUCT DESIGN **9**

Characteristics of Successful Product development –Duration and Cost of Product Development – Challenges of Product Development - Product Development Processes and Organizations – Product Planning Process - Process of Identifying Customer Needs

UNIT– II PRODUCT SPECIFICATIONS, CONCEPT GENERATION, SELECTION AND TESTING **9**

Establish Target and Final product specifications – Activities of Concept Generation - Concept Screening and Scoring - Concept Testing Methodologies.

UNIT–III PRODUCT ARCHITECTURE AND INDUSTRIAL DESIGN **9**

Product Architecture – Implications and establishing the architecture – Delayed Differentiation – Platform Planning – Related system level design issues - Need and impact of industrial design - Industrial design process - management of the industrial design process - assessing the quality of industrial design

UNIT– IV DESIGN FOR MANFACTURE, PROTOTYPING AND ROBUST DESIGN **9**

DFM Definition - Estimation of Manufacturing cost- Reducing the component costs, costs of supporting function and assembly costs – Impact of DFM decision on other factors - Prototype basics - Principles of prototyping – Prototyping technologies - Planning for prototypes - Robust design –Robust Design Process

UNIT– V PRODUCT DEVELOPMENT ECONOMICS AND MANAGING PROJECTS **9**

Economic Analysis – Elements of Economic Analysis - Understanding and representing tasks- Baseline Project Planning - Accelerating the project - Project execution – Postmortem project evaluation.

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

1. Apply the principles of generic development process; product planning; customer need analysis for new product design and development.
2. Set product specifications and generate, select, screen, test concepts for new product design and development.
3. Apply the principles of product architecture, industrial design and design for manufacturing principles in new product development.
4. Apply the adopt Prototyping techniques and Design of Experiment principles to develop a robust design and document a new product for patent.

REFERENCES:

1. Karl T.Ulrich, Steven D.Eppinger, Anita Goyal, "Product Design and Development", McGraw –Hill Education (India) Pvt. Ltd, 4th Edition, 2012.
2. Kenneth Crow, "Concurrent Engineering/Integrated Product Development". DRM Associates, 6/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569,Workshop Book
3. Kevin N Otto, Kristin L Wood, “Product Design – Techniques in Reverse Engineering and New Product Development”, Pearson Education, Inc, 2016
4. Stephen Rosenthal, "Effective Product Design and Development", Business One Orwin Homewood, 1992
5. Stuart Pugh, "Total Design – Integrated Methods for successful Product Engineering", Addison Wesley Publishing, Neyourk, NY, 1991**.**

CO	PO					
	1	2	3	4	5	6
1	3	3	3	3	3	-
2	3	3	3	3	3	-
3	3	3	3	3	3	-
4	3	3	3	3	3	-
5	3	3	3	3	3	-
AVg.	3	3	3	3	3	-

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

ED4072 COMPOSITE MATERIALS AND MECHANICS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. Study of different composite materials and finding its mechanical strength
2. Fabrication of FRP and other composites by different manufacturing methods
3. Stress analysis of fiber reinforced Laminates for different combinations of plies with different orientations of the fiber.
4. Calculation of stresses in the lamina of the laminate using different failure theories
5. Calculation of residual stresses in different types of laminates under thermo-mechanical load using the Classical Laminate Theory.

UNIT-I INTRODUCTION TO COMPOSITE MATERIALS 9

Definition-Matrix materials-polymers-metals-ceramics - Reinforcements: Particles, whiskers, inorganic fibers, metal filaments-ceramic fibers-fiber fabrication-natural composite wood, Jute-Advantages and drawbacks of composites over monolithic materials. Mechanical properties and applications of composites, Particulate-Reinforced composite Materials, Dispersion-Strengthened composite, Fiber-reinforced composites Rule of mixtures-Characteristics of fiber-Reinforced composites, Manufacturing fiber and composites

UNIT- II MANUFACTURING OF COMPOSITES 9

Manufacturing of Polymer Matrix Composites (PMCs)-handlay-up, spray technique, filament winding, Pultrusion, Resin Transfer Moulding (RTM)-,bag moulding, injection moulding, Sandwich Mould Composites (SMC) - Manufacturing of Metal Matrix Composites (MMCs) - Solid state, liquid state, vapour state processing, Manufacturing of Ceramic Matrix Composites (CMCs)–hot pressing-reaction bonding process-infiltration technique, directoxidation-interfaces

UNIT-III LAMINA CONSTITUTIVE EQUATIONS 9

Lamina Constitutive Equations: Lamina Assumptions–Macroscopic Viewpoint.Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle PlyLaminates, CrossPly Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.

UNIT-IV LAMINA STRENGTH ANALYSIS AND ANALYSIS OF LAMINATED FLAT PLATES 9

Introduction- Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill's Criterion for Anisotropic materials. Tsai-Hill's Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations–Natural Frequencies

UNIT- V THERMO-STRUCURALANALYSIS 9

Fabrication stresses / Residual stresses in FRP laminated composites-Co-efficient of Thermal Expansion (C.T.E.) - Modification of Hooke's Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T.E's -Stress and Moment Resultants due cooling of the laminates during fabrication-Calculations for thermo-mechanical stresses in FRP laminates

Case studies: Implementation of CLT for evaluating residual stresses in the components made with different isotropic layers such as electronic packages etc.

TOTAL= 45 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

1. Calculate for mechanical strength of the composite material
2. Fabricate the FRP and other composites by different manufacturing methods
3. Analyze fiber reinforced Laminates for different combinations of plies with different orientations of the fiber.

4. Evaluate the stresses in the lamina of the laminate using different failure theories
5. Analyze thermo-mechanical behavior and evaluate residual stresses in different types of laminates using the Classical Laminate Theory.

REFERENCES:

1. Agarwal BD and Broutman LJ, "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York,1990.
2. Gibson RF, Principles of Composite Material Mechanics, CRC press,4th Edition,2015.
3. Hyer MW and Scott R White, "Stress Analysis of Fiber – Reinforced Composite Materials",McGraw-Hill,1998
4. Issac M Daniel and Orilshai, "Engineering Mechanics of Composite Materials", Oxford University Press - 2006, First Indian Edition-2007
5. Madhujit Mukhopadhyay,"Mechanics of Composite Materials and Structures", University Press(India)Pvt.Ltd.,Hyderabad,2004(Reprinted 2008)
6. Mallick PK, Fiber – Reinforced Composites: Materials, Manufacturing and Design, CRC Press, 3rd Edition,2007.

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	1	1	3	2	2	2
2	1	1	3	2	2	2
3	1	1	3	2	2	2
4	1	1	3	2	2	2
5	1	1	3	2	2	2
AVg.	1	1	3	2	2	2

ED4074 DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS

L	**T**	**P**	**C**
3	**0**	**0**	**3**

COURSE OBJECTIVES:

1. To introduce the different components of hydraulic systems and its design and selection procedures.
2. To formulate a thorough understanding on the need and use of various control and regulating elements in hydraulic systems.
3. To enable them to independently design hydraulic circuits for industrial applications
4. To expose them to the different components of pneumatic systems and enable them to design simple pneumatic systems.
5. To make them understand the need to integrate electronics and develop low cost systems and provide solution to simple industrial applications

UNIT– I OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS 9

Hydraulic Power Generators – Selection and specification of pumps, pump characteristics. Linear and Rotary Actuators – selection, specification and characteristics, Hydrostatic drives, types, selection.

UNIT– II CONTROL AND REGULATION ELEMENTS 9

Pressure-direction and flow control valves-relief valves, non-return and safety valves-actuation systems, Proportional Electro hydraulic servo valves.

UNIT–III HYDRAULIC CIRCUITS 9

Reciprocation, quick return, sequencing, synchronizing circuits - accumulator circuits – industrial circuits - press circuits - hydraulic milling machine - grinding, planning, copying, - forklift, earth mover circuits design methodology-design and selection of components-safety and Emergency mandrels–Cascade method.

UNIT– IV PNEUMATIC SYSTEMS AND CIRCUITS 9

Pneumatic fundamentals-control elements, position and pressure sensing, Pneumatic equipments- selection of components - design calculations - logic circuits - switching circuits – fringe conditions modules and these integration-sequential circuits-cascade methods-mapping methods - step counter method - compound circuit design - combination circuit design-Karnaugh-Veitch map

UNIT– V ELECTROMAGNETIC & ELECTRONIC CONTROL OF HYDRAULICS & PNEUMATIC CIRCUIT 9

Electrical control of pneumatic circuits–use of relays, counters, timers, ladder diagrams, use of microprocessor in circuit design – use of PLC in hydraulic and pneumatic circuits – Fault finding–application-fault finding -hydro pneumatic circuits –use of microprocessors for Sequencing- PLC, Low cost automation- Robotic circuits.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Design and select appropriate pumps in industries based on need.
2. Select correct sizing and rating of control elements in hydraulics.
3. Design basic circuits (hydraulic) for industrial applications.
4. Design basic pneumatic circuits for industrial applications.
5. Identify and provide solution for troubleshooting and design low cost automation for industrial application.

REFERENCES:

1. Anthony Esposito, “Fluid Power with Applications”, Prentice Hall,2009.
2. Jagadeesha T, “Pneumatics Concepts, Design and Applications“, Universities Press,2015
3. James A.Sullivan, “Fluid Power Theory and Applications”, Fourth Edition, Prentice Hall, 1997
4. Majumdar,S.R., “Oil Hydraulics Systems–Principles and Maintenance”, Tata McGrawHill, 2001
5. Shanmuga Sundaram.K, “Hydraulic and Pneumatic Controls”.Chand&Co,2006

CO	PO					
	1	2	3	4	5	6
1	1	1	1	2	2	1
2	1	1	1	2	2	1
3	1	1	1	2	2	1
4	1	1	1	2	2	1
5	1	1	1	2	2	1
AVg.	1	1	1	2	2	1

ED4079	QUALITY CONCEPTS IN DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To impart knowledge on various concepts in engineering design, material selection and manufacturing methods.
2. To learn the principles of implementing quality in a product or services using different tools
3. To enhance the quality of product by use of failure mode effect analysis and implement methods to uphold the status of six sigma
4. To develop a robust product or service using various strategies of design of experiments
5. To maintain the quality of the product by use of statistical tools and enforce methods to improve the reliability of a product

UNIT – I DESIGN FUNDAMENTALS, METHODS AND MATERIAL SELECTION 9

Morphology of Design – The Design Process – Computer Aided Engineering – Concurrent Engineering – Competition Bench Marking – Creativity – Theory of Problem solving (TRIZ) – Value Analysis - Design for Manufacture, Design for Assembly – Design for casting, Forging, Metal Forming, Machining and Welding.

UNIT – II DESIGN FOR QUALITY 9

Quality Function Deployment -House of Quality-Objectives and functions-Targets-Stakeholders-Measures and Matrices-Design of Experiments –design process-Identification of control factors, noise factors, and performance metrics - developing the experimental plan- experimental design – testing noise factors- Running the experiments –Conducting the analysis-Selecting and conforming factor-Set points-reflecting and repeating.

UNIT – III FAILURE MODE EFFECTS ANALYSIS AND DESIGN FOR SIX SIGMA 9

Basic methods: Refining geometry and layout, general process of product embodiment - Embodiment checklist- Advanced methods: systems modeling, mechanical embodiment principles-FMEA method- linking fault states to systems modeling - Basis of SIX SIGMA – Project selection for SIX SIGMA- SIX SIGMA problem solving- SIX SIGMA in service and small organizations - SIX SIGMA and lean production –Lean SIX SIGMA and services.

UNIT – IV DESIGN OF EXPERIMENTS 9

Importance of Experiments, Experimental Strategies, Basic principles of Design, Terminology, ANOVA, Steps in Experimentation, Sample size, Single Factor experiments – Completely Randomized design, Randomized Block design, Statistical Analysis, Multifactor experiments - Two and three factor full Factorial experiments, 2K factorial Experiments, Confounding and Blocking designs, Fractional factorial design, Taguchi's approach - Steps in experimentation, Design using Orthogonal Arrays, Data Analysis, Robust Design- Control and Noise factors, S/N ratios

UNIT – V STATISTICAL CONSIDERATION AND RELIABILITY 9

Frequency distributions and Histograms- Run charts –stem and leaf plots- Pareto diagrams-Cause and Effect diagrams-Box plots- Probability distribution-Statistical Process control–Scatter diagrams –Multivariable charts –Matrix plots and 3-D plots.-Reliability-Survival and Failure-Series and parallel systems-Mean time between failure-Weibull distribution.

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

1. Apply fundamentals of design process and material selection for developing a quality product
2. Apply the quality concepts to develop a robust product
3. Perform Failure Mode Effect Analysis on a product and use six sigma principles to enhance its quality
4. Apply different experimental design methods in product development
5. Implement various statistical tools to improve its quality and reliability

REFERENCES:

1. Amitava Mitra, "Fundamentals of Quality control and improvement", John Wiley & Sons, 2016
2. George E. Dieter, Linda C. Schmidt, "Engineering Design", McGraw Hill Education Pvt. Ltd., 2013
3. Karl T. Ulrich, Steven D. Eppinger, "Product Design And Development, ,Tata Mcgraw-Hill Education, 2015
4. Kevin N. Otto and Kristin L. Wood, "Product Design: Techniques in Reverse Engineering and New Product Development", Prentice Hall, 2001
5. Montgomery, D.C., "Design and Analysis of experiments", John Wiley and Sons, 2017.
6. Phillip J. Ross, "Taguchi techniques for quality engineering", Tata McGraw Hill, 2005.

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	1	1	3	2	2	2
2	1	1	3	2	2	2
3	1	1	3	2	2	2
4	1	1	3	2	2	2
5	1	1	3	2	2	2
AVg.	1	1	1	2	2	2

MA4071 APPLIED PROBABILITY AND STATISTICS FOR DESIGN ENGINEERS **L T P C 3 0 0 3**

COURSE OBJECTIVES:

- To compute moments of standard distributions.
- To gain the knowledge about correlation and regression.
- To provide the most appropriate estimator of the parameter in statistical inference.
- To decide whether to accept or reject specific value of a parameters.
- To understand many real-world problems fall naturally within the frame work of multivariate normal theory.

UNIT - I ONE DIMENSIONAL RANDOM VARIABLES 9

Random variables - Probability functions – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a random variable.

UNIT - II TWO DIMENSIONAL RANDOM VARIABLES 9

Joint distributions – Marginal and conditional distributions – Functions of two dimensional random variables – Correlation – Linear Regression.

UNIT- III ESTIMATION THEORY 9

Unbiased estimators – Method of moments – Maximum likelihood estimation - Principle of least squares – Regression lines.

UNIT - IV TESTING OF HYPOTHESIS 9

Sampling distributions – Type I and Type II errors – Small and large samples – Tests based on Normal, t, Chi square and F distributions for testing of mean, variance and proportions – Tests for independence of attributes and goodness of fit.

UNIT - V MULTIVARIATE ANALYSIS 9

Random vectors and matrices – Mean vectors and covariance matrices – Multivariate normal density and its properties – Principal components - Population principal components – Principal components from standardized variables

TOTAL : 45 PERIODS

COURSE OUTCOMES:

After completing this course, students should demonstrate competency in the following topics:

- Moments of discrete and continuous random variables.
- To deal problems involving two dimensional random variables.
- Unbiasedness of estimators, method of maximum likelihood estimation and Central Limit Theorem.
- Use statistical tests in testing hypotheses on data.
- Perform exploratory analysis of multivariate data, such as multivariate normal density, calculating descriptive statistics, testing for multivariate normality.

REFERENCES :

1. Devore, J. L., “Probability and Statistics for Engineering and the Sciences”, 8th Edition, Cengage Learning, 2014.
2. Dallas E. Johnson, “Applied Multivariate Methods for Data Analysis”, Thomson and Duxbury press, 1998.
3. Gupta S.C. and Kapoor V.K.,” Fundamentals of Mathematical Statistics”, 12th Edition, Sultan and Sons, New Delhi, 2020.
4. Johnson, R.A., Miller, I and Freund J., "Miller and Freund’s Probability and Statistics for Engineers ", 9th Edition, Pearson Education, Asia, 2016.
5. Richard A. Johnson and Dean W. Wichern, “Applied Multivariate Statistical Analysis”, 6th Edition, Pearson Education, Asia, 2012.

ED4080 TRIBOLOGY IN DESIGN L T P C

3 0 0 3

COURSE OBJECTIVES:

1. To study and measure the different types of surface features associated with the friction of metals and non-metals.
2. To study the different types of wear mechanism and surface modification techniques.
3. To analyze the various types of lubricants and lubrication system in the tribology.
4. To develop the methodology for deciding lubricants and lubrication regimes for different operating conditions.
5. To study the different types of high-pressure contacts and rolling bearings

UNIT I SURFACE INTERACTION AND FRICTION 9

Surface Topography – Surface features-Properties and measurement – Surface interaction – Laws of friction- Adhesive Theory of Sliding Friction – Static friction -Rolling Friction – Friction in extreme conditions –Thermal considerations in sliding contact.

UNIT II WEAR AND SURFACE TREATMENT 9

Types of wear mechanism – Laws of wear –Theoretical wear models- Abrasive wear – Adhesive wear – Fatigue wear – fretting wear – Cavitation wear - Wear of Metals and Nonmetals – Surface treatments – Surface modifications –Laser processing – instrumentation
– International standards in friction and wear measurements

UNIT III LUBRICANTS AND LUBRICATION REGIMES 9

Lubricants and their physical properties- Viscosity and other properties of oils –Additives-and selection of Lubricants- Lubricants standards ISO,SAE,AGMA, BIS standards – Lubrication Regimes –Solid Lubrication-Dry and marginally lubricated contacts- Boundary Lubrication-Hydrodynamic lubrication-Elasto and plasto hydrodynamic - Magneto hydrodynamic lubrication – Hydro static lubrication – Gas lubrication

UNIT IV THEORY OF HYDRODYNAMIC AND HYDROSTATIC LUBRICATION 9

Reynolds Equation-Assumptions and limitations-One and two dimensional Reynolds Equation Reynolds and Sommerfeld boundary conditions- Pressure wave, flow, load capacity and friction calculations in Hydrodynamic bearings-Long and short bearings-Pad bearings and Journal bearings-Squeeze film effects-Thermal considerations-Hydrostatic lubrication of Pad bearing Pressure, flow, load and friction calculations-Stiffness considerations- Various types of flow restrictors in hydro static bearings.

UNIT V HIGH PRESSURE CONTACTS AND ELASTO HYDRODYNAMIC LUBRICATION 9

Rolling contacts of Elastic solids- contact stresses – Hertzian stress equation- Spherical and cylindrical contacts-Contact Fatigue life- Oil film effects- Elasto Hydrodynamic lubrication Theory Soft and hard EHL Reynolds equation for elasto hydrodynamic lubrication- - Film shape within and outside contact zones-Film thickness and friction calculation- Rolling bearings- Stresses and deflections-Traction drives.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

- Develop the knowledge on the surface features and its role on the friction behavior of metals and nonmetals
- Understand the various types of wear mechanism and surface modification techniques
- Familiarize the different types of lubricants and lubrication systems in the tribology
- Methodology for deciding lubricants and lubrication regimes for different operating conditions
- Ability to understand the different types of high pressure contacts and rolling bearings

REFERENCES:

1. Rabinowicz.E, “Friction and Wear of materials”, John Willey & Sons ,UK,1995
2. Cameron, A. “Basic Lubrication Theory”, Ellis Herward Ltd., UK, 1981
3. Halling, J. (Editor) – “Principles of Tribology “, Macmillian – 1984
4. Williams J.A. “Engineering Tribology”, Oxford Univ. Press, 1994
5. S.K.Basu, S.N.Sengupta & B.B.Ahuja ,”Fundamentals of Tribology”, Prentice – Hall of India Pvt Ltd , New Delhi, 2005
6. G.W.Stachowiak& A.W .Batchelor , Engineering Tribology, Butterworth - Heinemann, UK, 2005

CO	PO					
	1	2	3	4	5	6
1	1	1	1	2	2	1
2	1	1	1	2	2	1
3	1	1	1	2	2	1
4	1	1	1	2	2	1
5	1	1	1	2	2	1
AVg.	1	1	1	2	2	1

ED4091	ADVANCED FINITE ELEMENT ANALYSIS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To study concept of Finite Element Analysis to solve problems involving plate and shell elements
2. To learn concept of Finite Element Analysis to solve problems involving geometric and material non linearity
3. To study solution techniques to solve dynamic problems
4. To study the concepts of Finite Element Analysis to solve fluid mechanics and heat transfer problems
5. To study error norms, convergence rates and refinement.

UNIT-I BENDING OF PLATES AND SHELLS 9

Review of Elasticity Equations – Bending of Plates and Shells – Finite Element Formulation of Plate and Shell Elements - Conforming and Non-Conforming Elements – C0 and C1 Continuity Elements –Degenerated shell elements-Application and Examples.

UNIT-II NON-LINEAR PROBLEMS 9

Introduction – Iterative Techniques – Material non-linearity – Elasto Plasticity – Plasticity – Visco Plasticity – Geometric Non linearity – large displacement Formulation –Solution procedure-Application in Metal Forming Process and Contact Problems.

UNIT-III DYNAMIC PROBLEM 9

Direct Formulation – Free, Transient and Forced Response – Solution Procedures – Eigen solution-Sub space Iterative Technique – Response analysis - Houbolt, Wilson, Newmark– Methods – Explicit & Implict Methods-Lanchzos, Reduced method for large size system equations.

UNIT-IV FLUID MECHANICS AND HEAT TRANSFER 9

Governing Equations of Fluid Mechanics – Solid structure interaction - Inviscid and Incompressible Flow – Potential Formulations – Slow Non-Newtonian Flow – Metal and Polymer Forming–Navier Stokes Equation–Steady and Transient Solution.

UNIT-V ERROR ESTIMATES AND ADAPTIVE REFINEMENT 9

Error norms and Convergence rates–h-refinement with adaptivity–Adaptive refinement.

TOTAL=45PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

- **CO1** Apply concept of Finite Element Analysis to solve problems involving plate and shell elements
- **CO2** Apply concept of Finite Element Analysis to solve problems involving geometric and material non linearity
- **CO3** Formulate solution techniques to solve dynamic problems
- **CO4** Apply concepts of Finite Element Analysis to solve fluid mechanics and heat transfer problems
- **CO5** Investigate error norms, convergence rates and refinement.

REFERENCES:

1. Bathe K.J., “Finite Element Procedures in Engineering Analysis”, Prentice Hall,1990
2. Logan. D. L.,“A first course in Finite Element Method”, Cengage Learning, 2012
3. Reddy, J.N. “An Introduction to Non linear Finite Element Analysis”, 2nd Edition, Oxford, 2015
4. Robert D.Cook, David S.Malkus, Michael E.Plesha, Robert J.Witt, “Concepts and Applications of Finite Element Analysis”, 4th Edition, Wiley Student Edition, 2004.
5. Tirupathi R. Chandrupatla and Ashok D.Belegundu,“Introduction to Finite Elements in Engineering”,InternationalEdition,PearsonEducationLimited,2014.
6. Zienkiewicz, O. C., Taylor, R. L. and Zhu. J .Z. ,“The Finite Element Method: Its Basis and Fundamentals”,7th Edition, Butterworth-Heinemann,2013.

CO	PO					
	1	2	3	4	5	6
1	2	1	3	2	2	1
2	2	1	3	2	2	1
3	2	1	3	2	2	1
4	2	1	3	2	2	1
5	2	1	3	2	2	1
Avg	2	1	3	2	2	1

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

ED4152 ADVANCED MECHANISMS IN DESIGN

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. To learn the concepts of gross motion capability and develop multi loop kinematic chainsand equivalent mechanisms
2. To study complex mechanisms to determine velocity and acceleration of output links.
3. To learn to locate inflection points and to draw the inflection circle
4. To study the synthesis of planar mechanisms
5. To learn to design of six bar coupler driven mechanisms and cam mechanisms

UNIT-I INTRODUCTION 9

Review of fundamentals of kinematics-classifications of mechanisms-components of mechanisms – mobility analysis – formation of one D.O.F. multi loop kinematic chains, Network formula – Gross motion concepts-Basic kinematic structures of serial and parallel robot manipulators-Compliant mechanisms - Equivalent mechanisms.

UNIT-II KINEMATIC ANALYSIS 9

Position Analysis – Vector loop equations for four bar, slider crank, inverted slider crank, geared five bar and six bar linkages. Analytical methods for velocity and acceleration Analysis– four bar linkage jerk analysis. Plane complex mechanisms-auxiliary point method. Spatial RSSR mechanism-Denavit-Hartenberg Parameters – Forward and inverse kinematics of robot manipulators.

UNIT-III PATH CURVATURE THEORY, COUPLER CURVE 9

Fixed and moving centrodes, inflection points and inflection circle. Euler Savary equation, graphical constructions – cubic of stationary curvature. Four bar coupler curve-cusp -crunode -coupler driven six-bar mechanisms-straight line mechanisms

UNIT-IV SYNTHESIS OF FOUR BAR MECHANISMS 9

Type synthesis – Number synthesis – Associated Linkage Concept. Dimensional synthesis – function generation, path generation, motion generation. Graphical methods-Pole technique inversion technique-point position reduction-two, three and four position synthesis of four- bar mechanisms. Analytical methods- Freudenstein's Equation-Bloch's Synthesis.

UNIT-V SYNTHESIS OF COUPLER CURVE BASED MECHANISMS & CAM MECHANISMS 9

Cognate Lingages-parallel motion Linkages. Design of six bar mechanisms-single dwell-double dwell-double stroke. Geared five bar mechanism-multi-dwell. Cam Mechanisms-determination of optimum size of cams. Mechanism defects. Study and use of Mechanism using Simulation Soft- ware packages. Students should design and fabricate a mechanism model as term project.

TOTAL = 45 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

1. Apply concepts of gross motion capability and develop multi loop kinematic chains andequivalent mechanisms
2. Determine velocity and acceleration of complex mechanisms
3. Evaluate inflection points and draw the inflection circle
4. Synthesise planar mechanisms
5. Design of six bar coupler driven mechanisms and cam mechanisms

REFERENCES:

1. Amitabha Ghosh and Asok Kumar Mallik, "Theory of Mechanism and Machines", EWLP, Delhi,1999.
2. Kenneth J, Waldron, Gary L. Kinzel, "Kinematics, Dynamics and Design of Machinery", John Wiley-sons, 2016.
3. Robert L.Norton., "Design of Machinery",Tata McGraw Hill, 2012
4. Sandor G.N., and Erdman A.G., "Advanced Mechanism Design Analysis and Synthesis", Prentice Hall, 1984.
5. Uicker, J.J., Pennock, G. R. and Shigley, J.E., "Theory of Machines and Mechanisms", Oxford University Press, 2017.

CO	PO					
	1	2	3	4	5	6
1	2	2	1	3	3	1
2	2	3	1	3	2	1
3	2	2	1	3	2	1
4	2	2	1	3	2	1
5	2	3	1	3	3	1
AVg.	2	2.4	1	3	2.4	1

AO4091 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING L T P C
3 0 0 3

OBJECTIVE:

1. To gain knowledge on artificial intelligence.
2. To understand the concepts of Machine Learning.
3. To appreciate supervised learning and their applications.
4. To appreciate the concepts and algorithms of unsupervised learning.
5. To understand the theoretical and practical aspects of Probabilistic Graphical Models.

UNIT I ARTIFICIAL INTELLIGENCE 9

Artificial intelligence – Basics – Goals of artificial intelligence– AItechniques–problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots.

UNIT II INTRODUCTION TO MACHINE LEARNING 9

Machine Learning–Types of Machine Learning –Machine Learning process- preliminaries, testing Machine Learning algorithms, turning data into Probabilities, and Statistics for Machine Learning-Probability theory – Probability Distributions – Decision Theory.

UNIT III SUPERVISED LEARNING 9

Linear Models for Regression – Linear Models for Classification- Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Models – Decision Tree Learning – Bayesian Learning, Naïve Bayes – Ensemble Methods, Bagging, Boosting, Neural Networks, Multi-layer Perceptron, Feed- forward Network, Error Back propagation - Support Vector Machines.

UNIT IV UNSUPERVISED LEARNING 9

Clustering- K-means – EM Algorithm- Mixtures of Gaussians –Dimensionality Reduction, Linear Discriminant Analysis, Factor Analysis, Principal Components Analysis, Independent Components Analysis.

UNIT V PROBABILISTIC GRAPHICAL MODELS 9

Graphical Models – Undirected Graphical Models – Markov Random Fields – Directed Graphical Models –Bayesian Networks – Conditional Independence properties – Markov Random Fields-Hidden Markov Models – Conditional Random Fields (CRFs).

TOTAL:45PERIODS

OUTCOMES:

On Completion of the course the student will be able to

- Optimize the robots using Artificial Intelligence.
- Design a learning model appropriate to the application.
- Implement Probabilistic Discriminative and Generative algorithms for an application of your choice and analyze the results.
- Use a tool to implement typical Clustering algorithms for different types of applications.
- Identify applications suitable for different types of Machine Learning with suitable justification.

CO	PO					
	1	2	3	4	5	6
1	2	1	1	2	1	1
2	2	1	1	2	1	1
3	2	1	1	2	1	1
4	2	1	1	2	1	1
5	2	1	1	2	1	1
AVG	2	1	1	2	1	1

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

REFERENCES:

1. Christopher Bishop,"Pattern Recognition and Machine Learning" Springer, 2007.
2. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", Chapman and Hall, CRC Press, Second Edition,2014.
3. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
4. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Third Edition, 2014.
5. Tom Mitchell,"MachineLearning",McGraw-Hill,1997.

CD4001 ADVANCED COMPUTER MANUFACTURING L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To understanding the impact of computer-integrated manufacturing (CIM) on productivity, product cost, and quality.
2. To Obtain an overview of computer technologies for factory management and factory floor operations
3. To understand the industrial applications of Computer integrated manufacturing
4. To understand evolution of cloud based design and manufacturing

UNIT I INTRODUCTION 9

Introduction to Product life cycle management. Need of CAD/CAM integration through computers, Benefits of integration, Types of production systems and their automation, CAD/CAM integration. Concept of FMS and CIMS. DNC based factory management and control, Integrated CAD/CAM system and shared database.

UNIT II ELEMENTS OF A GENERAL CIM SYSTEM 9

Types of CIM systems, CAD-CAM link for CIMS, Benefits of CAM, FMS and CIMS, Automated material handling systems, equipment and their functions. Integration of Robots in CIMS, automated guided vehicle navigation system, Automatic Storage and Retrieval Systems (AS/RS), Carousel storage system, design of automatic material handling system, KWO analysis, work-part transfer mechanisms

UNIT III APPLICATION OF COMPUTER INTEGRATED MANUFACTURING (CIM) SYSTEMS 9

Concept and terminology, Part family formation, Classification and coding systems for components, Group technology machine cells. Group technology applications for computer-integrated manufacturing, Computer-aided Tooling Design for Manufacturing Processes-Industrial Applications

UNIT IV INTELLIGENT SYSTEMS IN MANUFACTURING 9

Current Developments and Future Prospects-Artificial intelligence techniques and the components of an intelligent manufacturing system. Concept of Artificial Intelligence, Conceptual Learning, Artificial Neural Networks - Biological Neuron, Artificial Neuron, Types of Neural Networks, Applications in Manufacturing. key artificial intelligence technologies (fuzzy logic, artificial neural networks, expert systems and genetic algorithms)

UNIT V CLOUD-BASED DESIGN AND MANUFACTURING 9

Evolution of design and manufacturing systems, Characteristics and requirements for cloud-based design and manufacturing systems, Cloud-based design and manufacturing example scenario, Cloud-Based Desktop Factory.

TOTAL:45 PERIODS

CO	PO					
	1	2	3	4	5	6
1	1	2	1	3	3	3
2	1	3	2	3	2	3
3	3	3	3	3	2	3
4	3	2	3	3	3	3
5	1	3	1	3	3	3
AVg.	1.8	2.6	2	3	2.6	3

COURSE OUTCOMES:

- To understand the basics of CAD/CAM integration, PLM management and need of process planning in manufacturing
- To apply the knowledge of Expert systems, Group technology and part representation for various applications
- To analyze the use of CIM for the various industrial applications
- To know the use of AI in manufacturing
- To know the latest trends in the cloud based design and manufacturing and its contemporary issues

REFERENCES:

1. MikellGroover, (2016), Automation, Production Systems and Computer-Integrated Manufacturing, 4th. Ed., ISBN # 0-13-349961-8, Pearson, New Jersey
2. Intelligent Manufacturing Systems/ Andrew Kusiak/Prentice Hall.
3. Artificial Neural Networks/ Yagna Narayana/PHI/2006 3. Automation, Production Systems and CIM / Groover M.P./PHI/2007
4. Groover, M. P., Automation, Production systems and Computer Integrated Manufacturing, Pearson Education Asia (2009).
5. Rao, P. N., Tewari, N. K. and Kundra, T. K., Computer Integrated Manufacturing, McGraw Hill (1998)

ED4093	OPTIMIZATION TECHNIQUES IN DESIGN	L	T	P	C
		3	0	0	3

COURSEOBJECTIVES:

1. To understand the basic concepts of unconstrained optimization techniques.
2. To understand the basic concepts of constrained optimization techniques.
3. To provide the mathematical foundation of artificial neural networks and swarm intelligence for design problems.
4. To implement optimization approaches and to select appropriates solution for design application.
5. To demonstrate selected optimization algorithms commonly used in static and dynamic applications.

UNIT– I UNCONSTRAINED OPTIMIZATION TECHNIQUES **9**

Introduction to optimum design - General principles of optimization – Problem formulation & their classifications- Single variable and multivariable optimization, Techniques of unconstrained minimization – Golden section, Random, pattern and gradient search methods – Interpolation methods.

UNIT– II CONSTRAINED OPTIMIZATION TECHNIQUES **9**

Optimization with equality and inequality constraints-Direct methods–Indirect methods using penalty functions, Lagrange multipliers-Geometric programming.

UNIT–III ARTIFICIAL NEURAL NETWORKS AND SWARM INTELLIGENCE **9**

Introduction–Activation functions, types of activation functions, neural network architectures, Single layer feed forward network, multi layer feed forward network, Neural network applications. Swarm intelligence-Various animal behaviors, Ant Colony optimization, Particle Swarm optimization.

UNIT– IV ADVANCED OPTIMIZATION TECHNIQUES **9**

Multistage optimization–dynamic programming, stochastic programming Multi objective optimization Genetic algorithms and Simulated Annealing technique.

UNIT– V STATIC AND DYNAMIC APPLICATIONS **9**

Structural applications – Design of simple truss members – Design of simple axial, transverse loaded members for minimum cost, weight – Design of shafts and torsionally loaded members –Design of springs.

Dynamic Applications – Optimum design of single, two degree of freedom systems, vibration absorbers. Application in Mechanisms–Optimum design of simple linkage mechanisms.

TOTAL: 45 PERIODS

COURSEOUTCOMES:

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

CO1 Formulate unconstrained optimization techniques in engineering design application.
CO2 Formulate constrained optimization techniques for various applications.
CO3 Implement neural network technique to real world design problems.
CO4 Apply genetic algorithms to combinatorial optimization problems.
CO5 Evaluate solutions by various optimization approaches for a design problem.

REFERENCES:

1. Goldberg, David.E, “Genetic Algorithms in Search,Optimization and Machine Learning”, Pearson, 2009.
2. Jang,J.S.R, Sun,C.T and Mizutani E.,"Neuro-Fuzzy and Soft Computing", Pearson Education. 2015,
3. JohnsonRay,C., “Optimum design of mechanical elements”, Wiley, 2nd Edition 1980.
4. KalyanmoyDeb, “Optimization for Engineering Design: Algorithms and Examples”, PHI Learning Private Limited, 2nd Edition, 2012.
5. RaoSingiresu S., “Engineering Optimization – Theory and Practice”, New Age International Limited, NewDelhi, 3rd Edition, 2013.
6. Rajasekaran S and Vijayalakshmi Pai, G.A, "Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI, 2011

CO	PO					
	1	2	3	4	5	6
1	3	3	2	-	-	1
2	3	2	2	-	2	-
3	3	2	3	-	2	-
4	3	3	3	-	2	-
5	3	3	3	3	2	-
AVg.	3	2.6	2.6	3	2	1

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

CD4091 **BIO MATERIALS** **L T P C**
3 0 0 3

OBJECTIVES:

- To study different concepts in selecting bio and smart materials
- To import knowledge on different electro-rheological and piezoelectric materials
- To import knowledge on different shape memory materials and their applications of materials in biomedical engineering and special materials for actuators, sensors, etc.
- To import knowledge on Materials for oral and maxillofacial surgery
- To import knowledge on materials for cardiovascular ophthalmology and skin regeneration.

UNIT I INTRODUCTION **9**

Human anatomy- tissues- organs- repair- regeneration- Wolff's Law – biomaterial – compatibility – classification- Biomimetics – Material response: swelling and leaching, corrosion and dissolution, deformation and failure, friction and wear – host response: the inflammatory process – coagulation and hemolysis- in vitro and in vivo evaluation of biomaterials – Testing and validation- government regulatory bodies.

UNIT II DENTAL MATERIALS **9**

Teeth composition, formation and properties – temporary fixation devices -classification — biomaterials used- metals and alloys- Fillings and restoration materials – oral and maxillofacial surgery – dental cements and dental amalgams – dental adhesives.

UNIT III ORTHOPAEDIC MATERIALS **9**

Bone composition, formation and regeneration - properties – defects - temporary fixation devices – joint replacement – biomaterials used in bone and joint replacement metals and alloys- stress shielding effect- bone tissue engineering.

UNIT IV WOUND DRESSING MATERIALS AND SURGICAL AIDS **9**

Skin structure – defects (burn, ulcer, trauma etc) and disease- skin regeneration – classification of regenerative material – Sutures- Adhesives – classification – Surgical tools-materials – sterilization - Laparoscopic tools

UNIT V CARDIOVASCULAR, OPTHALMOLOGY AND DRUG DELIVERY MATERIALS **9**

Blood clotting – blood theology– approaches to thrombo resistance materials development– blood vessels – The heart – aorta and valves – geometry of blood circulation – cardiac pacemakers – extracorporeal blood circulation devices. lungs – vascular implants: vascular graft, cardiac valve prostheses – Eye- defects – correction- Biomaterials in opthalmology – drug delivery methods and materials.

OUTCOMES:

On Completion of the course the student will be able to

- Use of Bio materials for cardiovascular Opthalmology and Skin Regeneration
- Use of Bio materials for Dental & Bone application
- Use of shape memory alloys in engineering application
- Explain the characteristics of Bio and smart materials
- Use of smart materials as sensors, actuators..

REFERENCES:

1. M. V. Gandhi and B. S. Thompson, "Smart Materials and Structures", Chapman and Hall, London, First Edition, 1992.
2. Sujata V., Bhat., "Biomaterials", Narosa Publication House, New Delhi, 2002.
3. Buddy D. Ratner (Editor), Allan S. Hoffman (Editor), Frederick J. Schoen (Editor), Jack E. Lemons, "Biomaterials Science: An Introduction to Materials in Medicine", Academic Press,2nd edition, 2004.
4. Duerig,T. W., Melton, K. N, Stockel, D. and Wayman, C.M., "Engineering aspects of Shapememory Alloys", Butterworth – Heinemann, 1990.
5. Mohsen Shahinpoor and Hans-Jo¨rg Schneider "Intelligent Materials", RSC Publishing,2008.

CO	PO						PSO		
	1	2	3	4	5	6	1	2	3
1	2			3			1		
2	3	1							1
3	3		1				2		
4	3	1							2
5	3								1
Avg	2.8	1	1	3			1.5		1.33

ED4075 MECHANICAL MEASUREMENTS AND ANALYSIS L T P C

3 0 0 3

COURSE OBJECTIVES:

1. The student will understand the principle of force and strain measurement.
2. The student will understand the vibration measurement and their applications.
3. To impart knowledge on the principle behind acoustics and wind flow measurements.
4. To familiarize with the distress measurements
5. To realize the non destructive testing principle and application

UNIT– I FORCESANDSTRAINMEASUREMENT 9

Strain gauge, principle, types, performance and uses. Photo elasticity–Principle and applications -Moire Fringe-Hydraulic jacks and pressure gauges–Electronic load cells–Proving Rings–Calibration of Testing Machines.

UNIT– II VIBRATION MEASUREMENTS 9

Characteristics of Structural Vibrations–Linear Variable Differential Transformer(LVDT)– Transducers for velocity and acceleration measurements. Vibration meter– Seismographs – Vibration Analyzer – Display and recording of signals – Cathode Ray Oscilloscope – XY Plotter – Chart Plotters–Digital data Acquisition systems.

UNIT–III ACOUSTICS AND WIND FLOW MEASUREMENTS 9

Principles of Pressure and flow measurements–pressure transducers–sound level meter– venturimeter and flow meters–wind tunnel and its use in structural analysis–structural modeling –direct and indirect model analysis

UNIT– IV DISTRESS MEASUREMENTS 9

Diagnosis of distress in structures–crack observation and measurements–corrosion of reinforcement in concrete – Half-cell, construction and use – damage assessment – controlled blasting for demolition.

UNIT– V NON DESTRUCTIVE TESTING METHODS 9

Load testing on structures, buildings ,bridges and towers–Rebound Hammer –acoustice mission –ultrasonic testing principles and application–Holography–use of laser for structural testing–Brittle coating

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

CO1 Measure physical quantities such as forces and strains.
CO2 Apply different vibration measurements techniques.
CO3 Measure physical quantities such as pressure and flow.
CO4 Apply techniques involved in crack measurement.
CO5 Select the appropriate nondestructive testing methods for various engineering applications.

REFERENCES:

1. Bray Don E and Stanley, R.K., "Non-destructive Evaluation", McGraw Hill Publishing Company, N.Y.1989
2. Garas,F.K.,Clarke,J.LandArmerGST,"Structuralassessment",Butterworths,London,1987
3. James W. Dally and William Franklin Riley, "Experimental Stress Analysis", McGraw Hill , 3rdEdition,1991
4. Sadhu Singh, Experimental Stress Analysis, KhannaPublishers,NewDelhi,2009.
5. SrinathLS, Raghavan Mr, Lingaiah K, Gargesha G, Pant Band Ramachandra,K, "Experimental Stress Analysis",TataMcGrawHillCompany,NewDelhi,1984
6. Sirohi,R.S.andRadhakrishna,H.C,"MechanicalMeasurements",NewAgeInternational (P) Ltd, 3rdEdition1997

	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	1	2	3	2	2	3
2	1	2	3	2	2	3
3	1	2	3	2	2	3
4	1	2	3	2	2	3
5	1	2	3	2	2	3
AVg.	1	2	3	2	2	3

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

BM4074 **WEARABLE TECHNOLOGIES** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- Identify the motivation, guiding principles, and challenges of Wearable Computing.
- Develop skills pertaining to the design of a holistic interactive wearable system comprising of the physical, digital, and the human aspects.
- To provide the basic understanding of measurement and instrumentation systems and the insight of the resistive sensors and its applications in real life..
- To introduce the concept of the reactive sensors and self-generating sensors and its applications in real life
- To impart the importance of smart sensors, sensor interface standards for wearable device applications and to provide a brief overview of the wearable technology and its impact on social life

UNIT I INTRODUCTION **9**

Attributes of wearables, Meta-wearable, Challenges and opportunities, Future of wearables - Social aspects of wearability and interaction: Social interpretation of Aesthetics - Case study: Google glass - Wearable haptics: Need for wearable haptic devices - Categories of wearable haptic and tactile display – Wearable sensorimotor enhancer.

UNIT II WEARABLE SENSORS **9**

Chemical and Biochemical sensors, System design, Challenges in chemical Bio-chemical sensing, Application areas - Inertia sensors, Parameters from inertia sensors - Applications for wearable motion sensors - Measurement of energy expenditure by body worn heat flow sensors.

UNIT III FLEXIBLE ELECTRONICS **9**

Introduction, Thin-film transistors: Materials and Technologies, Review of
Semi-conductors in flexible electronics - Low-power Integrated Circuit Design for Bio-potential sensing: Analog circuit design techniques - Low- power design for ADCs - Digital circuit design techniques - Architectural design for low-power bio-potential acquisition, Practical considerations.

UNIT VI ENERGY HARVESTING SYSTEMS **9**

Energy harvesting from human body: Temperature gradient, Foot motion - Wireless energy transmission - Energy harvesting from light and RF energy - Energy and power consumption issues, Future considerations.

UNIT V MONITORING PHYSICAL AND PHYSIOLOGICAL PARAMETERS **9**

Wearable sensors for physiological signal measurement - Physical measurement: Cardiovascular diseases, Neurological diseases, Gastrointestinal diseases - Wearable and non-invasive assistive technologies: Assistive devices for individuals with severe paralysis, Wearable tongue drive system, Sensor signal-processing algorithm, Dual-mode tongue drive system.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Understand the fundamentals of wearables, wearable design issues and user interfaces
CO2: Identify the different types of sensors used in wearable devices
CO3 : Recognize the materials used in the field of flexible electronics technology and its power constraints
CO4: Summarize the techniques and issues associated with energy harvesting from human body
CO5: Elucidate the applications of wearable technology in health care

REFERENCES

1. Edward Sazonov, Michael R Neuman, "Wearable Sensors: Fundamentals, Implementation and Applications", Academic Press, USA, 2014.
2. Tom Bruno , "Wearable Technology: Smart Watches to Google Glass for Libraries", Rowman & Littlefield Publishers, Lanham, Maryland, 2015.
3. Raymond Tong , "Wearable Technology in Medicine and Health Care", Academic Press, USA, 2018.
4. Haider Raad , "The Wearable Technology Handbook", United Scholars Publication, USA, 2017.

	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	-	1	2	2	-	2
CO2	3	2	2	2	-	1
CO3	3	2	2	1	-	2
CO4	1	1	2	1	1	2
CO5	3	1	2	2	-	2
Avg	(10/4)=2.5	(7/5)=1.4	(10/5)=2	(8/5)=1.6	(1/1)=1	(9/4)=2.25

AP4251 **INDUSTRIAL INTERNET OF THINGS** **L T P C**
3 0 0 3

OBJECTIVES:
- To understand the fundamentals of Internet of Things
- To learn about the basics of IOT protocols
- To build a small low cost embedded system using IoT
- To apply the concept of I0T in the real world scenario

UNIT I INTRODUCTION AND ARCHITECTURE OF IoT **9**
Introduction – Definition and characteristics of IoT – Physical and Logical Design of IoT - Communication models and APIs – Challenges in IoT - Evolution of IoT- Components of IoT - A Simplified IoT Architecture – Core IoT Functional Stack.

UNIT II INDUSTRIAL IoT **9**
IIoT-Introduction, Industrial IoT: Business Model and Reference Architecture: IIoT-Business Models, Industrial IoT- Layers: IIoT Sensing, IIoT Processing, IIoT Communication, IIoT Networking

UNIT III IIOT ANALYTICS **9**
Big Data Analytics and Software Defined Networks, Machine Learning and Data Science, Julia Programming, Data Management with Hadoop

UNIT IV IOT SECURITY **9**
Industrial IoT: Security and Fog Computing - Cloud Computing in IIoT, Fog Computing in IIoT, Security in IIoT

UNIT V CASE STUDY **9**
Industrial IOT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies: Milk Processing and Packaging Industries, Manufacturing Industries

TOTAL : 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, student will be able to
CO1: Understand the basic concepts and Architectures of Internet of Things.
CO2: Understand various IoT Layers and their relative importance.
CO3: Realize the importance of Data Analytics in IoT.
CO4: Study various IoT platforms and Security
CO5: Understand the concepts of Design Thinking.

REFERENCES:

1. Industry 4.0: The Industrial Internet of Things", by Alasdair Gilchrist (Apress), 2017
2. "Industrial Internet of Things: Cybermanufacturing Systems"by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer), 2017
3. Hands-On Industrial Internet of Things: Create a powerful Industrial IoT by Giacomo Veneri, Antonio Capasso, Packt, 2018.

ED4094	VEHICLE DYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

1. Apply and develop mathematical model of a system
2. Applying vehicular vibrations and response of vehicle
3. Applying attire model based on required performance.
4. Applying the various vehicle performance, control methodologies to ensure stability and ride comfort
5. Applying the principles vertical, longitudinal and lateral dynamics vehicle design

UNIT-I BASIS OF VIBRATION 9

Definitions, Modeling and Simulation, Global and Vehicle Coordinate System, Free, Forced, Undamped and Damped Vibration, Response Analysis of Single DOF, Two DOF, Multi DOF,Magnificationfactor,Transmissibility,Vibrationabsorber,Vibrationmeasuringinstruments,Torsionalvibration,Criticalspeed

UNIT-II TYRES 9

Tyreforcesandmoments,Tyrestructure,LongitudinalandLateralforceatvariousslipangles,rolling resistance, Tractive and cornering property of tyre. Performance of tyre on wetsurface. Ride property of tyres. Magic formulae tyre model, Estimation of tyre road friction. Teston Various road surfaces. Tyre vibration

UNIT-III VERTICAL DYNAMICS 9

Human response to vibration, Sources of Vibration. Design, analysis and computer simulation of Passive, Semi-active and Active suspension using Quarter car, half car and full car model. Influence of suspension stiffness, suspension damping, and tyre stiffness. Control law for LQR, H Infinite, Skyhook damping. Air suspension system and their properties

UNIT-IV LONGITUDINAL DYNAMICS AND CONTROL 9

Aerodynamic forces and moments. Equation of motion. Tyre forces, rolling resistance, Load distribution for three wheeler and four wheeler. Calculation of Maximum acceleration, Reaction forces for Different drives. Braking and Driving torque. Prediction of Vehicle performance. ABS, stability control, Traction control. Case Studies

UNIT-V LATERAL DYNAMICS 9

Steady state handling characteristics. Steady state response to steering input. Testing of handling characteristics. Transient response characteristics, Direction control of vehicles. Roll center, Rollaxis,Vehicle under side forces. Stability of vehicle on banked road and during turn. Effect of suspension on cornering

TOTAL= 45 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

CO1 Understand the basics of finding vibration in vehicle components and measuring equipments

CO2 Develop the knowledge of various tyres model and their parameters.

CO3 Design analysis and computer simulation of vertical dynamics in vehicles.

CO4 Understanding the aerodynamic concepts in longitudinal dynamics and control in vehicle dynamics.

CO5 Understand the concepts in lateral dynamics of vehicles.

CO	PO					
	1	2	3	4	5	6
1	1	1	1	2	2	1
2	1	1	1	2	2	1
3	1	1	1	2	2	1
4	1	1	1	2	2	1
5	1	1	1	2	2	1
AVg.	1	1	1	2	2	1

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

PD4151 CREATIVITY AND INNOVATION L T P C
3 0 0 3

COURSE OBJECTIVES:

1. Applying the principles of essential theory of creativity in new product design and development.
2. Applying the principles of various methods and tools for creativity in new product design and development.
3. Applying the design principles of creativity in new product design and development.
4. Applying the various innovation principles and practices in new product design and development.
5. Applying the principles of innovation management in new product design and development.

UNIT I INTRODUCTION TO ESSENTIAL THEORY OF CREATIVITY 9

Directed creativity: The Need for Creative Thinking in the Pursuit of Quality - Essential Theory for Directed Creativity: Definitions and the Theory of the Mechanics of Mind; Heuristics and Models: Attitudes, Approaches, and Actions That Support Creative Thinking.

UNIT II METHODS AND TOOLS FOR CREATIVITY 9

Three basic principles behind the tools of directed creativity – Tools that prepare the mind for creative thought – Tools that stimulate the imagination for new idea – Development and action: the bridge between mere creativity and the rewards of innovation - ICEDIP: Inspiration, Clarification, Distillation, Perspiration, Evaluation and Incubation – Creativity and Motivation

UNIT III DESIGN AND APPLICATION OF CREATIVITY 9

Three levels of emotional design: Visceral, Behavioral and Reflective – Process design, reengineering, and creativity – Creativity and customer needs analysis – Innovative product and service design – Creative problem solving and incremental improvement.

UNIT IV INNOVATION PRINCIPLES & PRACTICES 9

Methods of Creativity Activation: Morphological Box – Requirements for Inventive Problem Solving – Altshuller's Engineering Parameters– Altshuller's Inventive Principles– Altshuller's Contradiction Matrix Algorithm.

UNIT V INNOVATION MANAGEMENT 9

Disruptive Innovation Model – Two Types of Disruption – Three Approaches to Creating New- Growth Businesses – New Market Disruptions: Three Case Histories – Product Architectures and Integration – Process of commoditation and de-commoditation – Two Processes of Strategy Formulation – Role of senior executive in leading new growth: The Disruptive Growth Engine.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

1. Apply the principles of essential theory of creativity in new product design and development.
2. Apply the principles of various methods and tools for creativity in new product design and development.
3. Apply the design principles of creativity in new product design and development.
4. Apply the various innovation principles and practices in new product design and development.
5. Apply the principles of innovation management in new product design and development

REFERENCES:

1. Clayton M. Christensen Michael E. Raynor," The Innovator's Solution", Harvard Business School Press Boston, USA, 2013
2. Donald A. Norman," Emotional Design", Perseus Books Group New York , 2004
3. Geoffrey Petty," how to be better at Creativity", The Industrial Society 1999
4. Rousing Creativity: Think New Now Floyd Hurr, ISBN 1560525479, Crisp Publications Inc. 1999
5. Semyon D. Savransky," Engineering of Creativity – TRIZ", CRC Press New York USA 2003.

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	2	2	2	3	2	3
2	2	2	2	3	2	3
3	2	2	2	3	2	3
4	2	2	2	3	2	3
5	2	2	2	3	2	3
AVg.	2	2	2	3	2	3

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

CD4092 INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS L T P C
3 0 0 3

OBJECTIVES:

- To appreciate the need and scope for robotics and to understand the principles of robot kinematics
- To design the drive systems and its control
- To understand the principles of sensors and vision systems
- To envision the industrial applications of robots and its safety
- To gain knowledge on artificial intelligence and expert systems.

UNIT I INTRODUCTION AND ROBOT KINEMATICS 9

Definition need and scope of Industrial robots– Robot anatomy – Work volume – Precision movement – End effectors – Sensors. Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects.

UNIT II ROBOT DRIVES AND CONTROL 9

Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers.

UNIT III ROBOT SENSORS 9

Transducers and Sensors – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Representation - Image Grabbing –Image processing and analysis – Edge Enhancement – Contrast Stretching – Band Rationing - Image segmentation – Pattern recognition – Training of vision system.

UNIT IV ROBOT CELL DESIGN AND APPLICATION 9

Robot work cell design and control – Safety in Robotics – Robot cell layouts – Multiple Robots and machine interference – Robot cycle time analysis. Industrial application of robots.

UNIT V ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS 9

Methods of Robot Programming – Characteristics of task level languages lead through programming methods – Motion interpolation. Artificial intelligence – Basics – Goals of artificial intelligence – AI techniques–problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots.

TOTAL : 45 PERIODS

OUTCOMES:

On Completion of the course the student will be able to

- Understand robot kinematics
- Incorporate mechanical components and concepts in robotics
- Understand the basics of various sensors to effectively design a robot
- Design suitable robots for specific applications
- Optimize the robots using Artificial Intelligence

REFERENCES

1. K.S.Fu, Gonzalez, R.C. and Lee, C.S.G., “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill, 1987
2. Koren,Y., “Robotics for Engineers”, McGraw-Hill, 1987
3. Kozyrey, Yu. “Industrial Robots”, MIR Publishers Moscow, 1985.
4. Klafter,R.D., Chmielewski, T.A. and Negin,M., “Robotics Engineering – An Integrated Approach”,Prentice-Hall of India Pvt. Ltd., 1984
5. Deb, S.R.”Robotics Technology and Flexible Automation”, Tata McGraw-Hill, 1994
6. Groover,M.P., Weis,M., Nagel,R.N. and Odrey,N.G., “Industrial Robotics Technology, Programming and Applications”, McGraw-Hill, Int., 1986
7. Jordanides,T. and Torby,B.J., ,”Expert Systems and Robotics“, Springer –Verlag, New York, May 1991

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	1	3	3		2	1
2	1	3	3		2	1
3	1	3	3		2	1
4	1	3	3		2	1
5	1	3	3		2	1
AVg.	1	3	3		2	1

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

PD4291 DESIGNING WITH ADVANCED MATERIALS L T P C
3 0 0 3

OBJECTIVES:
The main learning objective of this course is to prepare the students for:
1. Analyzing the different strengthening and failure mechanism of the metals
2. Applying the effects of metallurgical parameters in the materials design
3. Analyzing the relationship between the selection of materials and processing
4. Developing the novel material through understanding the properties of the existing metallic materials
5. Analyzing the different materials used in the engineering applications.

UNIT I INTRODUCTION TO REVERSE ENGINEERING & GEOMETRICFORM 9
Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering - Surface and Solid Model Reconstruction – Dimensional Measurement – Prototyping.

UNIT II MATERIAL CHARACTERISTICS, PART DURABILITY AND LIFE LIMITATION 9
Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength – Hardness –Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure

UNIT III MATERIAL IDENTIFICATION AND PROCESS VERIFICATION 9
Material Specification - Composition Determination - Microstructure Analysis - Manufacturing Process Verification.

UNIT IV DATA PROCESSING, PART PERFORMANCE AND SYSTEM COMPATIBILITY 9
Statistical Analysis – Data Analysis – Reliability and the Theory of Interference – Weibull Analysis – Data Conformity and Acceptance – Data Report – Performance Criteria – Methodology of Performance Evaluation – System Compatibility.

UNIT V ACCEPTANCE, LEGALITY AND INDUSTRIAL APPLICATIONS OF RE 9
Legality of Reverse Engineering – Patent – Copyrights –Trade Secret – Third-Party Materials – Reverse Engineering in the Automotive Industry; Aerospace Industry; Medical Device Industry.

TOTAL : 45 PERIODS

OUTCOMES:
On Completion of the course the student will be able to
- Analyze the different strengthening and failure mechanism of the metals
- Apply the effects of metallurgical parameters in the materials design
- Analyze the relationship between the selection of materials and processing
- Develop the novel material through understanding the properties of the existing metallic materials
- Analyze the different materials used in the engineering applications

CO	PO					
	1	2	3	4	5	6
1	3	-	3	1	1	2
2	3	-	3	1	1	2
3	3	-	3	1	1	2
4	3	-	3	1	1	2
5	3	-	3	1	1	2
Avg.	3	-	3	1	1	2

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

REFERENCES:

1. George E.Dieter, Mechanical Metallurgy, McGraw Hill, 1988
2. Thomas H. Courtney, Mechanical Behavior of Materials, (2nd edition), McGraw Hill, 2000
3. Willam D. CallisterJr.and David G. Rethwisch, Callister's Materials Science and Engineering,(2nd edition)Wiley Editorial,2018
4. Charles, J.A., Crane, F.A.A. and Fumess, J.A.G., Selection and use of engineering materials,(34d edition), Butterworth-Heiremann, 1997
5. Flinn, R.A., and Trojan, P.K., Engineering Materials and their Applications, (4th Edition) Jaico, 1999
6. Metals Hand book, Vol.10, Failure Analysis and Prevention, (10th Edition), Jaico, 1999
7. Ashby M.F., materials selection in Mechanical Design 2nd Edition, Butter worth 1999
8. www.astm.org/labs/pages/131350.htm

IC4291 COMPUTATIONAL FLUID DYNAMICS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- This course aims to introduce numerical modeling and its role in the field of heat, fluid flow and combustion. It will enable the students to understand the various discretisation methods and solving methodologies and to create confidence to solve complex problems in the field of heat transfer and fluid dynamics.
- To develop finite volume discretised forms of the governing equations for diffusion processes.
- To develop finite volume discretised forms of the convection-diffusion processes.
- To develop pressure-based algorithms for flow processes.
- To introduce various turbulence models, Large Eddy Simulation and Direct Numerical Simulation.

UNIT – I GOVERNING DIFFERENTIAL EQUATIONS AND DISCRETISATION TECHNIQUES **9**

Basics of Heat Transfer, Fluid flow – Mathematical description of fluid flow and heat transfer – Conservation of mass, momentum, energy and chemical species - Classification of partial differential equations – Initial and Boundary Conditions – Discretisation techniques using finite difference methods – Taylor's Series - Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

UNIT – II DIFFUSION PROCESSES: FINITE VOLUME METHOD **9**

Steady one-dimensional diffusion, Two- and three-dimensional steady state diffusion problems, Discretisation of unsteady diffusion problems – Explicit, Implicit and Crank-Nicholson's schemes, Stability of schemes.

UNIT – III CONVECTION-DIFFUSION PROCESSES: FINITE VOLUME METHOD **9**

One dimensional convection – diffusion problem, Central difference scheme, upwind scheme – Hybrid and power law discretization techniques – QUICK scheme.

UNIT – IV FLOW PROCESSES: FINITE VOLUME METHOD **9**

Discretisation of incompressible flow equations – Pressure based algorithms, SIMPLE, SIMPLER & PISO algorithms.

UNIT – V TURBULENCE MODELS **9**

Turbulence – RANS equation - Algebraic Models, One equation model, Two equation models – k & standard k – ϵ model, Low Reynold number models of k- ϵ, Large Eddy Simulation (LES), Direct Numerical Simulation (DNS) - Introduction. Solving simple cases using standard CFD codes.

TOTAL:45 PERIODS

COURSE OUTCOMES:

On successful completion of this course the students will be able to:

- Analyse the governing equations and boundary conditions.
- Analyse various discretization techniques for both steady and unsteady diffusion problems.
- Analyse the various convection-diffusion problems by Finite-Volume method.
- Analyse the flow processes by using different pressure bound algorithms.
- Select and use the different turbulence models according to the type of flows.

PO &CO Mapping:

CO	PO					
	1	2	3	4	5	6
1	2	1	3	-	-	-
2	2	1	3	-	-	-
3	3	1	3	-	3	-
4	3	1	3	-	3	-
5	3	1	3	-	3	-
Avg	2.6	1	3	-	3	-

REFERENCES:

1. Versteeg and Malalasekera, N, “An Introduction to computational Fluid Dynamics The Finite Volume Method,” Pearson Education, Ltd., Second Edition, 2014.
2. Ghoshdastidar, P.S., “Computer Simulation of Flow and Heat Transfer”, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1998.
3. Muralidhar, K., and Sundararajan, T., “Computational Fluid Flow and Heat Transfer”, Narosa Publishing House, New Delhi, 2003.
4. Subas and V.Patankar “Numerical heat transfer fluid flow”, Hemisphere Publishing Corporation, 1980.
5. JiyuanTu, Guan Heng Yeoh, Chaogun Liu, “Computational Fluid Dynamics A Practical Approach” Butterworth – Heinemann An Imprint of Elsevier, Madison, U.S.A., 2008
6. John D. Anderson. JR. “Computational Fluid Dynamics the Basics with Applications” McGraw-Hill International Editions, 1995.

ED4092 ENGINEERING FRACTURE MECHANICS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. Formulation of governing equations for elastic problems
2. Stresses calculations/displacements around the crack tip for different modes of fracture
3. Estimation of K1c/SIF/critical flaws/failure stresses for different crack geometries
4. Life assessment of the cracked components under different types of repeated/variable fatigue loads and design for its life extension.
5. Analysis of failed engineering components under different modes of fracture.

UNIT-I ELEMENTS OF SOLID MECHANICS 9

Introduction to Failure and Fracture- Spectacular Failures-Basics Principles-Governing equations for the deformable body-Stress-Strain relations and general equations of elasticity in Cartesian and Polar Coordinates-vectors and tensors-differential equations of equilibrium-compatibility-boundary conditions-representation of three-dimensional stress system -generalized hook's law – plane stress and stain problems - Airy's stress function. Methods of formulation of Governing Differential equations for plane elasticity-Naviers Equation-Biharmonic equation in Cartesian and polar coordinates.

UNIT-II **STRESS AND DISPLACEMENT AROUND THE CRACK TIP FOR DIFFERENT MODES OF FRACTURE** **9**

Brittle and Ductile Fracture-Modes of Fracture-Weakness of the components due to Flaws-Need for Linear Elastic Fracture Mechanics (LEFM) – Evaluation of Structural Design-Stress and displacement around the crack tip in K-annulus for Mode-I and Mode-II plane crack problems – Stress and displacement around the crack tip in K-annulus for Mode III crack problems

UNIT-III **STATIONARY CRACK UNDER STATIC LOADING** **9**

Griffith analysis- Irwin's approximation-CTOD and stress ahead of the crack tip- Westergaard solutions: Analytical Calculations for SIF for different crack geometries-Critical crack length and fracture stress calculations.

Two dimensional elastic fields – Analytical solutions for small scale yielding near a crack front –- plastic zone size –Specimen size calculations: K1c Testing for Fracture toughness of the Material.

UNIT-IV **FATIGUE FAILURE AND ENVIRONMENTAL-ASSISTED FRACTURE** **9**

Introduction to fatigue failure-S-N Curve-Crack Initiation-Crack propagation- Effect of an Overload-Variable amplitude Fatigue load-Crack closure- Characteristics of fatigue crack-Paris Law- Fatigue Crack Growth Test to evaluate Paris constants- life calculations for a given load amplitude –effects of changing the load spectrum

Environmental-assisted Fracture-Micro mechanisms-factors influencing Environmental-assisted fracture-Environment-assisted Fatigue Failure affecting fatigue performance, fatigue loading, constant and variable amplitude loading.

UNIT-V **APPLICATIONS OF FRACTURE MECHANICS** **9**

J-integral, Mixed-mode fracture, Crack arrest methodologies- Case studies: Analysis on failed components and design for the extension of its life

TOTAL (L: 45)=45 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

- **CO1** Formulate governing equation for elastic problems
- **CO2** Calculate stresses/displacements around the crack tip for different modes of fracture
- **CO3** Estimate K1c/SIF/critical flaws/failure stresses for different crack geometries
- **CO4** Assess the life of the cracked components under different types of repeated/variablefatigue loads and design for its life extension.
- **CO5** Analyze failed engineering components under different modes of fracture.

REFERENCES:

1. Broek, David, "Elementary Engineering Fracture Mechanics ", Springer Netherlands, 1982.
2. John M.Barson and Stanely T.Rolfe, "Fatigue and fracture control in structures", Butterworth-Heinemann; 3rd edition. 1999
3. Kare Hellan, "Introduction of Fracture Mechanics", McGraw-Hill Book Company, 1985
4. Prashant Kumar, "Elements of Fracture Mechanics", Tata McGraw-Hill Publishing Company Ltd, 2009.
5. Ted L. Anderson, "Fracture Mechanics: Fundamentals and Applications", CRC Taylor and Francis, 4th Edition, 2017
6. Tribikram Kundu, "Fundamentals of Fracture Mechanics", Ane Books Pvt. Ltd. New Delhi/ CRC Press, 1st Indian Reprint, 2012

CO	PO					
	1	2	3	4	5	6
1	1	1	1	2	2	1
2	1	1	1	2	2	1
3	1	1	1	2	2	1
4	1	1	1	2	2	1
5	1	1	1	2	2	1
AVg.	5	5	5	10	10	5

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

ED4071 DESIGN OF HYBRID AND ELECTRIC VEHICLES L T P C
3 0 0 3

COURSE OBJECTIVES:

1. Fundamental concepts of electric and hybrid vehicle operation and architectures.
2. Understand the properties of batteries and its types.
3. Provide knowledge about design of series hybrid electric vehicles.
4. Provide knowledge about design of parallel hybrid electric vehicles.
5. Understand of electric vehicle drive train.

UNIT– I INTRODUCTION TO ELECTRIC VEHICLES 9

Electric Vehicles (EV) system- EV History – EV advantages – EV market – vehicle mechanics: roadway fundamentals- law of motion-vehicle kinetics- dynamics of vehicle motion – propulsion power–velocity and acceleration-propulsion system design.

UNIT– II ENERGY SOURCE 9

Battery basics-lead acid battery–alternative batteries–battery parameters-technical characteristics–battery power–alternative energy sources: Fuel cells-Fuel Cell characteristics-Fuel cell types.

UNIT–III SERIES HYBRID ELECTRIC DRIVE TRAIN DESIGN 9

Operation Patterns- Control Strategies-Sizing of the Major Components -Design of peaking power source- Traction Motor Size - Design of the Gear Ratio-Verification of Acceleration Performance- .Verification of grade ability-- Design of Engine/Generator Size - Design of the Power Capacity- Design of the Energy Capacity –Fuel Consumption.

UNIT– IV PARALLEL HYBRID ELECTRIC DRIVE TRAIN DESIGN 9

Control Strategies of ParallelHybridDriveTrain-DriveTrainParameters-EnginePowerCapacity-Electric Motor Drive Power Capacity-Transmission Design- Energy Storage Design

UNIT–V ELECTRIC VEHICLE DRIVE TRAIN 9

EV Transmission configurations–Transmission components–Ideal gear box–Gearratio-torque–speed characteristics-EV motor sizing–initial acceleration-rated vehicle velocity–maximum velocity – maximum gradability

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be ableto:

CO1 Explain how a hybrid vehicle works and describe its main components and their function.
CO2 Choose proper energy storage systems for vehicle applications
CO3 Design series hybrid electric vehicles.
CO4 Design parallel hybrid electric vehicles.
CO5 Describe the transmission components and their configurations for electric vehicles

REFERENCES:

1. Ehsani,M, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press,2005
2. "Hybrid Electric Vehicle Technology Assessment: Methodology, Analytical Issues, and Interim Results,"CenterforTransportationResearchArgonneNationalLaboratory,United States Department of Energy.
3. Iqbal Hussain, "Electric & Hybrid Vehicles– Design Fundamentals", Second Edition, CRC Press,2011.
4. James Larminie, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003.
5. Sandeep Dhameja, "Electric Vehicle Battery Systems", Newnes, 2000 .http://nptel.ac.in/courses/108103009/

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	2	1	3	2	2	3
2	2	1	3	2	2	3
3	2	1	3	2	2	3
4	2	1	3	2	2	3
5	2	1	3	2	2	3
AVg.	2	1	3	2	2	3

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

IL4093 **SUPPLY CHAIN MANAGEMENT** **L T P C**
3 0 0 3

OBJECTIVES:

- Explain the role of supply chain management in an organization.
- Identify the various aspects of supply chain management and the factors affecting
- them.
- Explain the relationship among various factors involved in planning, organising and controlling supply chain operations.
- Summarize the sourcing and inventory decisions involved in supply chain operations.
- Explain the use of information technology in supply chain management.

UNIT I INTRODUCTION SUPPLY CHAIN MANAGEMENT 9

Introduction, Types of supply chains with and examples, Evolution of SCM concepts, Supply chain performance, Strategic Fit, Drivers of Supply Chain Performance – key decision areas – External Drivers of Change. Supply contracts – centralized vs. decentralized system

UNIT II SUPPLY CHAIN NETWORK DESIGN 9

Need for distribution network design- Factors affecting, Design options for distribution network. Network design decisions - Framework, factors influencing, Models of facility location and capacity allocation. Role of Transportation in supply chain, modes of transportation Modal Selection, Classification of carriers, Carrier Selection, Transportation Execution and Control. Food Mile Concept., design options.

UNIT III DEMAND AND SUPPLY IN SUPPLY CHAIN 9

Forecasting in supply chain- Methods, Approach, Errors. Aggregate planning in supply chain- Problem, Strategies and Implementation. Predictable variability in supply chain, Managing supply and demand. Distribution strategies-direct shipment, traditional warehousing, cross docking, inventory pooling, transhipment, Choosing appropriate strategy, Milk Run Model.

UNIT IV SOURCING AND INVENTORY DECISIONS IN SUPPLY CHAIN 9

Purchasing Vs Procurement Vs Strategic Sourcing, Item procurement importance matrix, Strategic Sourcing Methodology, Managing sourcing and procurement process, Supplier selection and evaluation, Bullwhip effect and its management, Economies of scale in supply chain- Cycle inventory, Estimation, Quantity discounts, Multiechelon cycle inventory. Uncertainty in supply chain- Safety inventory, Determination of appropriate level, Impact on uncertainity.

UNIT V SUPPLYCHAIN AND INFORMATION SYSTEMS 9

Information in supply chain, Role of Information technology, IT framework in supply chain, Supplier and Customer relationship management. Role of e-business in supply chain, e-sourcing and e-procurement. Technology drivers in supply chain - Risk management.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

CO1: To introduce the concepts and elements of supply chain management.
CO2: to understand supply chain network design aspects for various manufacturing and service sectors.
CO3: To understand the principle of demand and supply in supply chain
CO4: To gain knowledge on the sourcing and inventory decisions in supply chain.
CO5: To understand the concepts of supply chain information systems.

REFERENCES

1. Chopra S. and Meihdl P., “Supply Chain Management- Strategy, Planning and Operations”, Pearson Education Asia. 2007.
2. Dougart L., Stock J. and Ellram L., “Logistic Management”, Irwin McGraw Hill International Edition" 1998.
3. Kaminsky S., “Design and Managing the Supply chain” , McGraw Hill International Edition. 2000.
4. Raghuram G, and N.Rangaraj, “Logistics and Supply Chain Management -cases and concepts”, McMilan India Pvt Ltd, New Delhi,. 2000.
5. Sahay B.S. “Supply Chain Management: For Global Competitiveness”, 2nd Edition, Macmillan, India Ltd, 2011.

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	2	-
CO4	-	-	-	-	-	-
CO5	2	-	-	-	-	-
Avg.	(1+2)/2=1.5	-	-	-	2/1=2	-

II4091 **INDUSTRY 4.0** **L T P C**
3 0 0 3

OBJECTIVES:
The students will be able to
- Understand Industry 4.0
- Apply iot and iot for Industry 4.0
- Understand CPS for Industry 4.0

UNIT I **9**
Introduction to Industry 4.0 The Various Industrial Revolutions - Digitalisation and the Networked Economy - Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0 - Comparison of Industry 4.0 Factory and Today's Factory - Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation

UNIT II **9**
Road to Industry 4.0 - Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services - Smart Manufacturing - Smart Devices and Products - Smart Logistics - Smart Cities - Predictive Analytics

UNIT III **9**
System, Technologies for enabling Industry 4.0–Cyber Physical Systems - Robotic Automation and Collaborative Robots - Support System for Industry 4.0 - Mobile Computing - Cyber Security

UNIT IV **9**
Role of data, information, knowledge and collaboration in future organizations - Resource- based view of a firm - Data as a new resource for organizations - Harnessing and sharing knowledge in organizations - Cloud Computing Basics -Cloud Computing and Industry 4.0

UNIT V **9**
Industry 4.0 IIoT case studies - Opportunities and Challenges - Future of Works and Skills for Workers in the Industry 4.0 Era - Strategies for competing in an Industry 4.0 world – Society 5.0

TOTAL : 45 PERIODS

OUTCOMES:
The students will be able to
- Use Industry 4.0 for Industrial Applications
- Use iot and iiot for Industry 4.0
- Apply smart devices Industrial Applications

TEXT BOOKS
1. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things
2. Arsheep Bahga, Internet of Things: A Hands-On Approach

ED4073 MATERIAL HANDLING SYSTEMS AND DESIGN L T P C
(Use of Approved Data Book is Permitted) 3 0 0 3

COURSE OBJECTIVES:

1. Fundamental concepts related to material handling.
2. Design of various hoisting gears for different material handling applications
3. Development of conveyer systems for material flow in different industrial production systems.
4. Design of elevators for various manufacturing and service applications.
5. Integrated mechanical system design for machine tools, power transmission and engine parts

UNIT– I INTRODUCTIONS AND DESIGN OF HOISTS 9

Types, selection and applications, Design of hoisting elements: Welded and roller chains-Hemp and wire ropes - Design of ropes, pulleys, pulley systems, sprockets and drums, Load handling attachments. Design of forged hooks and eye hooks – crane grabs - lifting magnets –Grabbing attachments-Design of arresting gear -Brakes: shoe, band and cone types.

UNIT– II DRIVES OF HOISTING GEAR 9

Hand and power drives - Traveling gear - Rail traveling mechanism - cantilever and monorailcranes-slewing,jibandluffinggear-cogwheeldrive-selecting the motor ratings.

UNIT–III CONVEYORS 9

Types-description-design and applications of Belt conveyors, apron conveyors and escalators Pneumatic conveyors, Screw conveyors and vibratory conveyors.

UNIT– IV ELEVATORS 9

Bucket elevators: design - loading and bucket arrangements - Cage elevators - shaft way, guides, counter weights, hoisting machine, safety devices-Design of fork lift trucks.

UNIT– V INTEGRATED DESIGN 9

Integrated Design of systems - Valve Gear Mechanisms, Portable Air Compressor, Hay-Balelifter, Cam Testing Machine, Power Screws, Gear Box Design more than six speed.

TOTAL:45 PERIODS

COURSEOUTCOMES:

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

CO1 Design hoists and brakes used in any handling applications.
CO2 Design drive mechanisms and hoisting gear for different handling applications.
CO3 Design different conveyor systems for material handling applications.
CO4 Design bucket, cage and fork lift elevators for to and fro transportation of. materials in vertical direction.
CO5 Design of integrated mechanical system for machine tools, power transmission and engine parts

REFERENCES:

1. Alexandrov,M.,MaterialsHandlingEquipments,MIRPublishers,1981.
2. Boltzharol, A.,MaterialsHandlingHandbook,TheRonaldPressCompany,1958
3. Norton.LRobert."MachineDesign–AnIntegratedApproach"PearsonEducation,2nd Edition, 2005.
4. Rudenko,N.,Materialshandlingequipment,ELnveePublishers,1970.
5. Spivakovsy, A.O.and Dyachkov,V.K., Conveying Machines, VolumesIandII,MIRPublishers,1985.

APPROVED DATA BOOKS:

1. P.S.G.Tech.,"DesignDataBook",KalaikathirAchchagam,Coimbatore,2003.
2. Lingaiah.K.and Narayana Iyengar,"Machine Design Data Hand Book", Vol.1&2,Suma Publishers,Bangalore,1983

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	2	1	1	2	2	1
2	2	1	1	2	2	1
3	2	1	1	2	2	1
4	2	1	1	2	2	1
5	2	1	1	2	2	1
AVg.	2	1	1	2	2	1

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

AUDIT COURSES

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

COURSE OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

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

COURSE OUTCOMES

CO1 Understand that how to improve your writing skills and level of readability
CO2 Learn about what to write in each section
CO3 Understand the skills needed when writing a Title
CO4 Understand the skills needed when writing the Conclusion
CO5 Ensure the good quality of paper at very first-time submission

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** **L T 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

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 "'New Royal book Company, 2007.
3. Sahni, Pardeep Et. 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

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: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: 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

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

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

AX4094	நற்றமிழ் இலக்கியம்	L T P C 2 0 0 0

UNIT I **சங்க இலக்கியம்** **6**

1. தமிழின் துவக்க நூல் தொல்காப்பியம்
   – எழுத்து, சொல், பொருள்
2. அகநானூறு (82)
   - இயற்கை இன்னிசை அரங்கம்
3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி
4. புறநானூறு (95,195)
   - போரை நிறுத்திய ஔவையார்

UNIT II **அறநெறித் தமிழ்** **6**

1. அறநெறி வகுத்த திருவள்ளுவர்
   - அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புரவறிதல் ஈகை, புகழ்
2. பிற அறநூல்கள் - இலக்கிய மருந்து
   – ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை
   (தூய்மையை வலியுறுத்தும் நூல்)

UNIT III **இரட்டைக் காப்பியங்கள்** **6**

1. கண்ணகியின் புரட்சி
   - சிலப்பதிகார வழக்குரை காதை
   சமூகசேவை இலக்கியம் மணிமேகலை
   - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை

UNIT IV **அருள்நெறித் தமிழ்** **6**

1. சிறுபாணாற்றுப்படை
   - பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குத் போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்
2. நற்றிணை
   - அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618)
   - இயமம் நியமம் விதிகள்
4. தர்மச்சாலையை நிறுவிய வள்ளலார்
5. புறநானூறு
   - சிறுவனே வள்ளலானான்
6. அகநானூறு (4) - வண்டு
   நற்றிணை (11) - நண்டு
   கலித்தொகை (11) - யானை, புறா
   ஐந்திணை 50 (27) - மான்
   ஆகியவை பற்றிய செய்திகள்

UNIT V **நவீன தமிழ் இலக்கியம்** **6**

1. உரைநடைத் தமிழ்,
- தமிழின் முதல் புதினம்,
- தமிழின் முதல் சிறுகதை,
- கட்டுரை இலக்கியம்,
- பயண இலக்கியம்,
- நாடகம்,
2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
5. அறிவியல் தமிழ்,
6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

TOTAL: 30 PERIODS

<u>தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்</u>

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University) - www.tamilvu.org
2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia) -https://ta.wikipedia.org
3. தர்மபுர ஆதீன வெளியீடு
4. வாழ்வியல் களஞ்சியம் - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக் களஞ்சியம் - தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம் - தமிழ்ப் பல்கலைக்கழகம், 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.

CO – PO Mapping - INTEGRATED WATER RESOURCES MANAGEMENT

POs/PSOs		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	3	2	2	2	2	2
PO2	Problem analysis	1	3	2	2	2	2
PO3	Design / development of solutions		2	2	2	2	2
PO4	Investigation	1	2			1	1
PO5	Modern Tool Usage	1	1	2	1	1	1
PO6	Individual and Team work		2	2			2
PO7	Communication		2	2			2
PO8	Engineer and Society	2	2	3	2	3	3
PO9	Ethics		2	3	2	2	2
PO10	Environment and Sustainability	3	3	3	3	3	3
PO11	Project Management and Finance	1	1	1		1	1
PO12	Life Long Learning		2	2	2	2	2
PSO1	Knowledge of field research methodology, gender, legal and environmental aspects in the context of integrated water resources management	3	2	2	2	2	2
PSO2	Formulate, analyze and comprehend the differences in social and environmental variability in South Indian context with their peers and strive to work towards sustainability	2	2	2	2	2	2
PSO3	Produce and publish professional reports, peer-reviewed journal, on contemporary and state of the art research in integrated water resources management	2	2	2	2	2	2

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).

CO PO MAPPING : WATER, SANITATION AND HEALTH

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences		1	1	M	1	1
PO2	Problem analysis		2	2	2	2	2
PO3	Design / development of solutions			2	1	2	2
PO4	Investigation		2	3	3	3	3
PO5	Modern Tool Usage				1		1
PO6	Individual and Team work		2	2	1	2	2
PO7	Communication				2	2	2
PO8	Engineer and Society		3	3	3	3	3
PO9	Ethics			1	2	2	2
PO10	Environment and Sustainability		3			3	3
PO11	Project Management and Finance					1	1
PO12	Life Long Learning	2	3	2	3	3	3
PSO1	Explain the concepts of water management, field research methodology, gender, legal and environmental aspects in the context of integrated water resources management		3	3	3	3	3
PSO2	Formulate, analyse and comprehend the differences in social and economic variability in South Asian context with their peers and strive to work towards sustainability.		3	2	3	3	3
PSO3	Produce and publish professional reports, peer reviewed journal on contemporary and state of art research in water resources Engineering.		3	3	3	2	3

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.

CO – PO Mapping –Principles of Sustainable Development

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences						
PO2	Problem analysis	3	3				3
PO3	Design / development of solutions				3	3	3
PO4	Investigation		2	2	2	2	2
PO5	Modern Tool Usage						
PO6	Individual and Team work		2	2			2
PO7	Communication					1	1
PO8	Engineer and Society	3			3		3
PO9	Ethics				2	2	2
PO10	Environment and Sustainability	3	3	3	3	3	3
PO11	Project Management and Finance						
PO12	Life Long Learning					1	1
PSO1	Knowledge of Environmental Management discipline	3	3	3	3		3
PSO2	Environmental Performance Evaluation and coordination						
PSO3	Conceptualization of Environmental Management Systems						

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.

CO – PO Mapping- ENVIRONMENTAL IMPACT ASSESSMENT

PO/PSO		Course Outcome					Overall Correlation of COs to Pos
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences		3			3	3
PO2	Problem analysis		2	2			2
PO3	Design / development of solutions		3	3	3		3
PO4	Investigation		2	2		2	2
PO5	Modern Tool Usage		2	2	3		2
PO6	Individual and Team work		2	2	2		2
PO7	Communication				1		1
PO8	Engineer and Society	2			2		2
PO9	Ethics	3	3	3	2	2	3
PO10	Environment and Sustainability	3			2		2
PO11	Project Management and Finance				1		L
PO12	Life Long Learning		1	1			L
PSO1	Knowledge of Environmental Engineering discipline	2					2
PSO2	Environmental Performance Evaluation and coordination		2	2	2		2
PSO3	Conceptualization of Environmental Engineering Systems		2		2		2

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.

CO-PO Mapping

CO	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
1	2	1	3	2	2	3
2	2	1	2	3	2	2
3	2	1	3	1	2	1
4	2	1	2	3	2	2
5						
Avg	2.00	1.00	2.50	2.25	2.00	2.00

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 VI 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

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 sustainability performances.
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

MAPPING OF POs AND COs:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	1	2	2
CO2	3	2	2	2	1	2
CO3	3	3	1	2	2	3
CO4	3	3	2	1	1	2
CO5	3	3	2	1	2	2

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.

MAPPING OF POs AND COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	1	-	-
CO2	3	3	3	3	2	3
CO3	3	3	2	2	3	3
CO4	3	2	2	2	1	1
CO5	3	2	2	3	2	1

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. V. 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.

MAPPING OF POs AND COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	2	3
CO2	3	3	2	3	1	3
CO3	3	3	3	3	2	3
CO4	3	3	3	2	1	3
CO5	3	3	3	2	2	3

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.

MAPPING OF POs AND COs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	2	3
CO2		3	2	3	1	3
CO3	3	3	3	3	2	3
CO4	3	3	3	2	1	3
CO5	3	3	3	2	2	3

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

CO	PO					
	1	2	3	4	5	6
1	1	2	1	-	-	-
2	-	2	-	-	-	-
3	1	2	-	1	3	-
4	2		3	3	3	3
5	3	2	3	3	3	3
Avg.	1.75	2	2.33	2.33	3	2

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.

CO	PO					
	1	2	3	4	5	6
1	1	3	1	-	-	-
2	2	3	2	-	-	-
3	3	-	3	-	3	-
4	2	3	3	-	-	-
5	3	3	3	-	3	-
6	3	3	3	-	3	-
7	3	3	3	-	3	-
Avg.	2.42	3	2.57	-	3	-

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: 9780262035613, 2016.
3. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.
4. Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
5. 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 University Press, 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.

CO-PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2	2	2	1
CO2	3		2	3	3	3
CO3	3		2	3	3	3
CO4	3		2	3	3	2
CO5	3		2	2	2	2

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.

MAPPING OF CO'S WITH PO'S

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	3	2	-	2	2	2
2	3	-	2	2	-	2
3	2	-	1	-	-	-
4	1	-	-	3	3	1
5	-	2	2	2	2	3
AVG	2.25	2	1.66	2.25	2.3	2

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.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	2	1	1	2	1
2	2	1	3	1	1	2
3			2	3	3	3
4	2	2	1	2	1	3
5	1		1	1	2	3
Avg	1.50	1.67	1.60	1.60	1.80	2.40

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.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	3	3	2	1
2	3	3	3	3	2	1
3	3	3	3	3	2	1
4	3	3	3	3	2	1
5	3	3	3	3	2	1
Avg	3	3	3	3	2	1

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

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1				1		
2				2		
3	2		2	2	2	2
4	2		2	2	3	2
5	2		2	2	3	3
Avg	2		2	1.8	2.6	2.3

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.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1		1	1	1	
2	1	3	1	1	1	3
3	1	3	1	1	1	3
4	1	3	1	1	1	3
5	1	3	1	1	1	3
Avg	(5/5)=1	(12/4)=3	(5/5)=1	(5/5)=1	(5/5)=1	(12/4)=3

CX4016 ENVIRONMENTAL SUSTAINABILITY

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION **9**

Valuing the Environment: Concepts, Valuing the Environment: Methods, Property Rights, Externalities, and Environmental Problems

UNIT II CONCEPT OF SUSTAINABILITY **9**

Sustainable Development: Defining the Concept, the Population Problem, Natural Resource Economics: An Overview, Energy, Water, Agriculture

UNIT III SIGNIFICANCE OF BIODIVERSITY **9**

Biodiversity, Forest Habitat, Commercially Valuable Species, Stationary - Source Local Air Pollution, Acid Rain and Atmospheric Modification, Transportation

UNIT IV POLLUTION IMPACTS **9**

Water Pollution, Solid Waste and Recycling, Toxic Substances and Hazardous Wastes, Global Warming.

UNIT V ENVIRONMENTAL ECONOMICS **9**

Development, Poverty, and the Environment, Visions of the Future, Environmental economics and policy by Tom Tietenberg, Environmental Economics

TOTAL : 45 PERIODS

REFERENCES

1. Andrew Hoffman, Competitive Environmental Strategy - A Guide for the Changing Business Landscape, Island Press.
2. Stephen Doven, Environment and Sustainability Policy: Creation, Implementation, Evaluation, the Federation Press, 2005
3. Robert Brinkmann., Introduction to Sustainability, Wiley-Blackwell., 2016
4. Niko Roorda., Fundamentals of Sustainable Development, 3rd Edn, Routledge, 2020
5. Bhavik R Bakshi., Sustainable Engineering: Principles and Practice, Cambridge University Press, 2019

TX4092 TEXTILE REINFORCED COMPOSITES L T P C
3 0 0 3

UNIT I REINFORCEMENTS 9
Introduction – composites –classification and application; reinforcements- fibres and its properties; preparation of reinforced materials and quality evaluation; preforms for various composites

UNIT II MATRICES 9
Preparation, chemistry, properties and applications of thermoplastic and thermoset resins; mechanism of interaction of matrices and reinforcements; optimization of matrices

UNIT III COMPOSITE MANUFACTURING 9
Classification; methods of composites manufacturing for both thermoplastics and thermosets- Hand layup, Filament Winding, Resin transfer moulding, prepregs and autoclave moulding, pultrusion, vacuum impregnation methods, compression moulding; post processing of composites and composite design requirements

UNIT IV TESTING 9
Fibre volume and weight fraction, specific gravity of composites, tensile, f lexural, impact, compression, inter laminar shear stress and fatigue properties of thermoset and thermoplastic composites.

UNIT V MECHANICS 9
Micro mechanics, macro mechanics of single layer, macro mechanics of laminate, classical lamination theory, failure theories and prediction of inter laminar stresses using at ware

TOTAL: 45 PERIODS

REFERENCES

1. BorZ.Jang,"Advanced Polymer composites",ASM International,USA,1994.
2. Carlsson L.A. and Pipes R.B., "Experimental Characterization of advanced composite Materials",SecondEdition,CRCPress,NewJersey,1996.
3. George LubinandStanley T.Peters, "Handbook of Composites", Springer Publications,1998.
4. Mel. M. Schwartz, "Composite Materials", Vol. 1 &2, Prentice Hall PTR, New Jersey,1997.
5. RichardM.Christensen,"Mechanics of compositematerials",DoverPublications,2005.
6. Sanjay K. Mazumdar, "Composites Manufacturing: Materials, Product, and Process Engineering",CRCPress,2001

NT4002 NANOCOMPOSITE MATERIALS L T P C
3 0 0 3

UNIT I BASICS OF NANOCOMPOSITES 9
Nomenclature, Properties, features and processing of nanocomposites. Sample Preparation and Characterization of Structure and Physical properties. Designing, stability and mechanical properties and applications of super hard nanocomposites.

UNIT II METAL BASED NANOCOMPOSITES 9
Metal-metal nanocomposites, some simple preparation techniques and their properties. Metal-Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Core-Shell structured nanocomposites

UNIT III POLYMER BASED NANOCOMPOSITES 9

Preparation and characterization of diblock Copolymer based nanocomposites; Polymer Carbon nanotubes based composites, their mechanical properties, and industrial possibilities.

UNIT IV NANOCOMPOSITE FROM BIOMATERIALS 9

Natural nanocomposite systems - spider silk, bones, shells; organic-inorganic nanocomposite formation through self-assembly. Biomimetic synthesis of nanocomposites material; Use of synthetic nanocomposites for bone, teeth replacement.

UNIT V NANOCOMPOSITE TECHNOLOGY 9

Nanocomposite membrane structures- Preparation and applications. Nanotechnology in Textiles and Cosmetics-Nano-fillers embedded polypropylene fibers – Soil repellence, Lotus effect - Nano finishing in textiles (UV resistant, anti-bacterial, hydrophilic, self-cleaning, flame retardant finishes), Sun-screen dispersions for UV protection using titanium oxide – Colour cosmetics. Nanotechnology in Food Technology - Nanopackaging for enhanced shelf life - Smart/Intelligent packaging.

TOTAL : 45 PERIODS

REFERENCES:

1. Introduction to Nanocomposite Materials. Properties, Processing, Characterization- Thomas E. Twardowski. 2007. DEStech Publications. USA.
2. Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V.Braun 2006.
3. Physical Properties of Carbon Nanotubes- R. Saito 1998.
4. Carbon Nanotubes (Carbon , Vol 33) - M. Endo, S. Iijima, M.S. Dresselhaus 1997.
5. The search for novel, superhard materials- Stan Vepr¡ek (Review Article) JVST A, 1999
6. Nanometer versus micrometer-sized particles-Christian Brosseau, Jamal BeN Youssef, Philippe Talbot, Anne-Marie Konn, (Review Article) J. Appl. Phys, Vol 93, 2003
7. Diblock Copolymer, - Aviram (Review Article), Nature, 2002
8. Bikramjit Basu, Kantesh Balani Advanced Structural Ceramics, A John Wiley & Sons, Inc.,
9. P. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead publication, London, 2006

BY4016 IPR, BIOSAFETY AND ENTREPRENEURSHIP L T P C

3 0 0 3

UNIT I IPR 9

Intellectual property rights – Origin of the patent regime – Early patents act & Indian pharmaceutical industry – Types of patents – Patent Requirements – Application preparation filing and prosecution – Patentable subject matter – Industrial design, Protection of GMO's IP as a factor in R&D,IP's of relevance to biotechnology and few case studies.

UNIT II AGREEMENTS, TREATIES AND PATENT FILING PROCEDURES 9

History of GATT Agreement – Madrid Agreement – Hague Agreement – WIPO Treaties – Budapest Treaty – PCT – Ordinary – PCT – Conventional – Divisional and Patent of Addition – Specifications – Provisional and complete – Forms and fees Invention in context of "prior art" – Patent databases – Searching International Databases – Country-wise patent searches (USPTO,espacenet(EPO) – PATENT Scope (WIPO) – IPO, etc National & PCT filing procedure – Time frame and cost – Status of the patent applications filed – Precautions while patenting – disclosure/non-disclosure – Financial assistance for patenting – Introduction to existing schemes Patent licensing and agreement Patent infringement – Meaning, scope, litigation, case studies

UNIT III BIOSAFETY 9

Introduction – Historical Backround – Introduction to Biological Safety Cabinets – Primary Containment for Biohazards – Biosafety Levels – Biosafety Levels of Specific Microorganisms – Recommended Biosafety Levels for Infectious Agents and Infected Animals – Biosafety guidelines – Government of India.

UNIT IV GENETICALLY MODIFIED ORGANISMS 9

Definition of GMOs & LMOs – Roles of Institutional Biosafety Committee – RCGM – GEAC etc. for GMO applications in food and agriculture – Environmental release of GMOs – Risk Analysis – Risk Assessment – Risk management and communication – Overview of National Regulations and relevant International Agreements including Cartegana Protocol.

UNIT V ENTREPRENEURSHIP DEVELOPMENT 9

Introduction – Entrepreneurship Concept – Entrepreneurship as a career – Entrepreneurial personality – Characteristics of successful Entrepreneur – Factors affecting entrepreneurial growth – Entrepreneurial Motivation – Competencies – Mobility – Entrepreneurship Development Programmes (EDP) - Launching Of Small Enterprise - Definition, Characteristics – Relationship between small and large units – Opportunities for an Entrepreneurial career – Role of small enterprise in economic development – Problems of small scale industries – Institutional finance to entrepreneurs - Institutional support to entrepreneurs.

TOTAL : 45 PERIODS

REFERENCES

1. Bouchoux, D.E., “Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets for the Paralegal”, 3rd Edition, Delmar Cengage Learning, 2008.
2. Fleming, D.O. and Hunt, D.L., “Biological Safety: Principles and Practices”, 4th Edition, American Society for Microbiology, 2006.
3. Irish, V., “Intellectual Property Rights for Engineers”, 2nd Edition, The Institution of Engineering and Technology, 2005.
4. Mueller, M.J., “Patent Law”, 3rd Edition, Wolters Kluwer Law & Business, 2009.
5. Young, T., “Genetically Modified Organisms and Biosafety: A Background Paper for Decision- Makers and Others to Assist in Consideration of GMO Issues” 1st Edition, World Conservation Union, 2004.
6. S.S Khanka, “Entrepreneurial Development”, S.Chand & Company LTD, New Delhi, 2007.