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

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs): (3)

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.

Note: Program may add up to three additional Pos.

4. PEO/POMapping:

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 - 1		√		√	√	
		Audit Course-I*	√	√		√		√
		Computer Aided Design Laboratory	√		√	√		√
		Technical Seminar		√	√	√		√
	SEMESTER II	Product Lifecycle Management	√		√	√		√
		Finite Element Methods in	√		√			
		Vibration Analysis and Control	√				√	
		Program Elective - II	√		√		√	
		Program Elective - III					√	
		Program Elective - IV	√			√	√	
		Audit Course - II			√		√	
		Vibration Laboratory		√	√			
		Simulation and Analysis Laboratory	√			√	√	
YEAR II	SEMESTER III	Program Elective - V	√		√			
		Program Elective - VI		√				
		Open Elective				√		
		Project Work-I	√			√		√
	SEMESTER IV	Project Work-II						

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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.	PD4351	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 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	ED4071	Advanced Finite Element Analysis	PEC	3	0	0	3	3
3	ED4152	Advanced Mechanisms in Design	PEC	3	0	0	3	3
4	AO4071	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.	ED4078	Optimization Techniques in Design	PEC	3	0	0	3	3
2.	CD4071	Bio Materials	PEC	3	0	0	3	3
3.	ED4077	Mechanical Measurements and Analysis	PEC	3	0	0	3	3
4.	BM4075	Wearable Technologies	PEC	3	0	0	3	3
5.	AP4202	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.	ED4081	Vehicle Dynamics	PEC	3	0	0	3	3
2.	PD4151	Creativity and Innovation	PEC	3	0	0	3	3
3.	CD4072	Industrial Robotics and Expert systems	PEC	3	0	0	3	3
4	PD4251	Designing with Advanced Materials	PEC	3	0	0	3	3
5	IC4251	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	ED4075	Engineering Fracture Mechanics	PEC	3	0	0	3	3
2	ED4073	Design of Hybrid and Electric Vehicles	PEC	3	0	0	3	3
3	IL4078	Supply Chain Management	PEC	3	0	0	3	3
4	II4071	Industry 4.0	PEC	3	0	0	3	3
5	ED4076	Material Handling Systems and Design	PEC	3	0	0	3	3

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

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

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&WELDEDCOMPONENTSDESIGN 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).

PD4351 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	-	-

0.1- Low 0.2- Medium 0.3- High

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 elementmatrices
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 numericalsolutions

CO2 Determine field variables for two dimensional scalar and vector variable problems

CO3 Apply Isoparametric transformation and numerical integration for evaluation of elementmatrices

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., NewDelhi, 2012.
6. TirupathiR.Chandrupatla and Ashok D.Belegundu, "Introduction to Finite Elements in Engineering", 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 inTrusses.
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:60PERIODS

LISTOFEQUIPMENTS/SOFTWARE:

Finite Element Analysis packages

COURSEOUTCOMES:

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(L:45) = 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 OriIshai, "Engineering Mechanics of Composite Materials", OxfordUniversityPress-2006,FirstIndian 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:45PERIODS

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

ED4071 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 BENDINGOFPLATESANDSHELLS 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-LINEARPROBLEMS 9

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

UNIT-III DYNAMICPROBLEM 9

Direct Formulation – Free, Transient and Forced Response – Solution Procedures – Eigensolution-SubspaceIterativeTechnique–Responseanalysis-Houbolt,Wilson,Newmark–Methods–Explicit&ImplictMethods-Lanchzos,Reducedmethodforlargesizesystemequations.

UNIT-IV FLUIDMECHANICSANDHEATTRANSFER 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 ERRORESTIMATESANDADAPTIVEREFINEMENT 9

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

TOTAL=45PERIODS

COURSE OUTCOMES:

On Completion oft the course the student will be able to

CO1 ApplyconceptofFiniteElementAnalysistosolveproblemsinvolvingplateandshellelements

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. BatheK.J.,"FiniteElement Procedures in Engineering Analysis",PrenticeHall,1990
2. Logan.D.L.,"AfirstcourseinFiniteElementMethod",CengageLearning,2012
3. Reddy,J.N."AnIntroductiontoNonlinearFiniteElementAnalysis",2nd Edition,Oxford,2015
4. Robert D.Cook, David S.Malkus, Michael E.Plesha, Robert J.Witt,"Concepts and Applications of Finite Element Analysis", 4thEdition,WileyStudentEdition,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.andZhu.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 and equivalent 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

AO4071 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 ARTIFICIALINTELLIGENCE 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 MACHINELEARNING 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 UNSUPERVISEDLEARNING 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.
- IdentifyapplicationssuitablefordifferenttypesofMachineLearningwithsuitablejustification.

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. ChristopherBishop,"PatternRecognitionandMachineLearning"Springer,2007.
2. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", Chapman andHall,CRCPress,SecondEdition,2014.
3. KevinP.Murphy,"MachineLearning:AProbabilisticPerspective",MITPress,2012.
4. EthemAlpaydin,"Introduction to Machine Learning",MIT Press,ThirdEdition,2014.
5. TomMitchell,"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

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)

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

ED4078 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 ADVANCEDOPTIMIZATIONTECHNIQUES **9**

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

UNIT– V STATICANDDYNAMICAPPLICATIONS **9**

Structural applications – Design of simple truss members – Design of simple axial, transverseloaded 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, vibrationabsorbers.ApplicationinMechanisms–Optimumdesignofsimplelinkagemechanisms.

TOTAL:45PERIODS

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 MachineLearning”,Pearson,2009.
2. Jang, J.S.R,Sun, C.TandMizutaniE.,"Neuro-Fuzzy andSoft Computing",PearsonEducation.2015,
3. JohnsonRay,C.,“Optimumdesignofmechanicalelements”,Wiley,2ndEdition1980.
4. KalyanmoyDeb,“OptimizationforEngineeringDesign:AlgorithmsandExamples” ,PHILearningPrivateLimited,2nd Edition,2012.
5. RaoSingiresu S.,“Engineering Optimization – Theory and Practice”, New Age InternationalLimited,NewDelhi,3rdEdition,2013.
6. Rajasekaran S and Vijayalakshmi Pai,G.A,"Neural Networks,FuzzyLogic andGeneticAlgorithms",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

CD4071 **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.

UNITIV 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.

TOTAL: 45 PERIODS

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

ED4077 MECHANICAL MEASUREMENTS AND ANALYSIS

L	T	P	C
3	0	0	3

COURSEOBJECTIVES:

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 pressuregauges–Electronicloadcells–ProvingRings–CalibrationofTestingMachines.

UNIT– II VIBRATIONMEASUREMENTS 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 ACOUSTICSANDWINDFLOWMEASUREMENTS 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 DISTRESSMEASUREMENTS 9

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

UNIT– V NONDESTRUCTIVETESTINGMETHODS 9

Load testing on structures,buildings ,bridges and towers–Rebound Hammer –acoustice mission –ultrasonictestingprinciplesandapplication–Holography–useoflaserforstructuraltesting–Brittlecoating

TOTAL:45PERIODS

COURSEOUTCOMES:

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. BrayDonEand Stanley,R.K.,"Non-destructiveEvaluation",McGrawHillPublishingCompany,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, RaghavanMr, LingaiahK, 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

BM4075 **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 PERIODS: 45

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

AP4202 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.

ED4081	**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 Drivingtorque.PredictionofVehicleperformance.ABS,stabilitycontrol,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. Rollcenter,Rollaxis,Vehicleundersideforces.Stabilityofvehicleonbanked road and duringturn. Effect of suspension on cornering

TOTAL=45PERIODS

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

CD 4072 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

OUTCOME:

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

PD4251 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 LIMITATION9

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 COMPATIBILITY9

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

1. analyze the different strengthening and failure mechanism of the metals
2. apply the effects of metallurgical parameters in the materials design
3. analyze the relationship between the selection of materials and processing
4. develop the novel material through understanding the properties of the existing metallic materials
5. analyze the different materials used in the engineering applications
6.

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

ED4075	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
7.

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

ED4073 DESIGN OF HYBRID AND ELECTRIC VEHICLES

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

COURSEOBJECTIVES:

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 INTRODUCTIONTOELECTRICVEHICLES 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 ENERGYSOURCE 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 powe 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 PARALLELHYBRIDELECTRICDRIVETRAINDESIGN 9

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

UNIT – V ELECTRICVEHICLEDRIVETRAIN 9

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

TOTAL:45PERIODS

COURSEOUTCOMES:

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

CO 1: 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.

CO:5 Describe the transmission components and their configurations for electric vehicles

REFERENCES:

1 Ehsani,M,"ModernElectric,HybridElectricandFuelCellVehicles:Fundamentals,TheoryandDesign", CRC Press,2005

2 "Hybrid Electric Vehicle Technology Assessment: Methodology, Analytical Issues, and Interim Results,"CenterforTransportationResearchArgonneNationalLaboratory,United States Department of Energy.

3 IqbalHussain,"Electric&HybridVehicles–DesignFundamentals",SecondEdition,CRC Press,2011.

4 JamesLarminie,"ElectricVehicleTechnologyExplained",JohnWiley&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

IL4078 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	-

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

II4071

II4071	INDUSTRY 4.0	LT 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

ED4076 MATERIAL HANDLING SYSTEMS AND DESIGN
(Use of Approved Data Book IsPermitted)

COURSEOBJECTIVES:

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. Integratedmechanicalsystemdesignformachinetools,powertransmission andengineparts

UNIT– I INTRODUCTIONSAND DESIGNOFHOISTS 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 HOISTINGGEAR 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:45PERIODS

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.

APPROVEDDATABOOKS:

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 மலர் க்காட்சி
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 போர் வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்
2. நற்றிணை
   - அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618)
   - இயமம் நியமம் விதிகள்
4. தர் மச் சாலையை 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. சுற்றுச் சூழல் 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. தர் மபுர ஆதீன வெளியீடு
4. வாழ்வியல் களஞ்சியம் - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
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