Er. PERUMAL MANIMEKALAI COLLEGE OF ENGINEERING

(An Autonomous Institution-Affiliated to Anna University, Chennai)

Koneripalli, Hosur - 635117.

PMC TECH

INSPIRE TO INNOVATE

ACADEMIC REGULATIONS 2023 (R23)

Curriculum

(Version 1)

M.E. Engineering Design

Applicable from 2023 -24 onwards

REGULATIONS 2023 - AUTONOMOUS

CHOICE BASED CREDIT SYSTEM

M. E. ENGINEERING DESIGN

CURRICULUM AND SYLLABI FOR I TO IV SEMESTERS

PROGRAMME EDUCATIONAL OBJECTIVES(PEOs):

I.	Have the ability to apply knowledge across the disciplines and in emerging areas of Mechanical Engineering for higher studies, research, and employability.
II.	Have good communication skills, soft skills, managerial skills, leadership qualities, ethical values, sense of responsibility to serve the society and protect the environment.
III.	Become entrepreneur / innovators to design and develop manufacturing systems and services to address social, technical and business challenges with lifelong learning for a successful professional carrier.

PROGRAMME OUTCOMES (POs):

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 should be able to understand the importance of creativity process in design and will demonstrate an ability to identify, formulate, design a system and solve engineering problems
5.	Students should be able to use the techniques, and modern engineering tools necessary for engineering problems.
6.	Responsibility of understanding ethically and professionally and develop confidence for self-education and ability for life-long learning

PROGRAM SPECIFIC OUTCOMES (PSO'S)

PSO1: Apply principles of machine design, manufacturing, thermal engineering and management to identify, formulate and solve real life problems in various fields of engineering problems/processes for individual and societal needs.

PSO2: Use modern modelling, simulation techniques and computational tools relevant to mechanical origin.

PEO/ POs & PSOs MAPPING:

PEOs/ POs & PSOs	PO1	PO2	PO3	PO4	PO5	PO6
PEO 1	3	3	2	1	1	1
PEO 2	3	3	1	1	1	2
PEO 3	3	2	3	2	2	3

SEMESTER 1

S.No	Course Code	Course Name	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1	PPED1PC01	Advanced Mechanics of Materials	PC	3	-	-	3	3
2	PPED1PC02	Vibration Analysis and Control	PC	3	-	-	3	3
3	PPED1PC03	Mechanical Behaviour of Materials	PC	3	-	-	3	3
4	PPED1PC04	Computer Applications in Design	PC	3	-	-	3	3
5	PPED1PC05	Design of Hydraulic and Pneumatic Systems	PC	3	-	-	3	3
6	PPED1RM01	Research Methodology and IPR	RM	3	-	-	3	3
7	PPED1ACXX	Audit Course – I *	AC	-	-	-	2	0
PRACTICALS								
8	PPED1PL01	CAD and Design for Manufacture, Assembly and Environment Laboratory	PL	-	-	4	4	2
9	PPED1PL02	Vibration Laboratory	PL	-	-	4	4	2
Total				18	0	08	28	22

***Registration for this course is optional to students**

ED D3

SEMESTER 2

S.No	Course Code	Course Name	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1	PPED2PC06	Finite Element Methods in Mechanical Design	PC	3	-	-	3	3
2	PPED2PC07	Integrated Mechanical Design	PC	3	-	-	3	3
3	PPED2PC08	Design for manufacturing, Assembly and Environment	PC	3	-	-	3	3
4	PPED2PEXX	Professional Elective-1	PE	3	-	-	3	3
5	PPED2PEXX	Professional Elective-2	PE	3	-	-	3	3
6	PPED2PEXX	Professional Elective-3	PE	3	-		3	3
PRACTICALS								
7	PPED2PL03	Simulation and Analysis Laboratory	PL	-	-	4	4	2
8	PPED2PL04	Product Design Laboratory	PL	-	-	4	4	2
Total				18	-	8	24	22

SEMESTER 3

S.No	Course Code	Course Name	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1	PPED3PC09	Material Handling Systems and Design	PC	3	-	-	3	3
2	PPED3PEXX	Professional Elective-4	PE	3	-	-	3	3
3	PPED3OEXX	Open Elective	OE	3	-	-	3	3
PRACTICALS								
4	PPED3PR01	Project Work I	PR	-	-	12	12	6
5	PPED3TS01	Technical Seminar	SD	-	-	2	2	1
Total				9	-	14	23	16

SEMESTER 4

S.No	Course Code	Course Name	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	PPED4PR02	Project Work II	PR	-	-	24	24	12
Total				-	-	24	24	12

SUMMARY

M.E. ENGINEERING DESIGN						
S.NO	Subject Area	I	II	III	IV	Total Credits
		Credits Per Semester				
1	PC	15	9	3		27
2	PL	4	4			8
3	PE		9	3		12
4	OE			3		3
5	PR			6	12	18
6	TE			1		1
7	RM	3				3
Total		22	22	16	12	72

TOTAL NUMBER OF CREDITS TO BE EARNED FOR AWARD OF THE DEGREE = 72

PROFESSIONAL CORE COURSES (PC)

S.No	Course Code	Course Name	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	PPED1PC01	Advanced Mechanics of Materials	PC	3	-	-	3	3
2	PPED1PC02	Vibration Analysis and Control	PC	3	-	-	3	3
3	PPED1PC03	Mechanical Behaviour of Materials	PC	3	-	-	3	3
4	PPED1PC04	Computer Applications in Design	PC	3	-	-	3	3
5	PPED1PC05	Design of Hydraulic and Pneumatic Systems	PC	3	-	-	3	3
6	PPED1RM01	Research Methodology and IPR	PC	2	-	-	2	2
7	PPED2PC06	Finite Element Methods in Mechanical Design	PC	3	-	-	3	3
8	PPED2PC07	Integrated Mechanical Design	PC	3	-	-	3	3
9	PPED2PC08	Design for manufacturing, Assembly and Environment	PC	3	-	-	3	3
10	PPED3PC09	Material Handling Systems and Design	PC	3	-	-	3	3

PROFESSIONAL ELECTIVE COURSES

SEMESTER 2 ELECTIVE 1

S.No	Course Code	Course Name	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	PPED2PE01	Surface Engineering	PE	3	-	-	3	3
2	PPED3PE02	Advanced machine tool design	PE	3	-	-	3	3
3	PPED2PE03	Product life cycle management	PE	3	-	-	3	3
4	PPED2PE04	Optimization in design technique	PE	3	-	-	3	3

ED 07

SEMESTER 2 ELECTIVE 2

S.No	Course Code	Course Name	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	PPED2PE05	Design for Sustainability	PE	3	-	-	3	3
2	PPED2PE06	Quality Concept in Design	PE	3	-	-	3	3
3	PPED2PE07	Applied Probability and Statistics for Design Engineers	PE	3	-	-	3	3
4	PPED2PE08	Industrial Internet of Things	PE	3	-	-	3	3

SEMESTER 2 ELECTIVE 3

S.No	Course Code	Course Name	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	PPED2PE09	Composite Materials and Mechanics	PE	3	-	-	3	3
2	PPED2PE10	Additive Manufacturing	PE	3	-	-	3	3
3	PPED2PE11	Computational Fluid Dynamics	PE	3	-	-	3	3
4	PPED2PE12	Material Characterisation Techniques	PE	3	-	-	3	3

SEMESTER 3 ELECTIVE 4

S.No	Course Code	Course Name	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	PPED3PE13	Bearing Design and Rotor Dynamics	PE	3	-	-	3	3
2	PPED3PE14	Advanced Finite Element Analysis	PE	3	-	-	3	3
3	PPED3PE15	Engineering fracture mechanics	PE	3	-	-	3	3
4	PPED3PE16	Industry 4.0	PE	3	-	-	3	3

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

S.No	Course Code	Course Name	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	PPED1AC01	English for Research Paper Writing	AC	2	-	-	2	0
2	PPED1AC02	நற்றமிழ் இலக்கியம்	AC	2	-	-	2	0
3	PPED2AC03	Disaster Management	AC	2	-	-	2	0
4	PPED2AC04	Constitution of India	AC	2	-	-	2	0

PPED1PC01	ADVANCED MECHANICS OF MATERIALS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

UNIT – I	ELASTICITY	9

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

UNIT – II	SHEAR CENTRE AND UNSYMMETRICAL BENDING	9

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

UNIT – III	STRESSES IN FLAT PLATES AND CURVED MEMBERS	9

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

UNIT – IV	TORSION OF NON-CIRCULAR SECTIONS	9

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

UNIT – V	STRESSES IN ROTATING MEMBERS AND CONTACT STRESSES	9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES		Cognitive Level
CO1	Apply the concepts of theory of elasticity in three-dimensional stress system.	Apply
CO2	Determine the shear Centre of various cross sections and deflections in beams subjected to unsymmetrical bending.	Evaluate
CO3	Evaluate the stresses in flat plates and curved members	Evaluate
CO4	Calculate torsional stress of non-circular sections.	Analyze

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

REFERENCE BOOKS:

1	Arthur P Boresi, Richard J. Schmidt, "Advanced Mechanics of Materials", Wiley India Pvt. Ltd., 2009.
2	Hibbeler. R.C., "Mechanics of Materials", Prentice-Hall, 2018.
3	Robert D. Cook, Warren C. Young, "Advanced Mechanics of Materials", Prentice Hall, 4th Edition 2001.
4	Srinath. L.S., "Advanced Mechanics of Solids", Tata McGraw Hill, 2009.
5	Timoshenko and Goodier, "Theory of Elasticity", Tata McGraw Hill, 2010.

WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:

1	https://archive.nptel.ac.in/courses/113/105/113105104/ - Metallurgy and Material Science.
2	https://nptel.ac.in/courses/113105104 - Bulk Material Transport and Handling Systems
3	http://www.nitttrc.edu.in/nptel/courses/video/113105104/lec45.pdf - Bulk Material Transport and Handling Systems
4	https://www.youtube.com/watch?v=Up1oSSJn6oM - Material handling systems

CO-PO MAPPING

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

ED 11

PPED1PC02	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 analysing the vibration levels in a body

UNIT – I	FUNDAMENTALS OF VIBRATION	9

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

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

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

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

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: 45 PERIODS

COURSE OUTCOMES		Cognitive Level
CO1	Apply the basic concepts of vibration in damped and undamped systems.	Apply
CO2	Determine the natural frequencies and mode shapes of the two-degree freedom systems.	Evaluate

CO3	Calculate the natural frequencies and mode shapes of the multi degree freedom and continuous systems.	Evaluate
CO4	Control the vibration and noise levels in a body.	Analyze
CO5	Measure and analyze the vibration levels in a body.	Analyze

REFERENCE BOOKS:

1	Graham Kelly, Sand Shashidhar K. Kudari, "Mechanical Vibrations", Tata McGraw – Hill Publishing Com. Ltd.,
2	Singiresu S. Rao, "Mechanical Vibrations," Pearson Education Incorporated, 2017
3	Ramamurti. V, "Mechanical Vibration Practice with Basic Theory", Narosa Publishing House, 2010.
4	William T. Thomson, "Theory of Vibration with Applications", Taylor & Francis,2018

WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:

1	https://www.digimat.in/nptel/courses/video/112107212/L01.html - Introduction to Mechanical Vibration
2	https://nptel.ac.in/courses/112104040 - Introduction to Vibration Control
3	https://onlinecourses.nptel.ac.in/noc20_me48/preview - Principles of Vibration Control
4	https://engineering.lbl.gov/vibration-analysis-control/ - Vibration Analysis & Control

CO-PO MAPPING

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

PPED1PC03	MECHANICAL BEHAVIOR OF MATERIALS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	Analysing the different strengthening and failure mechanism of the metals.
2	Applying the effects of metallurgical parameters in the materials design.
3	Analysing the relationship between the selections of materials and processing.
4	Developing the novel material through understanding the properties of the existing metallic materials.
5	Analysing the different materials used in the engineering applications.

UNIT – I	BASIC CONCEPTS OF MATERIAL BEHAVIOR	9

Engineering Design process and the role of materials; materials classification and their properties, strengthening mechanisms-grain size reduction, solid solution strengthening, strain hardening, grain boundary strengthening, precipitation, particle, fibre and dispersion strengthening, Effect of temperature, strain and strain rate on plastic behavior–Super plasticity–Failure of metals.

UNIT – II	BEHAVIOUR UNDER CYCLIC LOADS AND DESIGN APPROACHES	9

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

UNIT – III	SELECTION OF MATERIALS	9

Selection of materials based on function, Objective, Constraints, free variables and service requirements – Relationship between materials selection and processing – Case studies in advanced materials selection with relevance to aero, auto, marine, machinery and nuclear applications.

UNIT – IV	MODERN METALLIC MATERIALS	9

Steels-Advanced high strength steel, Dual phase (DP) steel, Transformation induced plasticity (TRIP) Steel, Maraging steel, Nitrogen steel, Austenitic steel and Q&P steels – Intermetallic, Ni and Ti aluminides – Alloys – Al, Mg, Cu, Superalloys- Iron base, Cobalt base, Nickel base. Metal matrix composites (MMC).

UNIT – V	NONMETALLIC MATERIALS	9

. Polymeric materials–Formation of polymer structure, properties and applications of engineering polymers, Environmental aspects of polymers – Ceramic- Advanced ceramics, WC, TIC, TaC, Al2O3, SiC, Si3N4CBN and diamond– Fracture of ceramics-Stress strain behavior- Deformation behavior. Glasses-Clay products – refractory ceramics, Composite Materials-GFRP and CFRP laminated composite.

TOTAL: 45 PERIODS

COURSE OUTCOMES		Cognitive Level
CO1	Analyze the different strengthening and failure mechanism of the metals	Analyze
CO2	Apply the effects of metallurgical parameters in the materials design	Apply

CO3	Analyze the relationship between the selection of materials and processing	Analyze
CO4	Develop the novel material through understanding the properties of the existing metallic materials	Create
CO5	Analyze the different materials used in the engineering applications	Analyze

REFERENCE BOOKS:

1	George E. Dieter, Mechanical Metallurgy, McGraw Hill, 2014.
2	Thomas H. Courtney, Mechanical Behavior of Materials, (2nd edition), Waveland Press.
3	Willam D. Callister Jr. and David G. Rethwisch, Callister's Materials Science and Engineering, (9th edition) Wiley Editorial,2014
4	Charles, J.A., Crane, F.A.A. and Fumes, J.A.G., Selection and use of engineering materials, Butterworth-Heiremann, 2014.
5	Flinn, R.A., and Trojan, P.K., Engineering Materials and their Applications, (4th Edition) Jaico.
6	Metals Handbook, Vol.10, Failure Analysis and Prevention, (10thEdition), Jaico.
7	Ashby M.F., Materials Selection in Mechanical Design, 2nd Edition, Butterworth, 2011.

WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:

1	https://onlinecourses.nptel.ac.in/noc21_mm27/preview - Mechanical Behaviour of Materials
2	https://archive.nptel.ac.in/courses/113/106/113106101/ - Mechanical Behaviour of Materials
3	https://onlinecourses.nptel.ac.in/noc22_mm04/preview - Mechanical Behaviour of Materials (Part – I)
4	https://onlinecourses.nptel.ac.in/noc22_mm25/preview - Mechanical Behaviour of Materials (Part – II)
5	https://www.youtube.com/watch?v=s4TRNH4I9J0 - Mechanical Behaviour of Materials _ Course Introductory video

CO-PO MAPPING

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

ED 15

PPED1PC04	COMPUTER APPLICATIONS IN DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

UNIT – I	INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTAL	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: Hermite bi cubic 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 modelling.

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 CYCLEMANAGEMENT	9

Assembly modelling–Design for manufacture–Design for assembly–computer aided DFMA-inferences of positions and orientation - tolerances analysis –Centre 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		Cognitive Level
CO1	Solve 2D and 3D transformations for the basic entities like line and circle	Apply
CO2	Formulate the basic mathematics fundamental to CAD system.	Analyze

CO3	Use the different geometric modelling techniques like feature-based modelling, surface modelling and solid modelling.	Apply
CO4	Create geometric models through animation and transform into real world systems	Create
CO5	Simulate assembly of parts using Computer-Aided Design software.	Apply

REFERENCE BOOKS:

1	Boothroyd, G, "Assembly Automation and Product Design" Marcel Dekker, New York.
2	Chitale A. K and Gupta R.C "Product design and manufacturing "PHI learning private limited, 6thEdition 2015
3	David Rogers, James Alan Adams "Mathematical Elements for Computer Graphics" 2nd Edition, Tata McGraw-Hill Edition.
4	Ibrahim Zeid, "Mastering CAD/CAM", McGraw Hill, 2nd Edition, 2006.
5	William. M Newman and Robert F. Sproull "Principles of Interactive Computer Graphics", McGraw Hill Book Co. 1s t Edition.

WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:

1	https://archive.nptel.ac.in/courses/112/102/112102101/ - Computer Aided Design and Manufacturing
2	https://nptel.ac.in/courses/112104031 - Computer Aided Engineering Design
3	https://www.youtube.com/watch?v=I3vpd7n6t6k - Computer Aided Design Process
4	https://scholar.lib.vt.edu/ejournals/JCAEDE/v1n1/jones.html - Computer Applications in Design

CO-PO MAPPING

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

PPED1PC05	DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

UNIT – I	OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS	9

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

UNIT – II	CONTROL AND REGULATION ELEMENTS	9

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

UNIT – III	HYDRAULIC CIRCUITS	9

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

UNIT – IV	PNEUMATIC SYSTEMS AND CIRCUITS	9

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

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

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

TOTAL: 45 PERIODS

COURSE OUTCOMES		Cognitive Level
CO1	Design and select appropriate pumps in industries based on need.	Analyze
CO2	Select correct sizing and rating of control elements in hydraulics	Analyze
CO3	Design basic circuits (hydraulic)for industrial applications	Create

CO4	Design basic pneumatic circuits for industrial applications	Create
CO5	Identify and provide solution for trouble shooting and design low-cost automation for industrial application.	Analyze

REFERENCE BOOKS:

1	Jagadeesha T, "Pneumatics Concepts, Design and Applications ", Universities Press,2015
2	Anthony Esposito, "Fluid Power with Applications", Prentice Hall, 2009.
3	James A. Sullivan, "Fluid Power Theory and Applications", Fourth Edition, Prentice Hall, 2003
4	Majumdar, S.R., "Oil Hydraulics Systems–Principles and Maintenance", Tata McGraw Hill.
5	Shanmuga Sundaram. K, "Hydraulic and Pneumatic Controls". Chand & Co, 2006

WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:

1	https://archive.nptel.ac.in/courses/112/106/112106300/ - Hydraulics and Pneumatics
2	https://onlinecourses.nptel.ac.in/noc23_me28/preview - Oil Hydraulics and Pneumatics
3	https://www.youtube.com/watch?v=UGozt4Lum4Q - Hydraulic Circuits and Valves
4	https://jojibooks.com/2020/08/07/electro-pneumatics-and-automation/ - Pneumatic & Hydraulic Books

CO-PO MAPPING

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

PPED1RM01	RESEARCH METHODOLOGY AND IPR	L	T	P	C
		0	0	0	3

COURSE OBJECTIVES:

1	To familiarize students with the different aspects of research.
2	To provide an idea of good scientific writing and proper presentation skills.
3	To provide an understanding of philosophical questions behind scientific research.
4	To provide a brief background on the historical legacy of science.
5	To provide an insight of nature of Intellectual Property and new developments in IPR.

UNIT – I	RESEARCH DESIGN	9

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	9

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

UNIT – III	DATA ANALYSIS AND REPORTING	9

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	9

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	9

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: 45 PERIODS

COURSE OUTCOMES		Cognitive Level
CO1	Understand research problem formulation	Understand
CO2	Analyse Research related information and follow research ethics.	Analye
CO3	Understand that today's world is controlled by computer, information technology but Tomorrow's world will be ruled by ideas, concepts and creativity.	Understand
CO4	Understand that IPR would take such important place in growth of individuals and nation, it is needless to emphasize the need of information about Intellectual Property Right to be promoted among students in general and Engineering.	Understand

ED 20

CO5	Understand the nature of Intellectual Property and IPR in International Scenario	Understand

REFERENCE BOOKS:

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.

WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:

1	https://onlinecourses.nptel.ac.in/noc23_ge36/preview - Research Methodology
2	https://onlinecourses.nptel.ac.in/noc22_ge08/preview - Research Methodology
3	https://archive.nptel.ac.in/courses/127/106/127106227/ - Research Methodology
4	https://onlinecourses.swayam2.ac.in/cec20_hs17/preview - Research Methodology
5	http://www.ce.griet.ac.in/images/2021-22/Coursefile/RMIPR.pdf - Research Methodology and IPR

CO-PO MAPPING

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

PPED1PL01	CAD AND DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENT	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

1	To give exposure to CAD software tools needed to Solve engineering problems.
2	Students would have developed a thorough understanding of the Computer Aided Modelling with an ability to effectively use the tools to Part Modelling and Assembling.

LIST OF EXPERIMENTS

CAD Introduction.

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

Exercises in modeling and drafting of mechanical components - assembly using parametric and feature based packages. 2D TO 3D CONVERSION.

DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENT LABORATORY

Introduction to Design for Assembly and Manufacturability (DFA/DFM)- The New Product Design (NPD) Process-Design for Assembly –Assembly Method Selection-Design for Assembly – Boothroyd - Dewhurst Method-Cost Estimation Using DFM The students will be given training on the use and application of the following

1. DFMA software

TOTAL: 60 PERIODS

COURSE OUTCOMES		Cognitive Level
CO1	Use the modern engineering tools necessary for engineering practice	Apply
CO2	Draw 2D part drawings, sectional views and assembly drawings as per standards.	Create
CO3	Create 3D Model on any CAD software.	Create
CO4	Convert 3D solid models into 2D drawing and prepare different views, sections and dimensioning of part models.	Create
CO5	Familiarize with DFMA package which is necessary for cost estimation and evaluating the product design.	Evaluate

REFERENCE BOOKS:

1	Chitale A.K and Gupta R.C "Product design and manufacturing "PHI learning private limited, 6th Edition, 2015.
2	Ibrahim Zeid, "Mastering CAD/CAM", McGraw Hill, 2nd Edition, 2006.
3	William M Newman and Robert F.Sproull "Principles of Interactive Computer Graphics", McGraw Hill Book Co. 1st Edition, 2001.
4	Boothroyd, G, 2nd Edition 2002, Design for Assembly Automation and Product Design. New York, Marcel Dekker.

5	Finster, Mark P., 2013. Sustainable Perspectives to Design and Innovation.

CO-PO MAPPING

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

PPED1PL02	VIBRATION LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

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

LIST OF EXPERIMENTS

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

TOTAL: 60 PERIODS

COURSE OUTCOMES		Cognitive Level
CO1	Evaluate the stiffness and natural frequency of spring-mass systems	Evaluate
CO2	Determine the natural frequencies of damped and undamped torsional vibrations of single rotor systems	Evaluate
CO3	Acquire the critical speed of shaft supported at its ends.	Evaluate
CO4	Assess the natural frequency, damping coefficient, mode shapes of specimens under free vibrations.	Evaluate
CO5	Determine the natural frequency of specimens under forced vibrations.	Evaluate

REFERENCE BOOKS:

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, "Mechanical Vibration Practice with Basic Theory", Narosa Publishing House, 2010.
4	WilliamT. Thomson, "Theory of Vibration with Applications", Taylor & Francis,2018

CO-PO MAPPING						
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	2	2	3	2	1
CO2	1	2	2	3	2	1
CO3	1	2	2	3	2	1
CO4	1	2	2	3	2	1
CO5	1	2	2	3	2	1

PPED1AC01	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

1	Teach how to improve writing skills and level of readability
2	Tell about what to write in each section
3	Summarize the skills needed when writing a Title
4	Infer the skills needed when writing the Conclusion
5	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		Cognitive Level
CO1	Understand that how to improve your writing skills and level of readability	Understand
CO2	Learn about what to write in each section.	Understand
CO3	Understand the skills needed when writing a Title.	Understand
CO4	Understand the skills needed when writing the Conclusion	Understand
CO5	Ensure the good quality of paper at very first-time submission.	Understand

ED 26

REFERENCE BOOKS:	
1	1.Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2	2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2015
3	3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2012
4	4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 2015.
WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:	
1	https://tiramisutes.github.io/images/PDF/English+for+Writing+Research+Papers.pdf - English for writing research paper.
2	2. https://cfr.annauniv.edu/research/academics/download/Induction-Programme/Dr.K.N.Shoba-10.pdf - English for research paper writing
3	3. https://www.ref-n-write.com/blog/results-and-discussion-academic-phrases/ - Academic Phrases for Writing Results & Discussion Sections of a Research Paper
4	4. https://www.slideshare.net/sina1864/english-for-writing-research-papers-by-adrian-wallwork - English for Writing Research Papers
5	5. https://www.linkedin.com/pulse/10-skills-required-write-research-paper-dr-siddharth-srivastava - Skills Required to write a Research Paper

CO-PO MAPPING

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

PPED1AC02	நற்றமிழ் இலக்கியம்	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

UNIT – I	சங்க இலக்கியம்	6

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

UNIT – II	அறநெறித்தமிழ்	6

1. அறநெறி வகுத்த திருவள்ளுவர்
   - அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புரவறிதல் அறிதல், ஈகை, புகழ்
2. பிற அறநூல்கள் -இலக்கிய மருந்து

ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையை வலியுறுத்தும் நூல்)

UNIT – III	இரட்டைக் காப்பியங்கள்	6

1. கண்ணகியின் புரட்சி - சிலப்பதிகார வழக்குரை காதை

சமூகசேவை இலக்கியம் மணிமேகலை - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை

UNIT – IV	அருள்நெறித் தமிழ்	6

1. சிறுபாணாற்றுப்படை - பாரி முல்லைக்குத் தேர் குடுத்தது, பேகன் மயிலுக்கு போர்வை கொடுத்தது, அதியமான் அவ்வைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்
2. நற்றிணை - அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618) -- இயமம் நியமம் விதிகள்
4. தர்மசாலையை 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. உரை நடைத்தமிழ்
   - 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 நிலையனரின் மேம்பாட்டில் தமிழ் இலக்கியமும்
5. அறிவியல் தமிழ்
6. இணையத்தில் தமிழ்

சுற்றுசூழல் மேம்பாட்டில் தமிழ் இலக்கியமும்

TOTAL: 30 PERIODS

தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்

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

PPED2AC03	DISASTER MANAGEMENT	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

1	Summarize basics of disaster
2	Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
3	Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
4	Describe an understanding of standard so humanitarian response and practical relevance in specific types of disasters and conflict situations.
5	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		Cognitive Level
CO1	Ability to summarize basics of disaster	Understand
CO2	Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.	Understand
CO3	Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.	Analyze

ED 30

CO4	Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.	Analyze
CO5	Ability to develop the strengths and weaknesses of disaster management approaches.	Analyze

REFERENCE BOOKS:

1	Goel S.L., Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd. ,New Delhi,2012.
2	Nishitha Rai, SinghAK, "Disaster Management in India: Perspectives, issues and strategies "New Royal book Company,2015.
3	Sahni, Pardeep Et.Al.,"Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi, 2010.
4	Dr. Mirinalini Pandey, "Disaster Management", Kindle edition, 2014.
5	S.C. Sharma, "Disaster Management", Khanna Publishing House, 2015.

WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:

1	https://onlinecourses.swayam2.ac.in/cec19_hs20/preview - Disaster Management
2	https://nptel.ac.in/courses/124107010 - Disaster Recovery And Build Back Better
3	https://public.wmo.int/en/our-mandate/focus-areas/natural-hazards-and-disaster-risk-reduction - Natural hazards and disaster risk reduction.
4	https://nidm.gov.in/easindia2014/err/pdf/country_profile/India.pdf - Disaster prone areas in India
5	https://www.ifrc.org/our-work/disasters-climate-and-crises/disaster-preparedness - Disaster preparedness

CO-PO MAPPING

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

PPED2AC04	CONSTITUTION OF INDIA	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

1	Understand the premises in forming the twin theme so liberty and freedom from a civil rights perspective.
2	To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
3	Role and entitlement to civil and economic rights as well as the emergence nationhood in the early years of Indian nationalism.
4	To address the role of socialism in India after the commencement of the BolshevikRevolutionin1917and its impact on the initial drafting of the Indian Constitution.
5	Understandthepremisesinformingthetwinthemesoflibertyandfreedomfromacivilrightperspective.

UNIT – I	HISTORY OF MAKING OF THE INDIAN CONSTITUTION	5

History, Drafting Committee, (Composition & Working)

UNIT – II	PHILOSOPHY OF THE INDIAN CONSTITUTION	5

Preamble, Salient Features

UNIT – III	CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES	5

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	5

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	5

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Panchayati 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	5

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

PPED3PE02	ADVANCED MACHINE TOOL DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES On successful completion of this course, the student will be able to.		**Cognitive Level**
CO1	Select the different machine tool mechanisms.	Understand
CO2	Apply the of Design the Multi speed Gear Box and feed drives.	Apply
CO3	Apply the of Design the machine tool structures.	Apply
CO4	Apply the of Design the guideways and power screws.	Apply
CO5	Apply the of Design the spindles and bearings.	Apply

REFERENCE BOOKS:	
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, 2013
WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:	
1	https://archive.nptel.ac.in/courses/112/105/112105233/- Metal Cutting and Machine Tools
2	https://archive.nptel.ac.in/courses/112/105/112105233/- Metal Cutting and Machine Tools
3	https://www.vssut.ac.in/lecture_notes/lecture1424895069.pdf -Principle of Machine Tool
4	https://onedrive.live.com/embed?cid=9F0200C1153A2AA1&resid=9F0200C1153A2AA1%211403&authkey=AOvsTFBNZsa7dro&em=2- Advanced to Machine Toll

CO-PO MAPPING

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

PPED2PE03	PRODUCT LIFECYCLE MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE 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 tool0073

UNIT – IV	ROLE OF PLM ININDUSTRIES	9

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

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

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

TOTAL: 45 PERIODS

COURSE OUTCOMES The students will be able to		Cognitive Level
CO1	Summarize the history, concepts and terminology of PLM	Understand
CO2	Use the functions and features of PLM/PDM	Understand
CO3	Use different modules offered in commercial PLM/PDM tools.	Apply
CO4	Implement PLM/PDM approaches for industrial applications.	Apply

COURSE OUTCOMES		Cognitive Level
CO1	Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.	Understand
CO2	Discuss the intellectual origins of the framework of argument that in formed the conceptualization of social reforms leading to revolution in India.	Analyze
CO3	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.	Analyze
CO4	Discuss the passage of the Hindu Code Bill of 1956.	Understand
CO5	Discuss the Election Commission of India.	Understand

REFERENCE BOOKS:

1	The Constitution of India,1950 (Bare Act),Government Publication, 2015
2	Dr. S.N. Busi, Dr. B.R. Ambedkar framing of Indian Constitution, 1stEdition, 2015.
3	M.P. Jain, Indian Constitution Law, 7th Edition, LexisNexis, 2014.
4	D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.
5	Mahendra P Singh, Constitution of India, Eastern Book Company, 2015.

WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:

1	https://legislative.gov.in/constitution-of-india/ - Constitution of India
2	https://onlinecourses.nptel.ac.in/noc20_lw02/preview - Constitution of India and Environmental Governance
3	https://www.constitutionofindia.net/historical-constitutions/ - Historical Constitutions
4	https://www.centurylawfirm.in/blog/fundamental-rights-and-duties-in-indian-constitution/ - Fundamental Rights and Duties in Indian Constitution
5	https://www.egyankosh.ac.in/bitstream/123456789/20952/1/Unit-17.pdf - Organs Of Government : Executive, Legislature And Judiciary

CO-PO MAPPING

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

PPED2PC06	FINITE ELEMENT METHODS IN MECHANICAL DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

UNIT – I	FINITE ELEMENT ANALYSIS OF ONE DIMENSIONALPROBLMS	9

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-DIMENSIONALPROBLEMS	9

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

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

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes and parallel to the other by rotating object method. Development of lateral surfaces of solids with cut-outs and holes. Practicing three-dimensional modelling of simple objects by CAD Software (Not for examination).

UNIT – V	NON-LINEARANALYSIS	9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES		Cognitive Level
CO1	Develop mathematical models for one dimensional problem and their numerical solutions.	Understand
CO2	Determine field variables for two-dimensional scalar and vector variable problems	Understand
CO3	Apply Isoperimetric transformation and numerical integration for evaluation of element matrices	Apply

CO4	Apply various solution techniques to solve Eigen value problems	Apply
CO5	Formulate solution techniques to solve non-linear problems	Apply

REFERENCE BOOKS:

1	Rao, S.S., "The Finite Element Method in Engineering", 6th Edition, Butterworth- Heinemann,2018
2	Reddy, J.N. "Introduction to the Finite Element Method", 4 thEdition, Tata McGrawHill,2018
3	Tirupathi R.Chandrupatla and Ashok D.Belegundu, "Introduction to Finite Elements in Engineering", International Edition, Pearson Education Limited, 2014.
4	David Hutton, "Fundamentals of Finite Element Analysis", Tata McGrawHill, 2005
5	Bathe K.J., "Finite Element Procedures in Engineering Analysis", Prentice Hall, 1990

WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:

1	https://archive.nptel.ac.in/courses/112/104/112104193/ - Basic of Finite Element Analysis
2	https://onlinecourses.nptel.ac.in/noc22_me43/preview - Finite Element Method
3	https://www.jousefmurad.com/fem/the-finite-element-method-beginners-guide/ - The Finite Element Method (FEM) – A Beginner's Guide
4	https://www.iist.ac.in/sites/default/files/people/IN08026/FEM.pdf - Finite Element Method by Abdusamad A. Salih

CO-PO MAPPING

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

PPED2PC07	INTEGRATED MECHANICAL DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	To learn the various steps involved in the Design Process and various steps designing shafts for various applications.
2	To learn the design bevel, worm and cross helical gears of Transmission system
3	To learn the concepts of design multi and variable speed gear box for machine tool applications.
4	To learn the concepts of design to cams, brakes and clutches
5	To know the integrated design procedure of different machine elements for mechanical applications.

Use of P S G Design Data Book permitted

UNIT – I	FUNDAMENTALS AND DESIGN OF SHAFTS	9

Phases of design – Standardization and interchangeability of machine elements - Process and Function Tolerances – Individual and group tolerances – Selection of fits for different design situations – Design for assembly and modular constructions – Concepts of integration –BIS, ISO, DIN, BS, ASTM Standards. Oblique stresses – Transformation Matrix – Principal stresses – Maximum shear stress – Theories of Failure – Ductile vs. brittle component design - Analysis and Design of shafts for different applications – integrated design of shaft, bearing and casing – Design for rigidity

UNIT – II	BEVEL, WORM AND CROSS HELICAL GEARS	9

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair. Cross helical: Terminology-helix angles-Estimating the size of the pair of cross helical gears

UNIT – III	DESIGN OF GEAR BOX	9

Principles of gear tooth action – Gear correction – Gear tooth failure modes – Stresses and loads –Design for sub assembly – Integrated design of speed reducers and multi-speed gear boxes – application of software packages.

UNIT – IV	BRAKES & CLUTCHES	9

Dynamics and thermal aspects of brakes and clutches – Integrated design of brakes and clutches for machine tools, automobiles and mechanical handling equipment's.

UNIT – V	INTEGRATED DESIGN	9

Integrated Design of systems consisting of shaft, bearings, springs, motor, gears, belt, rope, chain, pulleys, Cam & Follower, flywheel

TOTAL: 45 PERIODS

COURSE OUTCOMES		Cognitive Level
CO1	Apply and Design of shaft subject to combined static and variable loads	Apply
CO2	Design of Gear in various applications.	Apply
CO3	Design of gear boxes for various applications.	Apply

CO4	Analyse about brakes and clutches under dynamic loads.	Analyze
CO5	Examine the integrated design while assembling various components.	Evaluate

REFERENCE BOOKS:

1	Norton L. R., "Machine Design – An Integrated Approach" Pearson Education, 2005
2	Maitra G.M., "Hand Book of Gear Design", Tata McGraw Hill..
3	Maitra G.M., "Hand Book of Gear Design", Tata McGraw Hill.
4	Newcomb, T.P. and Spur, R.T., "Automobile Brakes and Braking Systems", Chapman and Hall, 2nd Edition
5	Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958.

APPROVED DATA BOOKS

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

WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:

1	https://archive.nptel.ac.in/courses/112/105/112105124/ - Design of Machine Element 1
2	https://archive.nptel.ac.in/courses/112/106/112106137/ - Machine Design
3	http://www.nptelvideos.com/course.php?id=791- Design of Machine Elements I Video Lectures
4	https://fractory.com/types-of-machine-elements/ - Types of Machine Elements

CO-PO MAPPING

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

PPED2PC08	DESIGN FOR MANUFACTURING, ASSEMBLY AND ENVIRONMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	To know the concept of design for manufacturing, assembly and environment
2	To know the factor influencing in design for manufacturing and assembly
3	To know the design considerations while designing the formed and machined components.
4	To know the design considerations while designing the formed and casting components.
5	To know design considerations for environmental issues

UNIT – I	INTRODUCTION	9

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances Geometric tolerances - Assembly limits -Datum features - Tolerance stacks.

UNIT – II	FACTORS INFLUENCING FORM DESIGN	9

Working principle, Material, Manufacture, Design- Possible solutions - Materials choice – Influence of materials on form design - form design of welded members, forgings and castings

UNIT – III	COMPONENT DESIGN - MACHINING CONSIDERATION	9

Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation Design for machinability - Design for economy - Design for clamp ability– Design for accessibility - Design for assembly.

UNIT – IV	COMPONENT DESIGN – CASTING CONSIDERATION	9

Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design- Modifying the design - group technology - Computer Applications for DFMA

UNIT – V	DESIGN FOR THE ENVIRONMENT	9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES		Cognitive Level
CO1	Select relevant process; apply the general design principles for manufacturability	Remember
CO2	Factor influencing in design for manufacturing	Understand
CO3	Apply the design considerations machined components.	Apply
CO4	Apply the design considerations casting components.	Apply
CO5	Understand design considerations for environmental issues.	Understand

REFERENCE BOOKS:	
1	Kevien Otto and Kristin Wood, Product Design. Pearson Publication, 2004.
2	Boothroyd, G, 1980 Design for Assembly Automation and Product Design. New York, Marcel Dekker
3	Bralla, Design for Manufacture handbook, McGraw hill.
4	Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. Reason Pub.,
5	Dickson, John. R, and Corroda Poly, Engineering Design and Design for Manufacture and Structural Approach, Field Stone Publisher, USA, 1995.

WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:	
1	https://archive.nptel.ac.in/courses/107/103/107103012/ - Design For Manufacture and Assembly
2	https://onlinecourses.nptel.ac.in/noc20_me12/preview - Product Design and Manufacturing
3	https://onlinecourses.nptel.ac.in/noc19_me48/preview - Design for Quality, Manufacturing and Assembly
4	https://nptel.ac.in/courses/107103012 - Design for Manufacture and Assembly (DFMA)

CO-PO MAPPING

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

PPED2PL03	SIMULATION AND ANALYSIS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

1	To give exposure to software tools needed to analyse engineering problems.
2	Students would have developed a thorough understanding of the Computer Aided Finite Element Analysis packages with an ability to effectively use the tools of the analysis for solving practical problems arising in engineering design

LIST OF EXPERIMENTS

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

TOTAL: 60 PERIODS

COURSE OUTCOMES On successful completion of this course, the student will be able to.		**Cognitive Level**
CO1	Solve engineering problems numerically using Computer Aided Finite Element Analysis packages	Understand
CO2	Analyze the force, stress, deflection in mechanical components	Analyze
CO3	Analyze thermal stress and heat transfer in mechanical components	Analyze
CO4	Analyze the vibration of mechanical components.	Analyze
CO5	Analyze the modal, harmonic, transient and spectrum concepts in mechanical components	Analyze

REFERENCE BOOKS:

1	https://www.scribd.com/document/550897094/ME8711-Simulation-and-Analysis-Laboratory - ME8711-Simulation and Analysis Laboratory
2	https://www.iare.ac.in/?q=node/3155 - Simulation and Analysis Laboratory
3	https://vdocument.in/computer-aided-simulation-and-analysis-lab-manual7.html - COMPUTER AIDED SIMULATION AND ANALYSIS LAB MANUAL_7
4	https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/files/simulationlab-EE0405.pdf - SIMULATION LAB

CO-PO MAPPING						
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	3	3	2	3	3
CO2	2	3	3	2	3	3
CO3	2	3	3	3	3	3
CO4	2	3	3	1	2	3
CO5	2	3	3	3	3	3

PPED2PL04	PRODUCT DESIGN LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

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

LISTOFEXPERIMENTS

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:

1. Automotive components
2. Tool and die components
3. Press tool components
4. Consumer product
5. 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: 45 PERIODS

COURSE OUTCOMES On successful completion of this course, the student will be able to.		**Cognitive Level**
CO1	Appreciate the use of physical prototype models for evaluating product concept	Understand
CO2	Apply theoretical knowledge to design and development of physical product s using clay, wood, sheet metal and RP techniques	Analyze
CO3	Apply appropriate Engineering techniques, methodology and design processes of any components	Analyze

REFERENCE BOOKS:

1	https://web.bits-pilani.ac.in/hyderabad/mechanicalengineering/ProductDesignandRealizationlab - Product Design and Realization lab
2	https://cfi.iitm.ac.in/clubs/product-design-club - Product Design Club
3	https://productdesignlab.ucdavis.edu/ - Product Design Lab
4	https://link.springer.com/chapter/10.1007/978-981-13-5977-4_82 - SpringerLink

CO-PO MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	2	3	3
CO2	2	3	3	2	3	3
CO3	2	3	3	3	3	3

PPED2PE01	SURFACE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	To study the basics of surface features and different types of friction in metals and non-metals.
2	To analyze the different types of wear mechanism and international standard used infriction and wear measurement
3	To study the different types of corrosion and its preventive measures.
4	To study the different types of surface treatments and surface modification techniques.
5	To analyze the different types of materials used in the friction and wear applications

UNIT – I	FRICTION	9

Topography of Surfaces– Surface features – Properties and measurement– Surface interaction - Adhesive Theory of Sliding Friction–Rolling Friction- Friction properties of metallic and non-metallic materials–Friction in extreme conditions –Thermal considerations in sliding contact

UNIT – II	WEAR	9

Introduction – Abrasive wear, Erosive, Cavitation, Adhesion, Fatigue wear and Fretting Wear Laws of wear – Theoretical wear models – Wear of metals and non-metals – International standards in friction and wear measurement

UNIT – III	CORROSION	9

Introduction – Principle of corrosion – Classification of corrosion – Types of corrosion – Factors influencing corrosion– Testing of corrosion–In-service monitoring, Simulated service, Laboratory testing – Evaluation of corrosion – Prevention of Corrosion – Material selection, Alteration of environment, Design, Cathodic and Anodic Protection, Corrosion inhibitors

UNIT – IV	SURFACETREATMENTS	9

Introduction–Surface properties, Superficial layer–Changing surface metallurgy–Wear resistant coatings and Surface treatments – Techniques – PVD – CVD – Physical CVD – Ion implantation – Surface welding – Thermal spraying – Laser surface hardening and alloying, laser re-melting, and laser cladding. Applications of coatings and surface treatments in wear and friction control – Characteristics of Wear resistant coatings – New trends in coating technology –DLC – CNC – Thick coatings – Nano-engineered coatings – Other coatings, Corrosion resistant coating

UNIT – V	ENGINEERINGMATERIALS	9

Introduction–Advanced alloys–Super alloys, Titanium alloys, Magnesium alloys, Aluminium alloys, and Nickel based alloys–Ceramics–Polymers–Biomaterials–Applications–Bio Tribology Nano Tribology

TOTAL: 45 PERIODS

COURSE OUTCOMES On successful completion of this course, the student will be able to.		Cognitive Level
CO1	Understand the basics of surface features, laws of friction and different types of friction	Understand
CO2	Develop the knowledge of various wear mechanism and its measurement	Apply
CO3	Understand the types of corrosion and its preventive measures	Apply

CO4	Familiarize the types of surface properties and various surface modification techniques	Apply
CO5	Ability to understand the different types of materials used in the friction and wear applications	Apply

REFERENCE BOOKS:

1	G.W. Stachowiak & A.W. Batchelor, "Engineering Tribology", Butterworth-Heinemann, UK, 2016
2	Rabinowicz. E, "Friction and Wear of materials",JohnWilley&Sons,UK,2005
3	Halling, J .(Editor)–"Principles of Tribology", Mac millian–2012
4	Williams J.A."Engineering Tribology", Oxford Univ.Press,2012
5	S.K. Basu, S.N. Sengupta & B.B. Ahuja ,"Fundamentals of Tribology", Prentice –Hall of India Pvt. Ltd, New Delhi,2005

WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:

1	https://archive.nptel.ac.in/courses/112/107/112107248/- Fundamental of surface engineering
2	https://archive.nptel.ac.in/courses/113/105/113105086/ - Surface Engineering for Corrosion and wear resistance
3	https://archive.nptel.ac.in/noc/courses/noc18/SEM2/noc18-me66/- Fundamentals of Surface Engineering: Mechanisms, Processes and Characterizations
4	https://www.cambridge.org/core/books/introduction-to-surface-engineering/introduction-to-surface-engineering/73A7724E0C324F25DC30BA7A1EB4A8C6-Introduction to Surface Engineering

CO-PO MAPPING

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

PPED2PE06	QUALITY CONCEPTS IN DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

UNIT – I	DESIGN FUNDAMENTALS, METHODS AND MATERIALSELECTION	9

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

UNIT – II	DESIGN FOR QUALITY	9

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

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

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

UNIT – IV	DESIGN OF EXPERIMENTS	9

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

UNIT – V	STATISTICAL CONSIDERATION AND RELIABILITY	9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES On Completion of the course the student will be able to	Cognitive Level

ED48

CO1	Apply fundamentals of design process and material selection for developing a quality product	Apply
CO2	Apply the quality concepts to develop a robust product	Apply
CO3	Perform Failure Mode Effect Analysis on a product and use six sigma principles to enhance its quality.	Understand
CO4	Apply different experimental design methods in product development	Apply
CO5	Implement various statistical tools to improve its quality and reliability	Apply

REFERENCE BOOKS:

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

WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:

1	https://archive.nptel.ac.in/noc/courses/noc20/SEM1/noc20-mg18/Quality design and control.
2	https://archive.nptel.ac.in/courses/110/105/110105088/Quality design and control- Prof. Pradip kumar ray
3	https://onlinecourses.nptel.ac.in/noc19_me48/preview- design for quality, manufacturing and assembly.
4	https://archive.nptel.ac.in/courses/112/104/112104228/design practice

CO-PO MAPPING

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

PPED2PE07	APPLIED PROBABILITY AND STATISTICS FOR DESIGN ENGINEERS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

UNIT – I	ONE DIMENSIONAL RANDOM VARIABLES	9

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

UNIT – II	TWO DIMENSIONAL RANDOM VARIABLES	9

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

UNIT – III	ESTIMATION THEORY	9

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

UNIT – IV	TESTING OF HYPOTHESIS	9

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

UNIT – V	MULTIVARIATE ANALYSIS	9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES On successful completion of this course, the student will be able to		**Cognitive Level**
CO1	Moments of discrete and continuous random variables.	Remember
CO2	To deal problems involving two dimensional random variables.	Understand
CO3	Unbiasedness of estimators, method of maximum likelihood estimation and Central Limit Theorem.	Apply
CO4	Use statistical tests in testing hypotheses on data.	Apply
CO5	Perform exploratory analysis of multivariate data, such as multivariate normal density, calculating descriptive statistics, testing for multivariate normality	Understand

ED50

REFERENCE BOOKS:	
1	Devore, J. L., "Probability and Statistics for Engineering and the Sciences", 8th Edition, Cengage Learning, 2014.
2	Dallas E. Johnson, "Applied Multivariate Methods for Data Analysis", Thomson and Duxbury press, 1998.
3	Richard A. Johnson and Dean W. Wichern, "Applied Multivariate Statistical Analysis", 6th Edition, Pearson Education, Asia, 2012.
4	Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers ", 9th Edition, Pearson Education, Asia, 2016
5	Gupta S.C. and Kapoor V.K.," Fundamentals of Mathematical Statistics", 12th Edition, Sultan and Sons, New Delhi, 2020
WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:	
1	https://onlinecourses.nptel.ac.in/noc21_ma74/preview - Probability and Statistics
2	https://nptel.ac.in/courses/109104182 - Applied Statistics and Econometrics
3	https://archive.nptel.ac.in/courses/111/105/111105090/ Probability and Statistics
4	https://onlinecourses-archive.nptel.ac.in/noc19_ma08/preview - Probability and Statistics

CO-PO MAPPING

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

PPED2PE08	INDUSTRIAL INTERNET OF THINGS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

UNIT – I	INTRODUCTION AND ARCHITECTURE OF IoT	9

Introduction – Definition and characteristics of IoT – Physical and Logical Design of IoT - Communication models and APIs – Challenges in IoT - Evolution of IoT- Components of IoT - A Simplified IoT Architecture – Core IoT Functional Stack.

UNIT – II	INDUSTRIAL IoT	9

IIoT-Introduction, Industrial IoT: Business Model and Reference Architecture: IIoT-Business Models, Industrial IoT- Layers: IIoT Sensing, IIoT Processing, IIoT Communication, IIoT Networking

UNIT – III	IIOT ANALYTICS	9

Big Data Analytics and Software Defined Networks, Machine Learning and Data Science, Julia Programming, Data Management with Hadoop

UNIT – IV	IOT SECURITY	9

Industrial IoT: Security and Fog Computing - Cloud Computing in IIoT, Fog Computing in IIoT, Security in IIoT

UNIT – V	CASE STUDY	9

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

TOTAL: 45 PERIODS

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

REFERENCE BOOKS:	
1	Industry 4.0: The Industrial Internet of Things", by Alasdair Gilchrist (Apress), 2017
2	Industrial Internet of Things: Cyber manufacturing Systems "by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer), 2017
3	Hands-On Industrial Internet of Things: Create a powerful Industrial IoT by Giacomo Veneri, Antonio Capasso, Packt, 2018.
WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:	
1	https://archive.nptel.ac.in/noc/courses/noc20/SEM1 - Internet things
2	https://onlinecourses.nptel.ac.in/noc21_cs17/preview - Introduction to internet of things
3	https://onlinecourses.nptel.ac.in/noc23_cs82/announcements - Introduction To Industry 4.0
4	https://archive.nptel.ac.in/courses/106/105/106105195/ - Introduction to industry 4.0 and internet of things

CO-PO MAPPING

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

ED53

PPED2PE09	COMPOSITE MATERIALS AND MECHANICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

UNIT – I	INTRODUCTION TO COMPOSITE MATERIALS	9

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

UNIT – II	MANUFACTURING OF COMPOSITES	9

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

UNIT – III	LAMINA CONSTITUTIVE EQUATIONS	9

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

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

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

UNIT – V	THERMO-STRUCURALANALYSIS	9

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

laminates **Case studies:** Implementation of CLT for evaluating residual stresses in the components made with different isotropic layers such as electronic packages etc.
TOTAL: 45 PERIODS

COURSE OUTCOMES On Completion of the course the student will be able to		**Cognitive Level**
CO1	Calculate for mechanical strength of the composite material.	Analyze
CO2	Fabricate the FRP and other composites by different manufacturing methods.	Apply
CO3	Analyze fiber reinforced Laminates for different combinations of plies with different orientations of the fiber.	Analyze
CO4	Evaluate the stresses in the lamina of the laminate using different failure theories.	Evaluate
CO5	Analyze thermo-mechanical behaviour and evaluate residual stresses in different types of laminates using the Classical Laminate Theory.	Analyze

REFERENCE BOOKS:

1	Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", Fourth Edition, Wiley,New York, 2017.
2	Gibson, R.F., Principles of Composite Material Mechanics, Fourth Edition - CRC press ,2016
3	Hyer, M.W., "Stress Analysis of Fiber – Reinforced Composite Materials", DES tech Publication Inc, 2009
4	Issac M. Daniel and Ori Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press-2006, First Indian Edition – 2007
5	Madhujit Mukhopadhyay, "Mechanics of Composite Materials and Structures", University Press (India) Pvt .Ltd., Hyderabad, 2004 (Reprinted 2008).

WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:

1	https://nptel.ac.in/courses/112104168-Introduction to composites by Prof. Nachiketa Tiwari
2	https://www.openlearning.com/courses/mechanics-of-composite-materials/
3	https://www.mooc-list.com/tags/composites
4	https://www.classcentral.com/course/technology-of-modern-composite-materials-with-car-25332

CO-PO MAPPING

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

ED55

PPED2PE10	ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	To equip students with basic knowledge and process parameters of Additive Manufacturing.
2	To understand the applications of AM processes in various fields.
3	To Select the suitable material and process for fabricating a given product.
4	To apply the knowledge in Material science in Additive Manufacturing Components.
5	To design the products for AM processes

UNIT – I	INTRODUCTION TO ADDITIVE MANUFACTURING	9

Need - Development of AM systems – AM process chain - Impact of AM on Product Development- Virtual Prototyping- Rapid Tooling – RP to AM - Classification of AM processes-Benefits, Applications.

UNIT – II	REVERSE ENGINEERING AND CAD MODELING	9

Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modeling techniques: Wire frame, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation- Software for AM- Case studies.

UNIT – III	LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS	9

Stereolithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications. Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and applications. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

UNIT – IV	POWDER BASED ADDITIVE MANUFACTURING SYSTEMS	9

Selective Laser Sintering (SLS): Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations, and applications– Case Studies.

UNIT – V	POST PROCESSING OF AM PARTS	9

.Support Material Removal, Surface Texture Improvement, Accuracy Improvement, Aesthetic Improvement, Preparation for use as a Pattern, Property Enhancements using Non-thermal and Thermal Techniques. Guidelines for Process Selection: Introduction, Selection Methods for a Part, Challenges of Selection, Example System for Preliminary Selection, Process Planning and Control.

TOTAL: 45 PERIODS

COURSE OUTCOMES On Completion of the course the student will be able to		Cognitive Level
CO1	Understand history, concepts and terminology of additive manufacturing.	Understand

CO2	Apply the reverse engineering concepts for design development.	Apply
CO3	Understand the variety of additive manufacturing technique using liquid and solid medium.	Understand
CO4	Understand the variety of additive manufacturing technique using powder medium.	Understand
CO5	Design and develop a product for AM Process	Create

REFERENCE BOOKS:

1	Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", second edition, World Scientific Publishers, 2010.
2	Gebhardt, A., "Rapid prototyping", Hanser Gardener Publications, 2003.
3	Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
4	Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.
5	Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.

WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:

1	https://onlinecourses.nptel.ac.in/noc22_me122/preview-Fundamental of additive manufacturing technologies-Prof.Sajan kapil
2	https://www.mooc-list.com/tags/additive-manufacturing
3	https://www.coursera.org/learn/additive-manufacturing-3d-printing
4	https://www.open.edu/openlearn/science-maths-technology/additive-manufacturing/content-section-0

CO-PO MAPPING

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

PPED2PE11	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	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.
2	To develop finite volume discretised forms of the governing equations for diffusion processes.
3	To develop finite volume discretised forms of the convection-diffusion processes.
4	To develop pressure-based algorithms for flow processes.
5	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 Completion of the course the student will be able to		Cognitive Level
CO1	Analyse the governing equations and boundary conditions.	Analyze
CO2	Analyse various discretization techniques for both steady and unsteady diffusion problems.	Analyze
CO3	Analyse the various convection-diffusion problems by Finite-Volume method.	Analyze
CO4	Analyse the flow processes by using different pressure bound algorithms.	Analyze

CO5	Select and use the different turbulence models according to the type of flows.	Apply

REFERENCE BOOKS:

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.
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.
5	JiyuanTu, Guan Heng Yeoh, Chaogun Liu, "Computational Fluid Dynamics A Practical Approach" Butterworth – Heinemann An Imprint of Elsevier, Madison, U.S.A., 2008.

WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:

1	https://archive.nptel.ac.in/courses/112/105/112105254/Fundamentals of Computational fluid dynamics
2	https://www.coursera.org/learn/applied-computational-fluid-dynamics
3	https://www.mooc-list.com/tags/computational-fluid-dynamics
4	https://mooc.es/course/introduction-to-cfd/computational-fluid-dynamics

CO-PO MAPPING

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

CO5	Integrate PLM/PDM with legacy data bases, CAx& ERP systems.	Apply

REFERENCE BOOKS:

1	Antti Saaksvuori and Anselmi Immonen, "Product Lifecycle Management", Springer Publisher, 2013 (6rd 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, 2010.
4	John Stark, "Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question", Springer Publisher, 2012.
5	John Stark, "Product Lifecycle Management: 21st Century Paradigm for Product Realisation", Springer Publisher, 2011 (2nd Edition).

WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:

1	https://archive.nptel.ac.in/courses/110/104/110104084/ - Management of new product and service
2	https://onlinecourses.nptel.ac.in/noc22_mg82/preview - product brand management

CO-PO MAPPING

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

PPED2PE04	OPTIMIZATION TECHNIQUES IN 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	To understand the basic concepts of unconstrained optimization techniques.
2	To understand the basic concepts of constrained optimization techniques.
3	To provide the mathematical foundation of artificial neural networks and swarm intelligence for design problems.
4	To implement optimization approaches and to select appropriates solution for design application.
5	To demonstrate selected optimization algorithms commonly used in static and dynamic applications.

UNIT – I	UNCONSTRAINED OPTIMIZATION TECHNIQUES	9

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

UNIT – II	CONSTRAINED OPTIMIZATION TECHNIQUES	9

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

UNIT – III	ARTIFICIAL NEURAL NETWORKS AND SWARM INTELLIGENCE	9

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

UNIT – IV	ADVANCED OPTIMIZATION TECHNIQUES	9

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

UNIT – V	STATIC AND DYNAMIC APPLICATIONS	9

. Structural applications – Design of simple truss members – Design of simple axial, transverse loaded members for minimum cost, weight – Design of shafts and torsionally loaded members –Design of springs. Dynamic Applications – Optimum design of single, two degree of freedom systems, vibration absorbers. Application in Mechanisms–Optimum design of simple linkage mechanisms.

TOTAL: 45 PERIODS

COURSE OUTCOMES The students will be able to		**Cognitive Level**
CO1	Formulate unconstrained optimization techniques in engineering design application.	Understand
CO2	Formulate constrained optimization techniques for various applications.	Understand
CO3	Aly the Implement neural network technique to real world design problems.	Apply
CO4	Apply genetic algorithms to combinatorial optimization problems.	Apply

CO5	Apply solutions by various optimization approaches for a design problem.	Apply

REFERENCE BOOKS:

1	Jang, J. S.R, Sun, C. T and Mizutani E., "Neuro-Fuzzy and Soft Computing", Pearson Education.2015,
2	JohnsonRay, C.,"Optimumdesignofmechanicalelements",Wiley,2nd Edition 2014.
3	Kalyanmoy Deb,"OptimizationforEngineeringDesign:AlgorithmsandExamples",PHI Learning Private Limited, 2nd Edition, 2012.
4	Rao Singiresu S., "Engineering Optimization – Theory and Practice", New Age International Limited, NewDelhi, 3rd Edition, 2013.
5	Rajasekaran S and Vijayalakshmi Pai, G.A, "Neural Networks, Fuzzy Logic andGeneticAlgorithms",PHI,2011

WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:

1	https://nptel.ac.in/courses/111105039- Optimization
2	https://archive.nptel.ac.in/courses/112/106/112106064/#- Design and optimization of energy system
3	https://archive.nptel.ac.in/courses/108/103/108103108/ - Optimization techniques for digital VLSI
4	https://www.engr.uvic.ca/~mech410/lectures/6a_Optimization.pdf - Introduction to Design Optimization

CO-PO MAPPING

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

PPED2PE05	DESIGN FOR SUSTAINABILITY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

UNIT – I	INTRODUCTION	9

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

UNIT – II	CAST & WELDED COMPONENTS DESIGN	9

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

UNIT – III	FORMED & MACHINED COMPONENTS DESIGN	9

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

UNIT – IV	DESIGN FOR ASSEMBLY	9

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

UNIT – V	DESIGN FOR ENVIRONMENT	9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES On successful completion of this course, the student will be able to.		Cognitive Level
CO1	Select relevant process; apply the general design principles for manufacturability; GD&T.	Understand
CO2	Apply design considerations while designing the cast and welded components.	Apply
CO3	Apply design considerations while designing the formed and machined components.	Apply

CO4	Apply design considerations for assembled systems	Apply
CO5	Apply design considerations for environmental issues.	Apply

REFERENCE BOOKS:	
1	Sustainability Engineering: Concepts, Design and Case studies, Prentice Hall, 1stEdn, 2015
2	Introduction to Sustainability for Engineers, ToolseeramRamjeawon, CRC Press, 1stEdn., 2020
3	Boothroyd, G,Heartz and Nike, Product Design for Manufacture,MarcelDekker, 2009
4	Introduction to Sustainable Engineering, Rag. R.L. and Ramesh Lakshmi Dinachandran, PHI Learning Pvt. Ltd.,2ndEdn, 2016
5	Boothroyd, G, 2nd Edition 2002, Design for Assembly Automation and Product Design. New York, Marcel Dekker.
WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:	
1	https://onlinecourses.nptel.ac.in/noc21_de09/preview System Design for Sustainability
2	https://unesdoc.unesco.org/ark:/48223/pf0000375644.locale=en delivering on the Sustainable Development Goals
3	https:/https://nptel.ac.in/courses/107103081/www.macfound.org
4	https://nptel.ac.in/courses/127105018 Introduction to Environmental Engineering and science

CO-PO MAPPING

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

PPED2PE12	MATERIAL CHARACTERISATION TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	To understand the material characterization techniques and bulk averaging techniques.
2	To understand the fundamental principles behind the individual characterization methods which are included in the course.
3	To analyze, interpret and present observations from the different characterization methods.
4	To assess which methods of characterization are appropriate for different material /requirement/ condition/ problems.
5	To able to evaluate the uncertainty of observations and results from the different characterization methods.

UNIT – I	INTRODUCTION	9

Scope of subject, classification of techniques for characterization, macro and micro - characterization structure of solids. Bulk averaging techniques: Thermal analysis, DTA, DSC, TGA, dilatometry, resistivity/conductivity.

UNIT – II	ATOMIC AND MOLECULAR SPECTROSCOPY	9

Atomic Absorption, Fluorescence and Emission Spectroscopy, UV-Visible Spectroscopy, Infrared Spectroscopy, Raman Spectroscopy, Energy Dispersive X-ray Spectroscopy, X-ray Photoelectron Spectroscopy, Nuclear Magnetic Resonance Spectroscopy, Mass Spectrometry.

UNIT – III	IMAGING MICROSCOPIES&METALLOGRAPHIC TECHNIQUES	9

Imaging Microscopies and Image Analysis: Optical Microscopy, Scanning Electron Microscopy, Scanning Probe Microscopy, Image Analysis; Optical metallography, image analysis, quantitative phase estimation.

UNIT – IV	X-RAY AND ELECTRON DIFFRACTION	9

Properties of X-Rays, Review of Crystal Systems and Miller Indices, Stereographic Projections, The Reciprocal Lattice, Laué Equations, Diffraction Methods, Scattered Intensities, Phase Identification, Small angle scattering

UNIT – V	THERMAL AND THERMOMECHANICAL TECHNIQUES	9

Differential Scanning Calorimetry and Differential Thermal Analysis, Thermo gravimetric Analysis, Dynamic Mechanical Analysis and Thermo mechanical Analysis.

TOTAL: 45 PERIODS

COURSE OUTCOMES On Completion of the course the student will be able to		Cognitive Level
CO1	Understand the material characterization techniques and bulk averaging techniques.	Understand
CO2	Understand the fundamental principles behind the individual characterization methods which are included in the course.	Understand
CO3	Analyze, interpret and present observations from the different characterization methods.	Analyze
CO4	Assess which methods of characterization are appropriate for different material /requirement/ condition/ problems.	Apply

CO5	Evaluate the uncertainty of observations and results from the different characterization methods.	Evaluate

REFERENCE BOOKS:

1	Angelo P C, Material characterization, Cengage Learning India, 2016.
2	Cullity B.D., Stock S.R and Stock S., Elements of X ray Diffraction, 3rdEdition. Prentice Hall, 2018.
3	Skoog, Holler and Nieman, Principles of Instrumental Analysis, 7thedition, Cengage Learning, 2017.
4	Suryanarayana A. V. K., Testing of metallic materialism's publications, 2007.
5	Suryanarayana C, Experimental Techniques in materials and Mechanics, CRC Press,2011.

WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:

1	https://onlinecourses.nptel.ac.in/noc22_mm37/preview- Techniques of material characterisation by Prof. Shibayan Roy
2	https://www.aif.ncsu.edu/mct/ - Material Characterization Techniques
3	https://www.sciencedirect.com/journal/materials-characterisation-techniques
4	https://www.classcentral.com/course/technology-of-modern-composite-materials-with-car-25332 - Technology of modern composite materials with carbon fillers

CO-PO MAPPING

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

PPED3PC09	MATERIAL HANDLING SYSTEMS AND DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

UNIT – I	INTRODUCTIONS AND DESIGN OF HOISTS	9

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

UNIT – II	DRIVES OF HOISTING GEAR	9

Hand and power drives - Traveling gear - Rail traveling mechanism - cantilever and mono rail cranes-slewing, ji band luffing gear-cog wheel drive-selecting the motor ratings.

UNIT – III	CONVEYORS	9

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

UNIT – IV	ELEVATORS	9

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

UNIT – V	INTEGRATED DESIGN	9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES On Completion of the course the student will be able to		Cognitive Level
CO1	Design hoists and brakes used in any handling applications.	Apply
CO2	Design drives mechanisms and hoisting gear for different handling applications.	Apply
CO3	Design different conveyor systems for material handling applications.	Understand
CO4	Design bucket, cage and fork lift elevators for to and fro transportation of materials in vertical direction.	Apply
CO5	Design of integrated mechanical system for machine tools, power transmission and engine parts	Apply

ED67

REFERENCE BOOKS:	
1	Alexandrov ,M., Materials Handling Equipments, MIR Publishers.
2	Boltzharol, A., Materials Handling Handbook, The Ronald Press Company.
3	Norton.LRobert."MachineDesign–AnIntegratedApproach"PearsonEducation,2nd Edition, 2005.
4	Rudenko, N., Materials handling equipment, EL nvee Publishers.
5	Spivakovsy, A.O. and Dyachkov, V.K., Conveying Machines, Volumes I and II, MIR Publishers.
APPROVED DATABOOKS:	
1	P.S.G. Tech., "Design Data Book", Kalaikathir Achchagam, Coimbatore.
2	Lingaiah. K. and Narayana Iyengar,"Machine Design Data Hand Book", Vol.1&2,Suma Publishers, Bangalore.
WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:	
1	https://archive.nptel.ac.in/courses/113/105/113105104/bulk materials transport and handling systems
2	https://nptel.ac.in/courses/113105104/materials handling-Prof khanindra pathak.
3	http://www.nitttrc.edu.in/nptel/courses/video/113105104/lec45.pdf
4	https://www.youtube.com/watch?v=Up1oSSJn6oM

CO-PO MAPPING

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

PPED3PE13	BEARING DESIGN AND ROTOR DYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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 behaviour
5	Study the dynamics of rotors mounted on Hydrodynamic Bearings

UNIT – I	CLASSIFICATION AND SELECTION OF BEARINGS	9

Selection criteria – Dry and Boundary Lubrication Bearings-Hydrodynamic and Hydrostatic Bearings-Electro Magnetic bearings – Dry bearings – Rolling Element bearings-Bearings for Precision. Applications-Foil Bearings-Special bearings-Selection of plain Bearing materials – Metallic and Non-metallic bearings-Materials for rolling bearings

UNIT – II	DESIGN OF FLUID FILM BEARINGS	9

Design and performance analysis of Thrust and Journal bearings – Full, partial, fixed and pivoted journal bearings design procedure-Minimum film thickness – lubricant flow and delivery – power loss, Heat and temperature distribution calculations-Design based on Charts & Tables Design of Hydrostatic, Thrust and Journal bearings-Stiffness consideration-flow regulators and p ump design in hydrostatic bearings-Foil bearings-Air Bearings

UNIT – III	ROLLING CONTACTS SELECTION OF ROLLING BEARINGS	9

Contact Stresses in Rollingbearings-Centrifugalstresses-Elastohydrodynamiclubrication-Fatiquelife calculations-Bearing operating temperature-Lubrication- Selection of lubricants-Internal clearance – Shaft and housing fit- -Mounting arrangements. Manufacturing methods-Ceramic bearings-Rolling bearing cages-bearing seals selection

UNIT – IV	ROTOR DYNAMICS	9

Motion of the shaft in the bearing-Rotor supported on rigid and flexible supports-Campbell diagram, Rotor Dynamic Analyses- Un damped 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 HYDRO DYNAMIC 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 Centre Trajectory-Analysis of short bearings under dynamic conditions-Finite difference solution for dynamic conditions

TOTAL: 45 PERIODS

COURSE OUTCOMES On Completion of the course the student will be able to		**Cognitive Level**
CO1	Understand application of various types of bearings and their operating principles	Understand
CO2	Design and suggest bearings for specific applications	Create

ED 69

CO3	Perform fatigue life calculations for various types of bearings,	Apply
CO4	Understand and analyze bearing behavior	Analyze
CO5	Study the dynamics of rotors mounted on Hydrodynamic Bearings	Analyze

REFERENCE BOOKS:

1	Wen Jeng Chen, "Practical Rotor dynamics and Fluid Film Bearing Design", Trafford Publishing, 2015
2	G.W. Stachowiak &A.W. Batchelor, Engineering Tribology, Butterworth-Heinemann, UK, 2005
3	S.K. Basu, S. N. Sengupta & B. B. Ahuja , "Fundamentals of Tribology", Prentice – Hall of India Pvt Ltd, New Delhi,2005
4	Neale, M.J. "Tribology Hand Book", Butterworth Heinemann, United Kingdom 2001

WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:

1	https://archive.nptel.ac.in/courses/112/103/112103025/ - Theory & Practice of Rotor Dynamics
2	https://www.cranfield.ac.uk/courses/short/aerospace/rotor-dynamics - Rotor Dynamics
3	https://www.softinway.com/education/online-training/rotordynamics-bearings-design/ - Rotor Dynamics and Bearing Design
4	https://dyrobes.com/2022/09/fall-course-practical-rotordynamics-for-real-machinery-oct-17-20-2022/ = Practical Rotordynamics for Real Machinery

CO-PO MAPPING

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

ED 70

PPED3PE14	ADVANCED FINITE ELEMENT ANALYSIS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

UNIT – I	BENDING OF PLATES AND SHELLS	9

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

UNIT – II	NON-LINEAR PROBLEMS	9

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

UNIT – III	DYNAMIC PROBLEM	9

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

UNIT – IV	FLUID MECHANICS AND HEAT TRANSFER	9

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

UNIT – V	ERROR ESTIMATES AND ADAPTIVE REFINEMENT	9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES On Completion of the course the student will be able to		Cognitive Level
CO1	Apply concept of Finite Element Analysis to solve problems involving plate and shell elements	Apply
CO2	Apply concept of Finite Element Analysis to solve problems involving geometric and material non linearity	Apply
CO3	Formulate solution techniques to solve dynamic problems	Create

CO4	Apply concepts of Finite Element Analysis to solve fluid mechanics and heat transfer problems	Apply
CO5	Investigate error norms, convergence rates and refinement.	Evaluate

REFERENCE BOOKS:

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

WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:

1	https://onlinecourses.nptel.ac.in/noc22_me43/preview - Finite Element Method
2	https://ocw.mit.edu/courses/2-092-finite-element-analysis-of-solids-and-fluids-i-fall-2009/ - Finite Element Analysis of Solids and Fluids
3	https://courses.ansys.com/index.php/courses/analysis-of-the-finite-element-method/ - Finite Element Analysis
4	https://www.cranfield.ac.uk/courses/short/defence-and-security/finite-element-methods-in-engineering - Finite Element Methods in Engineering

CO-PO MAPPING

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

PPED3OE07	ETHICAL MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

UNIT – I	ETHICS AND SOCIETY	9

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

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

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

UNIT – III	STAKEHOLDERS IN ETHICAL MANAGEMENT	9

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

UNIT – IV	INDIVIDUAL VARIABLES IN ETHICAL MANJAGEMENT	9

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

UNIT – V	PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS	9

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

TOTAL: 45 PERIODS

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

REFERENCE BOOKS:	
1	Brad Agle, Aaron Miller, Bill O' Rourke, The Business Ethics Field Guide: the essential companion to leading your career and your company, 2016.
2	Steiner & Steiner, Business, Government & Society: A managerial Perspective, 2011.
3	Lawrence & Weber, Business and Society: Stakeholders, Ethics, Public Policy, 2020.
4	Trevino, L. K., & Nelson, K. A. *Managing business ethics: Straight talk about how to do it right*. John Wiley & Sons, 2003
5	Taft, S., & White, J. Ethics education: Using inductive reasoning to develop individual, group, organizational, and global perspectives. *Journal of Management Education, 31*(5), 2007
WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:	
1	https://cnx.org/contents/w6yyq31c@8.84:JaKv7fV9@5/5-1-Ethics-and-Business-Ethics-Defined
2	https://nptel.ac.in/courses/110105079 Business Ethics
3	https://nptel.ac.in/courses/110105097 Ethics in Engineering Practice
4	https://onlinecourses.nptel.ac.in/noc19_mg56/preview The Ethical Corporation

CO-PO MAPPING

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

PPED3OE08	MICRO AND SMALL BUSINESS MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

UNIT – I	INTRODUCTION TO SMALL BUSINESS	9

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

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

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

UNIT – III	BUILDING THE RIGHT TEAM AND MARKETING STRATEGY	9

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

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

UNIT – IV	FINANCING SMALL BUSINESS	9

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

UNIT – V	VALUING SMALL BUSINESS AND CRISIS MANAGEMENT	9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES		Cognitive Level
CO1	Familiarise the students with the concept of small business	Understand
CO2	In depth knowledge on small business opportunities and challenges	Understand
CO3	Ability to devise plans for small business by building the right skills and marketing strategies	Apply

CO4	Identify the funding source for small start ups	Apply
CO5	Business evaluation for buying and selling of small firms	Understand

REFERENCE BOOKS:

1	Hankinson,A.(2000). "The key factors in the profile of small firm owner-managers that influence business performance. The South Coast Small Firms Survey, 1997-2000." Industrial and Commercial Training 32(3):94-98.
2	Parker,R.(2000). "Small is not necessarily beautiful: An evaluation of policy support for small and medium-sized enterprise in Australia." Australian Journal of Political Science 35(2):239-253.
3	Anagnostopoulos, n.d. "Springer Reference—LISREL," www.researchgate.net/publication/323683239_LISREL, (accessed 8 September 2019)
4	Aksoy, H. "How Do Innovation Culture, Marketing Innovation and Product Innovation Affect the Market Performance of Small and Medium-Sized Enterprises (SMEs)?" Technology in Society 51, pp. 133-41. 2017
5	Andersén, J., Institution enför handel och företagande, Högskolan i Skövde, and Forsknings speciali seringen Framtidens Företagande. 2017

WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:

1	https://onlinecourses.swayam2.ac.in/ntr23_ed09/preview Entrepreneurship Development
2	https://www.investopedia.com/articles/pf/12/small-business-challenges.asp
3	https://www.overdrive.com/media/525775/fundamentals-of-entrepreneurship-and-small-business-mana
4	https://onlinecourses.swayam2.ac.in/cec19_mg39/preview Entrepreneurship

CO-PO MAPPING

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

PPED3PE16	INDUSTRY 4.0	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	To introduce and familiarize the industry 4.0 and its physical structure and inter-connectivity.
2	To understand the architecture, IOT and its protocols
3	To outline the cloud computing and data analytics
4	To familiar the concepts of integrated IOT.
5	To learn the IOT, cloud computing, data analytics and Industry 4.0

UNIT – I	INTRODUCTION TO INDUSTRY 4.0	9

The Various Industrial Revolutions - Digitalisation and the Networked Economy - Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0 - The Journey so far: Developments in USA, Europe, China and other countries - Comparison of Industry 4.0 Factory and Today's Factory - Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation.

UNIT – II	ROAD TO INDUSTRY 4.0	9

Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services - Smart Manufacturing - Smart Devices and Products - Smart Logistics - Smart Cities - Predictive Analytics

UNIT – III	INDUSTRIAL INTERNET OF THINGS	9

Fourth Revolution – Sustainability assessment of Manufacturing Industry – Lean Production system – Smart and connected business perspective – smart factories – cyber-physical systems – collaboration platform and PLM

UNIT – IV	APPLICATIONS	9

Inventory Management and Quality Control – Plant security and safety – Facility management – oil, chemical and Pharmaceutical Industry – Milk processing and packaging industries

UNIT – V	BUSINESS ISSUES IN INDUSTRY 4.0	9

Opportunities and Challenges - Future of Works and Skills for Workers in the Industry 4.0 Era - Strategies for competing in an Industry 4.0 world

TOTAL: 45 PERIODS

COURSE OUTCOMES On Completion of the course the student will be able to		Cognitive Level
CO1	Realize the need of industry 4.0 and its inter-connectivity.	Remember
CO2	Interpret the architecture of IOT and its protocols	Understand
CO3	Recognize the uses of cloud computing and data analytics	Apply
CO4	Plan the uses of IOT, cloud computing, data analytics and Industry 4.0 technologies	Apply
CO5	Understand the Business issues in Industry 4.0	Understand

ED77

REFERENCE BOOKS:	
1	Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things, APress, 2016.
2	Duato J, Yalamanchili S, and Lionel Ni, "Interconnection Networks: An Engineering Approach", Morgan Kaufmann Publishers, 2004.
3	Fayez Gebali, "Haytham Elmiligi, Mohamed Wathed and El -Kharashi "Networks- on chips: Theory and Practice", CRC Press, Taylor and Francis Group, 2009.
4	Giovanni De Micheli and Luca Benini, "Networks on Chips: Technology and Tools", Morgan Kaufmann, 2006.
5	Kiran Kumar Pabbathi, "Quick Start Guide to Industry 4.0: One-Stop Reference Guide for Industry 4.0", Createspace Independent Publishing Platform, 2018.
WEBSITE REFERENCE / NPTEL/ SWAYAM/ MOOC REFERENCE:	
1	https://onlinecourses.nptel.ac.in/noc20_cs69/preview-Introduction to Industry 4.0 and IIoT.
2	https://nptel.ac.in/courses/106105195-Introduction to IoT
3	https://www.ibm.com/topics/industry-4-0
4	https://www.sap.com/india/products/scm/industry-4-0/what-is-industry-4-0.html

CO-PO MAPPING

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