ANNA UNIVERSITY, CHENNAI

AFFILIATED INSTITUTIONS

REGULATIONS -2021

M.E. PRODUCT DESIGN AND DEVELOPMENT

CHOICE BASED CREDIT SYSTEM

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

I.	To prepare students to excel in new product design and development through application of knowledge and practical skills
II.	To provide students with a solid foundation in mathematical modeling of engineering problems required for bringing new products fast into the market
III.	To provide students with required scientific and engineering knowledge so as to comprehend, analyze, design and create innovative products and solutions for real life problems

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	Students will understand the importance of creativity in design process and will demonstrate an ability to identify, formulate, design a system and solve engineering problems.
5	an ability to use the techniques, and modern engineering tools necessary for engineering practice in product development
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.

3. PEO/PO Mapping:

PEO	PO					
	1	**2**	**3**	**4**	**5**	**6**
I	**-**	**-**	**1**	**3**	**3**	**1**
II	**2**	**2**	**2**	**3**	**1**	**1**
III	**1**	**1**	**1**	**3**	**2**	**3**

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

MAPPING OF COURSE OUTCOME AND PROGRAMME OUTCOME

		Subjects	PO1	PO2	PO3	PO4	PO5	PO6
YEAR 1	SEM1	Computer Applications in Design	2	-	2	3	2	-
		Reverse Engineering	1	-	-	3	2	1
		Creativity and Innovation	-	1	1	3	1	3
		Integrated Product Development	1	-	1	2	2	2
		CAD Laboratory and Multibody Dynamics Laboratory	-	-	-	-	3	-
		Reverse Engineering Laboratory	-	-	-	2	3	-
		Professional Elective I						
		Audit course						
	SEM2	Finite Element Methods in Mechanical Design	2	-	-	3	2	-
		Designing with Advanced Materials	2	1	-	2	-	-
		Solid Freeform Manufacturing	1	2	1	-	3	
		Design for Manufacture and Assembly						
		Concepts of Engineering Design	-	2	-	2	3	2
		Professional Elective II						
		Product Design Laboratory	-	-	-	1	3	-
YEAR 2		Advanced Analysis and Simulation Laboratory	-	-	-	1	3	-
	SEM3	Product Lifecycle Management	-	1	2	-	2	3
		Professional Elective III						
		Professional Elective IV						
		Open Elective						
		Project Work I						
	SEM4	Project Work II	3	3	2	2	2	3

ANNA UNIVERSITY, CHENNAI

NON- AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY

M.E. PRODUCT DESIGN AND DEVELOPMENT

REGULATIONS – 2021

CHOICE BASED CREDIT SYSTEM

I TO IV SEMESTERS CURRICULA AND SYLLABUS

SEMESTER I

Sl. No.	Course Code	Course Title	Category	Periods per Week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1	ED4153	Computer Applications in Design	PCC	3	0	0	3	3
2	PD4153	Reverse Engineering	PCC	3	0	0	3	3
3	PD4151	Creativity and Innovation	PCC	3	0	0	3	3
4	PD4152	Integrated Product Development	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	PD4111	CAD Laboratory and Multibody Dynamics Laboratory	PCC	0	0	4	4	2
9	PD4112	Reverse Engineering Laboratory	PCC	0	0	4	4	2
			TOTAL	**19**	**0**	**8**	**27**	**21**

* Audit Course is optional

SEMESTER II

Sl. No.	Course Code	Course Title	Category	Periods per Week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1	ED4251	Finite Element Methods in Mechanical Design	PCC	3	1	0	4	4
2	PD4251	Designing with Advanced Materials	PCC	3	0	0	3	3
3	CM4152	Solid Freeform Manufacturing	PCC	3	0	0	3	3
4	MF4071	Design for Manufacture and Assembly	PCC	3	0	0	3	3
5	CD4151	Concepts of Engineering Design	PEC	3	0	0	3	3
6		Professional Elective - II	PEC	3	0	0	3	3
7		Audit Course - II*	AC	2	0	0	2	0
PRACTICAL								
8	PD4211	Advanced Analysis and Simulation Laboratory	PCC	0	0	4	4	2
9	PD4261	Product Design 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	PD4351	Product Lifecycle Management	PCC	3	0	0	3	3
2		Professional Elective - III	PEC	3	0	0	3	3
3		Professional Elective - IV	PEC	3	0	0	3	3
4		Open Elective	OEC	3	0	0	3	3
PRACTICAL								
5	PD4311	Project Work I	EEC	0	0	12	12	6
			TOTAL	**12**	**0**	**12**	**24**	**18**

SEMESTER IV

Sl. No.	Course Code	Course Title	Category	Periods per Week			Total Contact Periods	Credits
				L	T	P		
PRACTICAL								
1.	PD4411	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:74

PROFESSIONAL ELECTIVES

SEMESTER I, ELECTIVE I

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	CC4071	Advanced Machine Tool Design	PEC	3	0	0	3	3
3	PD4001	Generative Design and Topology Optimization	PEC	3	0	0	3	3
4	IS4071	Data Analytics	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE II

Sl. No.	Course Code	Course Title	Category	Periods per Week			Total Contact Periods	Credits
				L	T	P		
1	CD4072	Industrial Robotics and Expert Systems	PEC	3	0	0	3	3
2	ED4075	Engineering Fracture Mechanics	PEC	3	0	0	3	3
3	PD4002	Enterprise Resource Planning and Management	PEC	3	0	0	3	3
4	AO4071	Artificial Intelligence and Machine Learning	PEC	3	0	0	3	3
5	PD4003	Design for Additive Manufacturing	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE III

Sl. No.	Course Code	Course Title	Category	Periods per Week			Total Contact Periods	Credits
				L	T	P		
1	PD4004	Quality and Financial Concepts in Product Development.	PEC	3	0	0	3	3
2	ED4078	Optimization Techniques in Design	PEC	3	0	0	3	3
3	ED4154	Vibration Analysis and Control	PEC	3	0	0	3	3
4	PD4005	IOT Technologies	PEC	3	0	0	3	3
5	IC4251	Computational Fluid Dynamics	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE IV

Sl. No.	Course Code	Course Title	Category	Periods per Week			Total Contact Periods	Credits
				L	T	P		
1	PD4006	Human Factors Engineering in Product Design	PEC	3	0	0	3	3
2	ED4073	Design of Hybrid and Electric Vehicles	PEC	3	0	0	3	3
3	PD4007	Rotor Dynamics	PEC	3	0	0	3	3
4	CD4071	Bio materials	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

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
Avg.	1	2	1	3	3	2

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

PD4153 **REVERSE ENGINEERING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

1. Applying the fundamental concepts and principles of reverse engineering in product design and development.
2. Applying the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
3. Applying the concept and principles of material identification and process verification in reverse engineering of product design and development.
4. Applying the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.
5. Analyzing the various legal aspect and applications of reverse engineering in product design and development.

UNIT I INTRODUCTION TO REVERSE ENGINEERING & GEOMETRIC FORM 9

Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering - Surface and Solid Model Reconstruction – Dimensional Measurement – Prototyping.

UNIT II MATERIAL CHARACTERISTICS, PART DURABILITY AND LIFE LIMITATION 9

Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength – Hardness –Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure

UNIT III MATERIAL IDENTIFICATION AND PROCESS de VERIFICATION 9

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

UNIT IV DATA PROCESSING, PART PERFORMANCE AND SYSTEM COMPATIBILITY 9

Statistical Analysis – Data Analysis – Reliability and the Theory of Interference – Weibull Analysis – Data Conformity and Acceptance – Data Report – Performance Criteria – Methodology of Performance Evaluation – System Compatibility.

UNIT V ACCEPTANCE, LEGALITY AND INDUSTRIAL APPLICATIONS OF RE 9

Legality of Reverse Engineering – Patent – Copyrights –Trade Secret – Third-Party Materials – Reverse Engineering in the Automotive Industry; Aerospace Industry; Medical Device Industry.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

1. Apply the fundamental concepts and principles of reverse engineering in product design and development.
2. Apply the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
3. Apply the concept and principles of material identification and process verification in reverse engineering of product design and development.
4. Apply the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.
5. Analyze the various legal aspect and applications of reverse engineering in product design and development

REFERENCES

1. Co-ordinate Measurement and reverse engineering, Donald R. Honsa, ISBN 1555897, American Gear Manufacturers Association
2. Data Reverse Engineering, Aiken, Peter, McGraw-Hill, 1996
3. Design Recovery for Maintenance and Reuse, T J Biggerstaff, IEEE Corpn. July 1991
4. Reverse Engineering, Katheryn, A. Ingle, McGraw-Hill, 1994
5. Reverse Engineering, Linda Wills, Kluiver Academic Publishers, 1996
6. White paper on RE, S. Rugaban, Technical Report, Georgia Instt. of Technology, 1994

CO	PO					
	1	2	3	4	5	6
1	3	2	1	1	-	-
2	3	3	1	2	-	-
3	3	3	1	2	-	1
4	3	3	1	2	-	1
5	1	2	1	1	-	1
AVg.	2.6	2.6	1	1.6	-	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

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

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.

PD4111 CAD LABORATORY AND MULTIBODY DYNAMICS LABORATORY L T P C
0 0 4 2

COURSE OBJECTIVE:

- To impart knowledge on how to prepare drawings for various mechanical components using any commercially available 3D modelling software’s.
- To expose the students to understand the forces and torques that come into action in various kinds of mechanical systems.

1. CAD Introduction & Sketcher
2. Solid modeling–Extrude, Revolve, Sweep, etc and Variational sweep, Loft, etc
3. Surface modeling–Extrude, Sweep, Trim..etc and Mesh of curves, Free form etc
4. Feature manipulation – Copy, Edit, Pattern, Suppress, History operations etc.
5. Assembly-Constraints, Exploded Views, Interference check
6. Drafting - Layouts, Standard & Sectional Views, Detailing &Plotting.

7. CAD data Exchange formats-IGES,PDES, PARASOLID,DXF and STL.
8. Free fall of rigid body
9. Projectile motion
10. Simulation of simple & Compound Pendulum
11. Kinematic & Dynamic Analysis four bar and slider crack mechanism and its inversions
12. Design of cam Profile for various follower output motion
13. Kinematic & Dynamic Analysis of Gear Tracks
14. Vibration Analysis SDOF and MDOF
15. Project on virtual product design using ADAMS

- Exercises in Modeling and drafting of Mechanical Components - Assembly using Parametric and feature based Packages like PRO-E / SOLID WORKS /CATIA / NX etc.
- Exercises in kinematics and dynamics using equations of motion in package like ADAMS.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

- With laboratory classes, it helps the students to get familiarized with the computer applications in design and preparing drawings for various mechanical components.
- The students get familiarized with modeling different systems and importing them into the multi body dynamic software.
- The students will be trained to obtain required dynamic properties by conducting multi body dynamic tests.
- The students will learn how to use this data in additional stress analysis software.

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

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

PD4112 REVERSE ENGINEERING LABORATORY L T P C
0 0 4 2

COURSE OBJECTIVES:

1. Applying the fundamental concepts and principles of reverse engineering in product design and development.
2. Applying the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
3. Applying the concept and principles of material identification and process verification in reverse engineering of product design and development.
4. Applying the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.
5. Analyzing the various legal aspect and applications of reverse engineering in product design and development.

Exercises

1. Surface measurement – CMM.
2. 3D Laser scanning of components.
3. Reverse engineering of Automotive components-cam shaft.
4. Material identification and process verification of welded components.
5. Reverse engineering of dental components - Bio medical applications.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

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

- Apply the fundamental concepts and principles of reverse engineering in product design and development.
- Apply the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
- Apply the concept and principles of material identification and process verification in reverse engineering of product design and development.
- Apply the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.
- Analyze the various legal aspect and applications of reverse engineering in product design and development.

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	3	2	1	1	-	
2	3	3	1	2	-	
3	3	3	1	2	-	1
4	3	3	1	2	-	1
5	1	2	1	1	-	1
AVg.	2.6	2.6	1	1.6	-	1

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

		L	T	P	C
ED4251	**FINITE ELEMENT METHODS IN MECHANICAL DESIGN**	**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

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 COMPATIBILITY 9

Statistical Analysis – Data Analysis – Reliability and the Theory of Interference – Weibull Analysis – Data Conformity and Acceptance – Data Report – Performance Criteria – Methodology of Performance Evaluation – System Compatibility.

UNIT V ACCEPTANCE, LEGALITY AND INDUSTRIAL APPLICATIONS OF RE 9

Legality of Reverse Engineering – Patent – Copyrights –Trade Secret – Third-Party Materials – Reverse Engineering in the Automotive Industry; Aerospace Industry; Medical Device Industry.

TOTAL : 45PERIODS

OUTCOMES:

On Completion of the course the student will be able to

- Analyze the different strengthening and failure mechanism of the metals
- Apply the effects of metallurgical parameters in the materials design
- Analyze the relationship between the selection of materials and processing
- Develop the novel material through understanding the properties of the existing metallic materials
- Analyze the different materials used in the engineering applications

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

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

REFERENCES:

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

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

MF4071 DESIGN FOR MANUFACTURE AND ASSEMBLY L T P C
3 0 0 3

OBJECTIVES:

(1) To apply various design rules in manufacturing processes
(2) To evaluate the process by design guidelines for optimum design
(3) To analyze the rules of concepts of GD& T
(4) To make the students to learn about tolerance analysis and allocation, geometrical tolerances
(5) Guide lines for design for manufacturing and assembly with suitable examples.

UNIT I TOLERANCE ANALYSIS 9

Introduction – Concepts, definitions and relationships of tolerancing – Matching design tolerances with appropriate manufacturing process – manufacturing process capability metrics – Worst care, statistical tolerance Analysis – Linear and Non-Linear Analysis – Sensitivity Analysis – Taguchi's Approach to tolerance design.

UNIT II TOLERANCE ALLOCATION 9

Tolerance synthesis – Computer Aided tolerancing – Traditional cost based analysis – Taguchi's quality loss function – Application of the Quadratic loss function to Tolerancing – Principles of selective Assembly – Problems.

UNIT III GD&T 9

Fundamentals of geometric dimensioning and tolerancing – Rules and concepts of GD&T – Form controls – Datum systems – Orientation controls – Tolerance of position – Concentricity and symmetry controls – Run out controls – Profile controls.

UNIT IV TOLERANCE CHARTING 9

Nature of the tolerance buildup – structure and setup of the tolerance chart – piece part sketches for tolerance charts – Arithmetic ground rules for tolerance charts – Determination of Required balance dimensions – Determination of Mean working Dimensions – Automatic tolerance charting – Tolerance charting of Angular surfaces.

UNIT V MANUFACTURING GUIDELINES 9

DFM guidelines for casting, weldment design – Formed metal components – Turned parts – Milled, Drilled parts – Non-metallic parts – Computer Aided DFM software – Boothroyd and Dewhurst method of DFMA – DCS – Vis/VSA – 3D Dimensional control – Statistical tolerance Analysis Software – Applications.

TOTAL: 45 PERIODS

OUTCOMES :

At the end of this course the students are expected
(1)To impart the knowledge about the significance of design for manufacturing and assembly
(2)To apply the principle of tolerancing in design
(3)Evaluate the process of GD & T using design guidelines
(4)Apply tolerance allocation and tolerance charting in design
(5)Apply guidelines for manufacturing and assembly

REFERENCES:

1. Alex Krulikowski, "Fundamentals GD&T", Delmar Thomson Learning, 1997.
2. C.M. Creveling, "Tolerance Design – A handbook for Developing Optimal Specifications", Addison – Wesley, 1997.
3. James D. Meadows, 'Geometric Dimensioning and Tolerancing", Marcel Dekker Inc., 1995.
4. James G. Bralla, "Handbook of Product Design for Manufacturing", McGraw Hill, 1986.
5. Oliver R. Wade, "Tolerance Control in Design and Manufacturing", Industrial Press, NY, 1967.

CO-PO Mapping

CO	PO					
	1	2	3	4	5	6
1	1	-	-	3	-	-
2	1	1	-	2	2	-
3	-	-	3	2	2	-
4	1	-	-	-	-	-
5	-	-	-	2	2	2
Avg	1	1	3	2.25	2	2

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

PD4211 **ADVANCED ANALYSIS AND SIMULATION LABORATORY** **L T P C**
0 0 4 2

OBJECTIVES:

1. To give exposure to software tools needed to analyze engineering problems.
2. To expose the students to different applications of simulation and analysis tools.

A. SIMULATION

1. MATLAB basics, Dealing with matrices, Graphing-Functions of one variable and two variables
2. Use of MATLAB to solve simple problems in vibration
3. Mechanism Simulation using Multibody Dynamic software

B. ANALYSIS

1. Force and Stress analysis using link elements in Trusses, cables etc.
2. Stress and deflection analysis in beams with different support conditions.
3. Stress analysis of flat plates and simple shells.

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. Model analysis of Beams.
9. Harmonic, transient and spectrum analysis of simple systems.
10. Analysis of machine elements under dynamic loads
11. Analysis of non-linear systems

TOTAL : 60 PERIODS

List of Equipment / Software:
Finite Element Analysis packages

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

1. Solve engineering problems numerically using Computer Aided Finite Element Analysis packages.

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

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

PD4261 **PRODUCT DESIGN LABORATORY** **L T P C**
0 0 4 2

OBJECTIVE:

- To give exposure to develop digital and physical prototype models using RP machine / clay models of a new product/ existing product.

The students in a group have to develop digital and physical prototype models using RP machine / clay models of a new product/ existing product with enhanced feature involving the following areas:

- Automotive components
- Tool and die components
- Press tool components
- Consumer product
- Injection moulded products.

The fabricated models may be in the form of RP models, clay models, sheet metal models or cardboard models etc.

The design and development of the product will be reviewed in two stages for awarding internal marks. The end semester examination mark will be based on the demonstration of the new product developed and oral examination on the same by internal examiners.

TOTAL : 60 PERIODS

COURSE OUTCOMES:
Upon conclusion of this course the student will be able to

CO1 Appreciate the use of physical prototype models for evaluating product concept
CO2 Apply theoretical knowledge to design and development of physical products usingclay, wood, sheet metal and RP techniques

CO	PO					
	1	2	3	4	5	6
1	3	3	3	3	3	-
2	3	3	3	3	2	2
Avg.	3	3	3	3	2.5	2

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

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:45PERIODS

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	-	-

1- Low 2- Medium 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.

PD4311 **PROJECT WORK I** **L T P C**
0 0 12 6

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

OUTCOME:

At the end of the course 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.

PD5411 **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.

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

OUTCOMES:
On completion of the project work students will be in a position to take up any challenging practical problem in the field of engineering design and find better solutions to it.

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
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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

CC4071 ADVANCED MACHINE TOOL DESIGN L T P C

3 0 0 3

COURSE OBJECTIVES

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

1. Selecting the different machine tool mechanisms.
2. Designing the Multi speed Gear Box and feed drives.
3. Designing the machine tool structures.
4. Designing the guideways and power screws.
5. Designing the spindles and bearings.

UNIT I INTRODUCTION TO MACHINE TOOL DESIGN 9

Introduction to Machine Tool Drives and Mechanisms, Auxiliary Motions in Machine Tools, Kinematics of Machine Tools, Motion Transmission

UNIT II REGULATION OF SPEEDS AND FEEDS 9

Aim of Speed and Feed Regulation, Stepped Regulation of Speeds, Multiple Speed Motors, Ray Diagrams and Design Considerations, Design of Speed Gear Boxes, Feed Drives, Feed Box Design

UNIT III DESIGN OF MACHINE TOOL STRUCTURES 9

Functions of Machine Tool Structures and their Requirements, Design for Strength, Design for Rigidity, Materials for Machine Tool Structures, Machine Tool Constructional Features, Beds and Housings, Columns and Tables, Saddles and Carriage.

UNIT IV DESIGN OF GUIDEWAYS AND POWER SCREWS 9

Functions and Types of Guideways, Design of Guideways, Design of Aerostatic Slide ways, Design of Anti-Friction Guideways, Combination Guideways, Design of Power Screws.

UNIT V DESIGN OF SPINDLES AND SPINDLE SUPPORT 9

Functions of Spindles and Requirements, Effect of Machine Tool Compliance on Machining Accuracy, Design of Spindles, Antifriction Bearings. Dynamics of Machine Tools: Machine Tool Elastic System, Static and Dynamic Stiffness

TOTAL = 45 PERIODS

OUTCOMES:

On Completion of the course the student will be able to

1. Select the different machine tool mechanisms.
2. Design the Multi speed Gear Box and feed drives.
3. Design the machine tool structures.
4. Design the guideways and power screws.
5. Design the spindles and bearings.

REFERENCES:

1. N.K. Mehta, Machine Tool Design and Numerical Control, TMH, New Delhi, 3rd edition 2012
2. G.C. Sen and A. Bhattacharya, Principles of Machine Tools, New Central Book Agency, 2015
3. K Pal, S. K. Basu, “Design of Machine Tools”, 6th Edition. Oxford IBH, 2014
4. N. S. Acherkhan, “Machine Tool Design”, Volume 2 University Press of the Pacific, 2000
5. F. Koenigsberger, Design Principles of Metal-Cutting Machine Tools, Pergamon Press, 1964
6. F. Koenigsberger, Machine Tool Structures, Pergamon Press,1970.

CO	PO

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

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

PD4001 GENERATIVE DESIGN AND TOPOLOGY OPTIMIZATION L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To impart knowledge on basic concepts in generative design.
2. To develop design methods to meet the needs of a customer.
3. To incorporate various design methods to develop a creative product.
4. To gain knowledge on topology aspects of design.
5. To gain knowledge on optimization in design.

UNIT I INTRODUCTION 9

Introduction to Generative design - Benefits of generative design -Design exploration- Examine multiple design options and review tradeoffs in materials. Performance, and manufacturing methods.

UNIT II GENERATIVE DESIGN 9

Editable geometry - Integrated workflows- Multiple manufacturing methods- Additive – 3 or 5 axis milling – Applications.

UNIT III LOW-DENSITY AREAS IN TOPOLOGY OPTIMIZATION 9

Localized mode in low-density areas - Localized deformation, Polynomial interpolation model, Breakdown issue in ESO. Dynamics – analysis and topology optimization under harmonic and random force excitations, Thermo-elastic problems - topology optimization in single and multiple materials.

UNIT IV INTEGRATED LAYOUT AND TOPOLOGY OPTIMIZATION 9

Introduction to integrated optimization, Finite-circle method, Density points and embedded, meshing, MPC-based component-structure connections, integrated optimization based on implicit model.

UNIT V POTENTIAL APPLICATIONS OFTOPOLOGY OPTIMIZATION 9

Shape-preserving design, Smart structure design, Structural features design, Topology optimization and additive manufacturing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

- Appreciate the aspects of need for design, design process used for designing various components
- Get familiarized with concepts related to design methods during the design of products
- Get acquainted with the knowledge of designing creative components
- Gain knowledge on topology aspects of design.
- Get equipped with optimization tools for improving quality, reliability and performance of a product.

REFERENCES:

1. Martin Philip Bendsoe, Ole Sigmund, "Topology Optimization: Theory, Methods, and Applications", Springer Science & Business Media, 2003.
2. Eris, Ozgur, "Effective Inquiry for Innovative Engineering Design", Springer,2004.
3. George I. N. Rozvany, Tomasz LewinskiTopology "Optimization in Structural and Continuum Mechanics". Springer; 2015 edition.
4. Gregoire Allaire "Shape Optimization by the Homogenization Method" Springer-Verlag New York 2002
5. Behrooz Hassani, Ernest Hinton "Homogenization and Structural Topology Optimization" Springer-Verlag London, 1999.

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

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

IS4071 DATA ANALYTICS L T P C
3 0 0 3

COURSE OBJECTIVES:

1. Recognize the importance of data analytics
2. Exhibit competence on data analytics packages
3. Apply solution methodologies for industrial problems.

UNIT I INTRODUCTION 9

Introduction to Multivariate Statistics-Degree of Relationship among Variables-Review of Univariate and Bivariate Statistics-Screening Data Prior to Analysis-Missing Data, Outliers, Normality, Linearity, and Homoscedasticity.

UNIT II MULTIPLE REGRESSION 9

Multiple Regression- Linear and Nonlinear techniques- Backward-Forward-Stepwise Hierarchical regression-Testing interactions (2way interaction) - Analysis of Variance and Covariance (ANOVA & ANCOVA) - Multivariate Analysis of Variance and Covariance (MANOVA & MANCOVA).

UNIT III LOGISTIC REGRESSION 9

Regression with binary dependent variable -Simple Discriminant Analysis Multiple Discriminant analysis-Assessing classification accuracy- Conjoint analysis (Full profile method).

UNIT IV PRINCIPAL COMPONENT ANALYSIS 9

Principal Component Analysis -Factor Analysis- Orthogonal and Oblique Rotation-Factor Score Estimation-Multidimensional Scaling-Perceptual Map-Cluster Analysis (Hierarchical Vs Nonhierarchical Clustering).

UNIT V LATENT VARIABLE MODELS 9

Latent Variable Models an Introduction to Factor, Path, and Structural Equation Analysis- Time series data analysis (ARIMA model) – Decision tree analysis (CHAID, CART) - Introduction to Big Data Management.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- To recognize the importance of data analytics
- To Exhibit competence on data analytics packages
- To apply solution methodologies for industrial problems.

REFERENCES:

1. Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. “Multivariate data analysis”, (7th edition). Pearson India. 2015
2. Tabachnick, B. G., & Fidell, L. S., “Using multivariate statistics”, (5th edition). Pearson Prentice Hall, 2001
3. Gujarati, D. N. , “Basic econometrics”, Tata McGraw-Hill Education, 2012
4. Malhotra, N. K., “ Marketing research: An applied orientation”, 5/e. Pearson Education India, 2008
5. Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. “ Applied multiple regression/correlation analysis for the behavioral sciences”, Routledge., 2013
6. Han, J., Kamber, M., & Pei, J. “Data mining: concepts and techniques: concepts and techniques”, Elsevier, 2011.

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

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.
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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

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: 45 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

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

REFERENCES:

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

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

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

PD4002 ENTERPRISE RESOURCE PLANNING AND MANAGEMENT L T P C
3 0 0 3

OBJECTIVE:

1. Students will be able to identify the needs of Enterprise resource planning.
2. Students will be able to understand the various technologies of ERP.
3. Students will be able to distinguish the various ERP packages.
4. Students will be able to understand the various architecture of ERP.
5. Students will be able to identify the issues in ERP procurement.

UNIT I ENTERPRISE RESOURCEPLANNINGANDVALUECHAINMANAGEMENT 9

Principle – ERP framework – Business Blue Print – Business Engineering vs Business process Re-Engineering – Tools – Languages – Value chain – Supply and Demand chain – Extended supply chain management – Dynamic Models –Process Models

UNIT II TECHNOLOGY ANDARCHITECTURE 9

Client/Serverarchitecture–Technologychoices–Internetdirection– Evaluationframework– CRM – CRM pricing– chain safety – Evaluation framework.

UNIT III ERP SYSTEMPACKAGES 9

SAP, People soft, Baan and Oracle – Comparison – Integration of different ERP applications– ERP as sales force automation – Integration of ERP and Internet – ERP Implementation strategies – Organizational and social issues.

UNIT IV ERPARCHITECTURE 9

Overview – Architecture – AIM – applications – Oracle SCM.SAP: Overview – Architecture – applications -Before and after Y2k – critical issues – Training on various modules of IBCS ERP Package-Oracle ERP and MAXIMO, including ERP on the NET

UNIT V ERP PROCUREMENTISSUES 9

Market Trends – Outsourcing ERP – Economics – Hidden Cost Issues – ROI – Analysis of cases from five Indian Companies.

TOTAL: 45 PERIODS

OUTCOMES:

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

1. Able to acquire integrated view of the various facets of business, including planning, manufacturing, sales, finance and marketing.
2. Able to understand the development of software to integrate business activities such as inventory management and control, order tracking, customer service, finance and human resources.
3. Awareness on the software applications and tools that are available to business to use to drive out costs and improve efficiency.
4. Understand the architecture of various ERP packages available in the market.
5. Ability to learn the outsourcing concepts of ERP and its economics.

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

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

REFERENCES:

1. ERPWARE, ERP Implementation Framework, Garg&Venkitakrishnan, Prentice Hall, 1999.
2. Jose Antonio Fernandez , The SAP R/3 Handbook, Tata Mcgraw Hill, 1998.
3. Sadagopan.S , ERP-A Managerial Perspective, Tata Mcgraw Hill, 1999.
4. Thomas E Vollmann and BeryWhybark , Manufacturing and Control Systems, Galgothia Publications, 1998.
5. 5.Vinod Kumar Crag and N.K.Venkitakrishnan ,Enterprise Resource Planning – Concepts and Practice, Prentice Hall of India, 1998.

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.
- ImplementProbabilisticDiscriminativeandGenerativealgorithmsforanapplicationofyourchoiceandanalyzethe 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.

PD4003 DESIGN FOR ADDITIVE MANUFACTURING L T P C

3 0 0 3

OBJECTIVES:

- To acquaint the students with evolution of Additive Manufacturing (AM).
- To gain knowledge on Design aspects of Additive Manufacturing (DFAM).
- To acquaint with Photopolymerization and Sintering processes and their applications.
- To acquaint the students with applications aspects of Additive Manufacturing.
- To gain knowledge in Future trends of Additive Manufacturing

UNIT I BASICS PRINCILPES OF ADDITIVE MANUFACTURING 9

Introduction to the Basic Principles of Additive Manufacturing, Additive Manufacturing Processes, Extrusion, Beam Deposition

UNIT II DESIGN CONCEPTS IN ADDITIVE MANUFACTURING 9

Design/Fabrication Processes: Data Sources, Software Tools, File Formats, Model Repair and Validation, Pre- & Post-processing, Designing for Additive Manufacturing, Multiple Materials, Hybrids, Composite Materials, current and future directions.

UNIT III DESIGN FORADDITIVE 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 IV DESIGNING FOR 3D PRINTING 9

General design considerations for 3D printing, 3D printed features, Designing for Material Jetting, Binder Jetting, FFF, SLA/DLP, SLS, DMLS/SLM, design rules.

UNIT V DESIGNSTANDARDS FOR ADDITIVE MANUFACTURING 9

Methods of testing and Testing organization - ASTM, ANSI, NBS, NEMA, NFPA, VL, SPI AND SPE.

TOTAL : 45 PERIODS

OUTCOMES:

On Completion of the course the student will be able to

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

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

CO3: Acquireknowledgeonprinciplesandapplicationsofpolymerizationandsheetlaminationprocesseswith case studies.

CO4: Acquire knowledge on principles of material extrusion and powder bed fusion processes and design guidelines.

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

CO	PO				
	1	2	3	4	5
1	1	1	1	2	2
2	3	1	3	3	3
3	3	3	2	3	2
4	2	2	2	3	3
5	3	1	3	3	3
Avg	2.4	1.6	2.2	2.8	2.6

0.3-Low 0.6-Medium 0.9-High

REFERENCES:

1. Andreas Gebhardt and Jan-Steffen Hotter, "Additive Manufacturing:3D Printing for Prototypingand Manufacturing", Hanser publications Munchen, Germany, 2015. ISBN:978-1-56990-582-1.
2. Ben Redwood, Brian Garret, Filemon Schöffer, and Tony Fadel, "The 3D Printing Handbook:Technologies,DesignandApplications",3DHubsB.V.,Netherland,2017.ISBN-13: 978-9082748505.
3. Ian Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: RapidPrototyping 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 forprototypedevelopment",CRCPress,1stEdition,2007FL,USA.ISBN- 9780849334092.
5. Milan Brandt., "Laser Additive Manufacturing 1st Edition Materials, Design, Technologies, andApplications",WoodheadPublishing,UK,2016.ISBN-9780081004333.

PD4004 QUALITY AND FINANCIAL CONCEPTS IN PRODUCT DEVELOPMENT

L T P C
3 0 0 3

OBJECTIVES:

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

1. Applying the concept and principles of quality tools such as seven old and new tools of quality, SPC, multivariate charts, box plots, Pareto charts in product development.
2. Applying the concept and principles of quality tools such as benchmarking, QFD, HoQ, and reliability in product development.
3. Applying the concept and principles of Six Sigma and Lean manufacturing in product development.
4. Applying the concept and principles of robust design and embodiment design in product development.
5. Applying the concept and principles of finance and working capital management in product development.

UNIT I QUALITY TOOLS I 9

Seven Statistical Tools of Quality – New Seven Management Tools – Multivariable Charts and 3D Plot – Statistical Process Control: Problems in Mean and Range Chart; p, np, u and c chart; Problems in Box Plot and Pareto Chart.

UNIT II QUALITY TOOLS II 9

Benchmarking: Types; Process; Benefits – Quality Function Deployment (QFD): Concept; Benefits; Process; House of Quality: Structure and Methodology – Reliability: Hazard / Failure Rate; Mean Time Between Failure; Simple problems in Series; Parallel; Combination; Standby Systems.

UNIT III DESIGN FOR SIXSIGMA AND LEAN PRINCIPLES 9

Six Sigma: Definition; Concept ;Process (DMAIC Methodology) – Project selection for Six Sigma (Types of Quality Problems) – Key Tools in Lean Production / Manufacturing – 4R Total Improvement – PDSA Cycle: Phases; Benefits – Kaizen and Kairyo – 5S House Keeping – TPM: Definition; Objective; Pillars; Steps.

UNIT IV ROBUST DESIGN AND EMBODIMENT DESIGN 9

Robust Design: Definition; Process Steps – Embodiment Design: Basic methods: Refining geometry and layout – General process of product embodiment – Embodiment checklist – Advanced methods: Systems modeling – Mechanical embodiment principles – FMEA Procedure; benefits.

UNIT V FINANCE AND WORKING CAPITAL MANAGEMENT 9

Financial Planning: Definition; Need; Sources; Capital Structure; Capitalization; Term Loans; Short term Finance; Venture Capital; Export Finance – Working Capital Management: Definition; Significance; Assessment; Factors; Sources; Management.

TOTAL:45 PERIODS

OUTCOMES:

The student will

1. Apply the concept and principles of quality tools such as seven old and new tools of quality, SPC, multivariate charts, box plots, Pareto charts in product development.
2. Apply the concept and principles of quality tools such as benchmarking, QFD, HoQ, and reliability in product development.
3. Apply the concept and principles of Six Sigma and Lean manufacturing in product development.
4. Apply the concept and principles of robust design and embodiment design in product development.
5. Apply the concept and principles of finance and working capital management in product development.

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

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

REFERENCES:

1. Fundamentals of Quality control and improvement 2nd edition, AMITAVA MITRA, Pearson Education Asia, 2002.
2. Product Design and Development, KARL T. ULRICH, STEVEN D. EPPINGER, TATA McGraw-HILL- 3rd Editions, 2003.
3. Product Design Techniques in Reverse Engineering and New Product Development, KEVIN OTTO & KRISTIN WOOD, Pearson Education (LPE), 2001.
4. The Management and control of Quality-6th edition-James R. Evens, William M Lindsay Pub: son south-western University of Mumbai, Mechanical Engineering, M E Product Design and Development (New 2014) Page 8/48.

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- Singlevariableandmultivariableoptimization,Techniquesofunconstrainedminimization - 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 - Designofsprings. 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

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

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

PD4005 **IOT TECHNOLOGIES** **L T P C**
3 0 0 3

OBJECTIVES:

1. To understand the different architectures for IoT.
2. To learn various protocols at the different layers for IoT.
3. To develop prototype systems using Arduino / RasberryPi.
4. To apply the use of data analytics in IoT.
5. To develop applications of IoT in Industrial contexts.

UNIT I ARCHITECTURES AND MODELS **9**

Introduction to IoT – IoT Architectures – Core IoT Functional Stack, Sensors and Actuators Layer, Communications Network Layer, Applications and Analytics Layer – IoT Data Management and Compute Stack, Fog Computing, Edge Computing, Cloud Computing – Sensors, Actuators, Smart Objects, Sensor networks.

UNIT II CONNECTIVITY **9**

Communications Criteria – Access Technologies – IP as IoT Network Layer – Business case – Optimization – Profiles and compliances – Application Protocols – Transport Layer – Application Transport Methods.

UNIT III SYSTEM DEVELOPMENT **9**

Design Methodology – Case study – Basic blocks of IoT device – Raspberry Pi – Board, Interfaces, Linux, Setting up, Programming – Arduino – Other IoT Devices.

UNIT IV DATA ANALYTICS AND IoT SECURITY **9**

Data Analytics for IoT – Big Data Analytics Tools and Technology – Edge Streaming Analytics – Network Analytics, Applications. Security history, challenges, variations – Risk Analysis Structures– Application in Operational Environment.

UNIT V IoT IN INDUSTRY **9**

Manufacturing, Architecture, Protocols – Utilities, Grid Blocks - Smart Cities, Architecture, Use cases – Transportation, Architecture, Use cases.

. **TOTAL = 45PERIODS**

OUTCOMES:

On Completion of the course the student will be able to

- Explain the underlying architectures and models in IoT.
- Analyze different connectivity technologies for IoT.
- Develop simple applications using Arduino/RaspberryPi.
- Apply data analytics techniques to IoT.
- Study the need and suggest appropriate solutions for Industrial applications.

REFERENCES:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, “IoTFundamentals:NetworkingTechnologies,ProtocolsandUseCasesforInternetofThings”,Cisco Press,2017
2. OlivierHersent,DavidBoswarthick,OmarElloum,“TheInternetofThings— KeyapplicationsandProtocols”,Wiley,2012.
3. MichaelMiller,“TheInternet ofThings”,PearsonEducation, 2015.
4. ArshdeepBahga,VijayMadisetti,“InternetofThings–Ahands-on approach”,UniversitiesPress,2015.
5. Jan Ho¨ ller, VlasiosTsiatsis, Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand.DavidBoyle,"FromMachine-to-MachinetotheInternetofThings-IntroductiontoaNewAgeofIntelligence",Elsevier,2014.
6. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), “Architecting the Internet ofThings”,Springer,2011.

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

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

IC4251 COMPUTATIONAL FLUID DYNAMICS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

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

UNIT – I GOVERNING DIFFERENTIAL EQUATIONS AND DISCRETISATION TECHNIQUES 9

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

UNIT – II DIFFUSION PROCESSES: FINITE VOLUME METHOD 9

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

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

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

UNIT – IV FLOW PROCESSES: FINITE VOLUME METHOD 9

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

UNIT – V TURBULENCE MODELS 9

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

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

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

PO &CO Mapping:

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

REFERENCES:

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

PD4006 HUMAN FACTORS ENGINEERING IN PRODUCT DESIGN L T P C
3 0 0 3

OBJECTIVES:

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

1. Applying the fundamental concepts and principles of ergonomics in product design and development.
2. Applying the concept and principles of work place design in product design and development.
3. Applying the concept and principles of equipment design in product design and development.
4. Applying the concept and principles of environmental design in product design and development.
5. Applying the concept and principles of cognitive ergonomics & human factor application in product design and development.

UNIT I FUNDAMENTALS OF ANTHROPOMETRYIN ERGONOMICS 9

Anthropometry and its uses in ergonomics – Principles of applied anthropometry in ergonomics – Application of anthropometry in design – Design for everyone.

UNIT II ERGONOMICS IN WORKPLACE DESIGN 9

Design for standing workers – Design for seated workers – Design for repetitive task – Design for manual handling activity task – Design for work capacity, stress, and fatigue.

UNIT III ERGONOMICS INEQUIPMENTDESIGN 9

Design for visual displays – Design for auditory displays – Design for controls – Design for virtual environments.

UNIT IV ERGONOMICS INENVIRONMENTAL DESIGN 9

Heat, cold and the design of the physical environment – Vision, light and lighting – Hearing, sound, noise and vibration

UNIT V COGNITIVE ERGONOMICS & HUMANFACTORAPPLICATION 9

Human information processing, skill and performance – Human–computer interaction, memory and language – Human–machine interaction, human error and safety. Resonance and mode shapes.

TOTAL = 45PERIODS

OUTCOMES:

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

1. Apply the fundamental concepts and principles of ergonomics in product design and.
2. Apply the concept and principles of work place design in product design and development.
3. Apply the concept and principles of equipment design in product design and development.
4. Apply the concept and principles of environmental design in product design and development.
5. Apply the concept and principles of cognitive ergonomics & human factor application in product design anddevelopment.

REFERENCES:

1. Bridger R S, “Introduction to Ergonomics”, Taylor and Francis, London,2003.
2. Chandler Allen Phillips, “Human Factors Engineering”, John Wiley and sons, New York, 2000
3. Mark S Sanders, “Human Factors in Engineering and Design”, McGraw Hill, New York, 1993.
4. Martin Helander, “A guide to Human Factors and Ergonomics”, 2nd Edition, CRC, Taylor & Francis Group 2006.
5. McCormik, J., “Human Factors Engineering and Design”, McGraw Hill,1992.

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

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-Fuelcell types.

UNIT–III SERIES HYBRID ELECTRIC DRIVE TRAIN DESIGN 9

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

UNIT– IV 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-Gearratio- 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:

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

REFERENCES:

1. Ehsani,M,"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

PD4007 **ROTOR DYNAMICS** **L T P C**

3 0 0 3

OBJECTIVES:

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

1. Apply and develop mathematical model of a system
2. Applying the design and suggest bearings for specific applications
3. Applying a fatigue life calculation for various types of bearings
4. Apply and analyze bearing behavior
5. Study the dynamics of rotors mounted on Hydrodynamic Bearings.

UNIT I **INTRODUCTION TO ROTOR DYNAMICS** **9**

Torsional vibrations analysis – critical speeds and response to imbalance- Transfer matrix analysis- Instability of rotors- Gyroscopic effects

UNIT II **HYDRODYNAMIC BEARINGS** **9**

Hydrodynamic Lubrication equation for dynamic loadings-Squeeze film effects in journal bearings and thrust bearings -Rotating loads , alternating and impulse loads in journal bearings – Journal center Trajectory- Analysis of short bearings under dynamic conditions- Finite difference solution for dynamic conditions.

UNIT III **BALANCING OF ROTORS** **9**

Classification of rotors and balancing criteria, balancing of rigid and flexible rotors- balance criteria for flexible rotors

UNIT IV **ROTOR DYNAMICS IN TURBOMACHINEY DESIGN** **9**

Motion of the shaft in the bearing- Rotor supported on rigid and flexible supports-Campbell diagram, Rotor Dynamic Analyses- Undamped critical speed - Unbalance response- Damped eigenvalue analysis- Bearing stiffness and damping coefficients- Mechanics of Hydro dynamic Instability- Half frequency whirl and Resonance whip- bearing instability and Oil Whirl Technologies to Improve the Stability of Rotor-bearing Systems--Design configurations of stable journal bearings.

UNIT V **DYNAMICS OF ROTORS MOUNTED ON HYDRODYNAMIC BEARINGS** **9**

Hydrodynamic Lubrication equation for dynamic loadings-Squeeze film effects in journal bearings and thrust bearings -Rotating loads , alternating and impulse loads in journal bearings – Journal center Trajectory- Analysis of short bearings under dynamic conditions- Finite difference solution for dynamic conditions.

TOTAL = 45PERIODS

OUTCOMES:

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

- understand application of various types of bearings and their operating principles
- design and suggest bearings for specific applications
- perform fatigue life calculations for various types of bearings,
- understand and analyze bearing behavior
- study the dynamics of rotors mounted on Hydrodynamic Bearings

CO	PO					
	1	2	3	4	5	6
1	3	3	2	-	-	1
2	3	2	2	-	2	-
3	3	2	2	-	2	-
4	3	3	2	-	2	-
5	3	3	3	3	2	-
Avg	3	2.6	2.2	3	2	1

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

REFERENCES:

1. Ehrich(ed.), F.F., 1992, Handbook of Rotor dynamics, McGraw-Hill.
2. Genta, G., 1999, Vibration of Structures and Machines, 3rd edition, Springer
3. Genta, G., 2005, Dynamics of Rotating Systems, Springer, NY
4. Goodwin M.J., 1989, Dynamics of Rotor-Bearing Systems, Unwin Hyman, Sydney.
5. Krämer E., 1993, Dynamics of Rotors and Foundations, Springer-Verlag, New York.

CD4071 BIO MATERIALS L T P C

3 0 0 3

OBJECTIVE:

1. To study different concepts in selecting bio and smart materials
2. To import knowledge on different electro-rheological and piezoelectric materials
3. To import knowledge on different shape memory materials and their applications of materials in biomedical engineering and special materials for actuators, sensors, etc.
4. To import knowledge on Materials for oral and maxillofacial surgery
5. 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.

UNITIII 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..

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

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.

AUDIT COURSES

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

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, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi, 2001.

AX4093 CONSTITUTION OF INDIA L T P C
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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**
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UNIT I **சங்க இலக்கியம்** **6**

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

UNIT II **அறநெறித் தமிழ்** **6**

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

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

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

UNIT IV **அருள்நெறித் தமிழ்** **6**

1. சிறுபாணாற்றுப்படை
- பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்
2. நற்றிணை
- அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618)
- இயமம் நியமம் விதிகள்
4. தர்மச் 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. தர்மபுர ஆதீன வெளியீடு
4. வாழ்வியல் களஞ்சியம்
   - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக் களஞ்சியம்
   - தமிழ் வளர்ச்சித்துறை (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம்
   - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்