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

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I.	To understand the concepts and tools for design and development of engineering principles to conceptualize, create, model, test and evaluate designs within the context of local and global needs.
II.	To understand and explore the behaviour of existing and new materials suitable for the design needs.
III.	To develop life skills to become design professionals, administrators and Academicians.
IV.	To pursue advanced education, research and development and other creative/ innovative efforts in their professional career.

2. PROGRAMME OUTCOMES (POs):

PO#	Programme Outcomes
1	An ability to independently carry out research/investigation and development work to solve practical problems
2	An ability to write and present a substantial technical report/document
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
4	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

4. PEO/PO Mapping:

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

1, 2, 3,-, scale against the correlation PO's with PEO's

PROGRAM ARTICULATION MATRIX OF M.E. ENGINEERING DESIGN

		COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6
	SEMESTER I	Advanced Mechanics of Materials	√	√	√		√	
		Advanced Mechanisms in Design	√	√	√	√	√	
		Computer Applications in Design	√	√	√		√	
		Vibration Analysis and Control						
		Research Methodology and IPR						
		Professional Elective- I						
		Audit Course-I*						
		CAD and Design for Manufacture and Assembly Laboratory	√	√	√	√		
		Vibration Laboratory	√	√	√	√	√	
	SEMESTER II	Mechanical Behavior of Materials						
		Finite Element Methods in Mechanical Design	√	√	√	√	√	
		Integrated Product Development	√	√	√	√	√	
		Professional Elective-II						
		Professional Elective-III						
		Professional Elective-IV						
		Audit Course–II*						
		Simulation and Analysis Laboratory	√	√	√	√		
		Product Design Laboratory	√	√	√	√	√	√
YEAR II	SEMESTER III	Professional Elective-V						
		Professional Elective-VI						
		Open Elective						
		Technical Seminar	√	√	√	√	√	√
		Project Work -I	√	√	√	√	√	
	SEMESTER IV	Project Work -II	√	√	√	√	√	

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M.E. ENGINEERING DESIGN

REGULATIONS 2021

CHOICE BASED CREDIT SYSTEM

I TO IV SEMESTERS CURRICULA AND SYLLABUS

SEMESTER I

SI. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	ED4151	Advanced Mechanics of Materials	PCC	3	1	0	4	4
2	ED4152	Advanced Mechanisms in Design	PCC	3	0	0	3	3
3	ED4153	Computer Applications in Design	PCC	3	0	0	3	3
4	ED4154	Vibration Analysis and Control	PCC	3	0	0	3	3
5	RM4151	Research Methodology and IPR	PCC	2	0	0	2	2
6		Professional Elective- I	PEC	3	0	0	3	3
7		Audit Course-I*	AC	2	0	0	2	0
PRACTICAL								
8	ED4111	CAD and Design for Manufacture and Assembly Laboratory	PCC	0	0	4	4	2
9	ED4161	Vibration Laboratory	PCC	0	0	4	4	2
			TOTAL	**19**	**1**	**8**	**28**	**22**

* Audit Course is optional

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	ED4201	Mechanical Behavior of Materials	PCC	3	0	0	3	3
2.	ED4251	Finite Element Methods in Mechanical Design	PCC	3	1	0	4	4
3.	PD4152	Integrated Product Development	PCC	3	0	0	3	3
4.		Professional Elective -II	PEC	3	0	0	3	3
5.		Professional Elective-III	PEC	3	0	0	3	3
6.		Professional Elective-IV	PEC	3	0	0	3	3
7.		Audit Course–II*	AC	2	0	0	2	0
PRACTICAL								
8.	ED4261	Simulation and Analysis Laboratory	PCC	0	0	4	4	2
9.	PD4261	Product Design Laboratory	PCC	0	0	4	4	2
			TOTAL	**20**	**1**	**8**	**29**	**23**

* Audit Course is optional

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1		Professional Elective-V	PEC	3	0	0	3	3
2		Professional Elective-VI	PEC	3	0	0	3	3
3		Open Elective	OEC	3	0	0	3	3
PRACTICAL								
4	ED4311	Technical Seminar	EEC	0	0	2	2	1
5	ED4312	Project Work I	EEC	0	0	12	12	6
			TOTAL	**9**	**0**	**14**	**23**	**16**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICAL								
1	ED4411	Project Work II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE: 73

PROFESSIONAL CORE COURSES (PCC)

SI. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	ED4151	Advanced Mechanics of Materials	PCC	3	1	0	4	4
2	ED4152	Advanced Mechanisms in Design	PCC	3	0	0	3	3
3	ED4153	Computer Applications in Design	PCC	3	0	0	3	3
4	ED4154	Vibration Analysis and Control	PCC	3	0	0	3	3
5	RM4151	Research Methodology and IPR	PCC	2	0	0	2	2
8	ED4111	CAD and Design for Manufacture and Assembly Laboratory	PCC	0	0	4	4	2
9	ED4161	Vibration Laboratory	PCC	0	0	4	4	2
10	ED4201	Mechanical Behavior of Materials	PCC	3	0	0	3	3
11	ED4251	Finite Element Methods in Mechanical Design	PCC	3	1	0	4	4
12	PD4152	Integrated Product Development	PCC	3	0	0	3	3
13	ED4261	Simulation and Analysis Laboratory	PCC	0	0	4	4	2
14	PD4261	Product Design Laboratory	PCC	0	0	4	4	2

RESEARCH METHODOLOGY AND IPR COURSE (RMC)

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

PROFESSIONAL ELECTIVE COURSES

SEMESTER I, ELECTIVES I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CD4152	Design for Sustainability	PEC	3	0	0	3	3
2.	ED4072	Composite Materials and Mechanics	PEC	3	0	0	3	3
3.	ED4074	Design of Hydraulic and Pneumatic Systems	PEC	3	0	0	3	3
4.	ED4079	Quality Concepts in Design	PEC	3	0	0	3	3
5.	MA4071	Applied Probability and Statistics for Design Engineers	PEC	3	0	0	3	3

SEMESTER II, ELECTIVES II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	ED4001	Surface Engineering	PEC	3	0	0	3	3
2.	CC4071	Advanced Machine tool Design	PEC	3	0	0	3	3
3.	PD4391	Product Lifecycle Management	PEC	3	0	0	3	3
4.	AO4091	Artificial Intelligence and Machine Learning	PEC	3	0	0	3	3

SEMESTER II, ELECTIVES III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	ED4093	Optimization Techniques in Design	PEC	3	0	0	3	3
2	CD4091	Bio Materials	PEC	3	0	0	3	3
3	ED4075	Mechanical Measurements and Analysis	PEC	3	0	0	3	3
4	ED4002	Design for X	PEC	3	0	0	3	3
5	AP4251	Industrial Internet of Things	PEC	3	0	0	3	3

SEMESTER II, ELECTIVES IV

SL. NO.	COURSECODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	ED4094	Vehicle Dynamics	PEC	3	0	0	3	3
2	ED4092	Engineering Fracture Mechanics	PEC	3	0	0	3	3
3	CM4152	Solid Freeform Manufacturing	PEC	3	0	0	3	3
4	ED4080	Tribology in Design	PEC	3	0	0	3	3
5	BM4074	Wearable Technologies	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE V

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	ED4091	Advanced Finite Element Analysis	PEC	3	0	0	3	3
2	ED4071	Design of Hybrid and Electric Vehicles	PEC	3	0	0	3	3
3	ED4003	Bearing Design and Rotor Dynamics	PEC	3	0	0	3	3
4	ED4073	Material Handling Systems and Design	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE VI

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	PD4151	Creativity and Innovation	PEC	3	0	0	3	3
2	IC4291	Computational Fluid Dynamics	PEC	3	0	0	3	3
3	IL4093	Supply Chain Management	PEC	3	0	0	3	3
4	II4091	Industry 4.0	PEC	3	0	0	3	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	ED4311	Technical Seminar	EEC	0	0	2	2	1
2.	ED4312	Project Work I	EEC	0	0	12	12	6
3.	ED4411	Project Work II	EEC	0	0	24	24	12

AUDIT COURSES (AC)
Registration for any of these courses is optional to students

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

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

COURSE OBJECTIVES

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

UNIT- I ELASTICITY 9+3

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

UNIT- II SHEAR CENTRE AND UNSYMMETRICAL BENDING 9+3

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

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

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

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

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

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

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

TOTAL = 60 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

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

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

CO3 Evaluate the stresses in flat plates and curved members.

CO4 Calculate torsional stress of non-circular sections.

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

REFERENCES:

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

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

ED4152 ADVANCED MECHANISMS IN DESIGN

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

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

UNIT-I INTRODUCTION 9

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

UNIT-II KINEMATIC ANALYSIS 9

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

UNIT-III PATH CURVATURE THEORY, COUPLER CURVE 9

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

UNIT-IV SYNTHESIS OF FOUR BAR MECHANISMS 9

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

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

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

TOTAL : 45 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

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

REFERENCES:

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

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

ED4153	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 modeling and viewing.
5. To create strong skills of assembly modeling and prepare the student to be an effective user ofa 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: Hermitebicubic surface- Bezier surface and B-Spline surface- surface manipulations.

UNIT – III NURBS AND SOLID MODELING 9

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

UNIT – IV VISUAL REALISM 9

Hidden Line removal, Hidden Surface removal, – Hidden Solid Removal algorithms - Shading – Coloring.

Animation - Conventional, Computer animation, Engineering animation - types and techniques.

UNIT – V ASSEMBLY OF PARTS AND PRODUCT LIFE CYCLEMANAGEMENT 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Solve 2D and 3D transformations for the basic entities like line and circle.
CO2 Formulate the basic mathematics fundamental to CAD system.
CO3 Use the different geometric modeling techniques like feature based modeling, surfacemodeling and solid modeling.
CO4 Create geometric models through animation and transform them into real world systems
CO5 Simulate assembly of parts using Computer-Aided Design software.

REFERENCES:

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

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

ED4154 VIBRATION ANALYSIS AND CONTROL

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

COURSE OBJECTIVES

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

UNIT - I FUNDAMENTALS OF VIBRATION 9+3

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

UNIT-II TWO DEGREE FREEDOM SYSTEM 9+3

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

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

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

UNIT-IV VIBRATION AND NOISE CONTROL 9+3

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

UNIT-V EXPERIMENTAL METHODS IN VIBRATION ANALYSIS 9+3

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

TOTAL : 60 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

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

REFERENCES:

1. Graham Kelly, Sand Shashidhar K. Kudari, "Mechanical Vibrations", Tata McGraw – Hill Publishing Com. Ltd., 2007
2. Singiresu S. Rao, "Mechanical Vibrations, "Pearson Education Incorporated, 2017
3. Ramamurti. V, "Mechanical Vibration Practice with Basic Theory", Narosa Publishing House, 2010
4. WilliamT. Thomson, "Theory of Vibration with Applications", Taylor & Francis,2018

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

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

UNIT I RESEARCH DESIGN 6

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

UNIT II DATA COLLECTION AND SOURCES 6

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

UNIT III DATA ANALYSIS AND REPORTING 6

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

UNIT IV INTELLECTUAL PROPERTY RIGHTS 6

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

UNIT V PATENTS 6

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

TOTAL : 30 PERIODS

REFERENCES

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

ED4111	CAD AND DESIGN FOR MANUFACTURE AND ASSEMBLY LABORATORY	L	T	P	C
		0	0	4	2

- **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 AND ASSEMBLY LABORATORY

Introduction to Design for Assembly and Manufacturability (DFA/DFM)- The New Product Design (NPD) Process-Design for Assembly –Assembly Method Selection-Design forAssembly – 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

OUTCOMES:

On Completion of the course the student will be able to

CO1 Use the modern engineering tools necessary for engineering practice

CO2 Draw 2D part drawings, sectional views and assembly drawings as per standards.

CO3 Create 3D Model on any CAD software.

CO4 Convert 3D solid models into 2D drawing and prepare different views, sections and dimensioning of part models.

CO5 familiarize with DFMA package which is necessary for cost estimation and evaluating the product design

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

ED4161	VIBRATION LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE:

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

LIST OF EXPERIMENTS: 30

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

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

CO 1 Evaluate the stiffness and natural frequency of spring-mass systems.
CO 2 Determine the natural frequencies of damped and undamped torsional vibrations of single rotor systems
CO 3 Acquire the critical speed of shaft supported at its ends.
CO 4 Assess the natural frequency, damping coefficient, mode shapes of specimens under free vibrations.
CO 5 Determine the natural frequency of specimens under forced vibrations.

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

ED4201 MECHANICAL BEHAVIOR OF MATERIALS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

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

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

UNIT-I 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 – Intermetallics, Niand Tialuminides – Alloys – Al, Mg, Cu, Superalloys-Ironbase,Cobaltbase, Nickelbase. Metalmatrixcomposites (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, Al_2O_3, SiC, Si_3N_4CBN and diamond– Fracture of ceramics-Stress strainbehavior-Deformationbehavior.Glasses-Clayproducts-refractoryceramics,Composite Materials-GFRP and CFRP laminated composite.

TOTAL= 45 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

CO1 Analyze the different strengthening and failure mechanism of the metals
CO2 Apply the effects of metallurgical parameters in the materials design
CO3 Analyze the relationship between the selection of materials and processing
CO4 Develop the novel material through understanding the properties of the existing metallic materials
CO5 Analyze the different materials used in the engineering applications

REFERENCES:

1. George E.Dieter, Mechanical Metallurgy, McGraw Hill, 1988
2. Thomas H.Courtney, Mechanical Behavior of Materials,(2nd edition), McGraw Hill, 2000
3. Willam D. CallisterJr.and David G. Rethwisch, Callister's Materials Science and Engineering,(2nd edition)Wiley Editorial,2018
4. Charles, J.A.,Crane, F.A.A. and Fumess, J.A.G., Selection and use of engineering materials,(34th edition), Butterworth-Heiremann,1997
5. Flinn, R.A., and Trojan, P.K., Engineering Materials and their Applications, (4th Edition)Jaico,1999
6. MetalsHandbook,Vol.10,FailureAnalysisandPrevention, (10thEdition),Jaico,1999
7. AshbyM.F.,materialsselectioninMechanicalDesign2ndEdition,Butterworth1999
8. www.astm.org/labs/pages/131350.htm

CO	PO					
	1	2	3	4	5	6
1	2	1	3	2	3	3
2	2	1	3	1	2	3
3	2	1	3	2	3	3
4	2	1	3	1	3	3
5	2	1	3	1	3	3
AVg.	2	1	3	1.4	2.8	3

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

ED4251 FINITE ELEMENT METHODS IN MECHANICAL DESIGN

L	T	P	C
3	1	0	4

COURSE OBJECTIVES

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

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

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

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

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

UNIT-III ISO-PARAMETRIC FORMULATION 9+3

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

UNIT-IV EIGEN VALUE PROBLEMS 9+3

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

UNIT-V NON-LINEAR ANALYSIS 9+3

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

TOTAL = 60 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

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

REFERENCES:

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

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

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

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

COURSE OBJECTIVES:

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

UNIT– I INTRODUCTION TO PRODUCT DESIGN 9

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

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

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

UNIT–III PRODUCT ARCHITECTURE AND INDUSTRIAL DESIGN 9

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

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

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

UNIT– V PRODUCT DEVELOPMENT ECONOMICS AND MANAGING PROJECTS 9

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

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

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

REFERENCES:

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

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

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

ED4261 SIMULATION AND ANALYSIS LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

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

LIST OF EXPERIMENTS

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

TOTAL:60PERIODS

LISTOFEQUIPMENTS/SOFTWARE:

Finite Element Analysis packages

COURSE OUTCOMES:

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

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

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

CO3 Analyze thermal stress and heat transfer in mechanical components.

CO4 Analyze the vibration of mechanical components.

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

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

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

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

OBJECTIVE:

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

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

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

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

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

TOTAL : 60 PERIODS

COURSE OUTCOMES:

Upon conclusion of this course the student will be able to

CO1 Appreciate the use of physical prototype models for evaluating product concept

CO2 Apply theoretical knowledge to design and development of physical products usingclay, wood, sheet metal and RP techniques

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

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

		L	T	P	C
ED4311	**TECHNICALSEMINAR**	**0**	**0**	**2**	**1**

COURSE OBJECTIVE:

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

Thestudentswillworkfortwohoursperweekguidedbyagroupofstaffmembers.Theywillbe asked to talk on any topic of their choice related to Engineering design topics and to engage in dialogue with the audience. A brief copy of their talk also should be submitted. Similarly, the students will have to present a seminar of not less than fifteen minutes and not more than thirty minutes on the technical topic. They will also answer the queries on the topic. The students as audience also should interact. Evaluation will be based on the technical presentation and the report and also on the interaction during the seminar.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

CO1 Understand inductive and deductive reasoning, and increase their general problem solving skills.

CO2 Develop communicative skills (e.g. speaking, listening, reading, and/or writing).

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

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

		L	T	P	C
ED4312	**PROJECT WORK I**	**0**	**0**	**12**	**6**

COUSE OBJECTIVES:

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

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

TOTAL: 180 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

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

CO2 Undertake problem identification, formulation and solution.

CO3 Design engineering solutions to complex problems utilising a systems approach

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

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

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

ED 4411 **PROJECT WORK II** **L T P C**
0 0 24 12

OBJECTIVES:

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

SYLLABUS:

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

TOTAL: 360 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

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

CO2 Undertake problem identification, formulation and solution.

CO3 Design engineering solutions to complex problems utilising a systems approach

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

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

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

CD4152	DESIGN FOR SUSTAINABILITY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

UNIT-I INTRODUCTION 9

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

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

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

REFERENCES:

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

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

ED4072 COMPOSITE MATERIALS AND MECHANICS **L T P C**
3 0 0 3

COURSE OBJECTIVES:

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

UNIT-I INTRODUCTION TO COMPOSITE MATERIALS 9

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

UNIT- II MANUFACTURING OF COMPOSITES 9

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

UNIT-III LAMINA CONSTITUTIVE EQUATIONS 9

Lamina Constitutive Equations: Lamina Assumptions–Macroscopic Viewpoint.Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle 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(L:45) = 45 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

1. Calculate for mechanical strength of the composite material
2. Fabricate the FRP and other composites by different manufacturing methods
3. Analyze fiber reinforced Laminates for different combinations of plies with different orientations of the fiber.
4. Evaluate the stresses in the lamina of the laminate using different failure theories
5. Analyze thermo-mechanical behavior and evaluate residual stresses in different types of laminates using the Classical Laminate Theory.

REFERENCES:

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

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

ED4074 DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

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

UNIT – I OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS 9

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

UNIT – II CONTROL AND REGULATION ELEMENTS 9

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

UNIT – III HYDRAULIC CIRCUITS 9

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

UNIT – IV PNEUMATIC SYSTEMS AND CIRCUITS 9

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

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

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Design and select appropriate pumps in industries based on need.
CO2 Select correct sizing and rating of control elements in hydraulics.
CO3 Design basic circuits (hydraulic) for industrial applications.
CO4 Design basic pneumatic circuits for industrial applications.
CO5 Identify and provide solution for troubleshooting and design low cost automation for industrial application.

REFERENCES:

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

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

ED4079 QUALITY CONCEPTS IN DESIGN

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To impart knowledge on various concepts in engineering design, material selection andmanufacturing 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 implementmethods to uphold the status of six sigma
4. To develop a robust product or service using various strategies of design of experiments
5. To maintain the quality of the product by use of statistical tools and enforce methods toimprove the reliability of a product

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 SIXSIGMA **9**

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

UNIT – IV DESIGN OF EXPERIMENTS **9**

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

UNIT – V STATISTICAL CONSIDERATION AND RELIABILITY **9**

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 apply fundamentals of design process and material selection for developing a quality product

CO2 apply the quality concepts to develop a robust product

CO3 perform Failure Mode Effect Analysis on a product and use six sigma principles to enhanceits quality

CO4 apply different experimental design methods in product development

CO5 implement various statistical tools to improve its quality and reliability

REFERENCES:

1. Amitava Mitra,"Fundamentals of Quality control and improvement", John Wiley & Sons, 2016
2. George E.Dieter,LindaC.Schmidt,"EngineeringDesign",McGrawHillEducationPvt.Ltd., 2013
3. KarlT.Ulrich,StevenD.Eppinger,"ProductDesignAndDevelopment,,TataMcgraw-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.,"DesignandAnalysisofexperiments",JohnWileyandSons,2017.
6. Phillip J. Ross, "Taguchi techniques for quality engineering", Tata McGraw Hill, 2005.

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

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

COURSE OBJECTIVES:

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

UNIT - I ONE DIMENSIONAL RANDOM VARIABLES 9

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

UNIT - II TWO DIMENSIONAL RANDOM VARIABLES 9

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

UNIT- III ESTIMATION THEORY 9

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

UNIT - IV TESTING OF HYPOTHESIS 9

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

UNIT - V MULTIVARIATE ANALYSIS 9

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

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

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

REFERENCES :

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

ED4001 **SURFACE ENGINEERING** **L T P C**
3 0 0 3

COURSEOBJECTIVES:

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 in friction 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 7

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

UNIT- II WEAR 6

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 10

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 12

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 10

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

TOTAL = 45PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

CO1 Understand the basics of surface features, laws of friction and different types of friction
CO2 Develop the knowledge of various wear mechanism and its measurement
CO3 Understand the types of corrosion and its preventive measures
CO4 Familiarize the types of surface properties and various surface modification techniques
CO5 Ability to understand the different types of materials used in the friction and wear applications

REFERENCES:

1. G.W.Stachowiak & A.W.Batchelor,“EngineeringTribology”,Butterworth-Heinemann, UK, 2005
2. Rabinowicz.E,“Friction and Wear of materials”,JohnWilley&Sons,UK,1995
3. Halling,J.(Editor)–“Principles of Tribology“,Mac millian–1984
4. WilliamsJ.A.“EngineeringTribology”,OxfordUniv.Press,1994
5. S.K.Basu, S.N.Sengupta & B.B.Ahuja ,”Fundamentals of Tribology”, Prentice –Hall of India Pvt.Ltd,New Delhi,2005
6. FontanaG.,“Corrosion Engineering”,McGrawHill,1985

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

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

CC4071 ADVANCED MACHINE TOOL DESIGN L T P C
3 0 0 3

COURSE OBJECTIVES

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

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

UNIT I INTRODUCTION TO MACHINE TOOL DESIGN 9

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

UNIT II REGULATION OF SPEEDS AND FEEDS 9

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

UNIT III DESIGN OF MACHINE TOOL STRUCTURES 9

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

UNIT IV DESIGN OF GUIDEWAYS AND POWER SCREWS 9

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

UNIT V DESIGN OF SPINDLES AND SPINDLE SUPPORT 9

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

TOTAL = 45 PERIODS

OUTCOMES:

On Completion of the course the student will be able to

- Select the different machine tool mechanisms.
- Design the Multi speed Gear Box and feed drives.
- Design the machine tool structures.
- Design the guideways and power screws.
- Design the spindles and bearings.

REFERENCES:

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

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

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

PD4391 PRODUCT LIFECYCLE MANAGEMENT L T P C

3 0 0 3

OBJECTIVES:

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

UNIT I HISTORY, CONCEPTS AND TERMINOLOGY OF PLM 9

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

UNIT II PLM/PDM FUNCTIONS AND FEATURES 9

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

UNIT III DETAILS OF MODULES IN APDM/PLM SOFTWARE 9

Case studies based on top few commercial PLM/PDM tools

UNIT IV ROLE OF PLM ININDUSTRIES 9

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

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

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

TOTAL:45 PERIODS

OUTCOMES:

The students will be able to

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

0.3- Low 0.6- Medium 0.9- High

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

REFERENCES

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

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

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

UNIT I ARTIFICIALINTELLIGENCE 9
Artificial intelligence – Basics – Goals of artificial intelligence– AI techniques–problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots.

UNIT II INTRODUCTION TO MACHINE LEARNING 9
Machine Learning–Types of Machine Learning –Machine Learning process- preliminaries, testing Machine Learning algorithms, turning data into Probabilities, and Statistics for Machine Learning-Probability theory – Probability Distributions – Decision Theory.

UNIT III SUPERVISED LEARNING 9
Linear Models for Regression – Linear Models for Classification- Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Models – Decision Tree Learning – Bayesian Learning, Naïve Bayes – Ensemble Methods, Bagging, Boosting, Neural Networks, Multi-layer Perceptron, Feed- forward Network, Error Back propagation - Support Vector Machines.

UNIT IV UNSUPERVISED LEARNING 9
Clustering- K-means – EM Algorithm- Mixtures of Gaussians –Dimensionality Reduction, Linear Discriminant Analysis, Factor Analysis, Principal Components Analysis, Independent Components Analysis.

UNIT V PROBABILISTIC GRAPHICAL MODELS 9
Graphical Models – Undirected Graphical Models – Markov Random Fields – Directed Graphical Models –Bayesian Networks – Conditional Independence properties – Markov Random Fields-Hidden Markov Models – Conditional Random Fields (CRFs).

TOTAL: 45 PERIODS

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

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

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

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

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

COURSE OBJECTIVES:

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, vibrationabsorbers.ApplicationinMechanisms–Optimumdesignofsimplelinkagemechanisms.

TOTAL: 45 PERIODS

COURSEOUTCOMES:

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

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

REFERENCES:

1. Goldberg, David. E, “Genetic Algorithms in Search, Optimization and Machine Learning”, Pearson, 2009.
2. Jang, J. S.R, Sun, C. T and Mizutani E., "Neuro-Fuzzy and Soft Computing", Pearson Education.2015,
3. JohnsonRay,C.,“Optimumdesignofmechanicalelements”,Wiley,2nd Edition1980.
4. KalyanmoyDeb,“OptimizationforEngineeringDesign:AlgorithmsandExamples”,PHI Learning Private Limited, 2nd Edition, 2012.
5. Rao Singiresu S., “Engineering Optimization – Theory and Practice”, New Age International Limited, NewDelhi, 3rd Edition, 2013.
6. Rajasekaran S and Vijayalakshmi Pai, G.A, "Neural Networks, Fuzzy Logic andGeneticAlgorithms",PHI,2011

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

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

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

OBJECTIVES:

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

UNIT I INTRODUCTION **9**

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

UNIT II DENTAL MATERIALS 9

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

UNIT III ORTHOPAEDIC MATERIALS 9

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

UNIT IV WOUND DRESSING MATERIALS AND SURGICAL AIDS 9

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

UNIT V CARDIOVASCULAR, OPTHALMOLOGY AND DRUG DELIVERY MATERIALS 9

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

TOTAL: 45 PERIODS

OUTCOMES:

On Completion of the course the student will be able to

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

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

REFERENCES:

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

ED4075 MECHANICAL MEASUREMENTS AND ANALYSIS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

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

UNIT– I FORCESANDSTRAINMEASUREMENT 9

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

UNIT– II VIBRATION MEASUREMENTS 9

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

UNIT–III ACOUSTICS AND WIND FLOW MEASUREMENTS 9

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

UNIT– IV DISTRESS MEASUREMENTS 9

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

UNIT– V NON DESTRUCTIVE TESTING METHODS 9

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

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

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

REFERENCES:

1. Bray Don E and Stanley, R.K., "Non-destructive Evaluation", McGraw Hill Publishing Company, N.Y.1989
2. Garas,F.K.,Clarke,J.LandArmerGST,"Structuralassessment",Butterworths,London,1987
3. James W. Dally and William Franklin Riley, "Experimental Stress Analysis", McGraw Hill , 3rd Edition,1991
4. Sadhu Singh, Experimental Stress Analysis, KhannaPublishers,NewDelhi,2009.
5. SrinathLS, Raghavan Mr, Lingaiah K, Gargesha G, Pant Band Ramachandra, K, "Experimental Stress Analysis",TataMcGrawHillCompany,NewDelhi,1984
6. Sirohi,R.S.andRadhakrishna,H.C,"MechanicalMeasurements",NewAgeInternational (P) Ltd,3rd Edition, 1997.

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

ED4002 **DESIGN FOR X** **L T P C**
3 0 0 3

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

UNIT II 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 clampability – Design for accessibility.

UNIT-III 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 – Design for assembly – Product design for manual assembly - Product design for automatic assembly – Robotic assembly-Automatic assembly – Computer Application for DFMA -Case studies

UNIT IV DESIGN FOR RELIABILITY AND MAINTAINABILITY **9**

Reliability design process, system effectiveness, economic analysis and life cycle cost, reliability allocation, design methods, parts and material selection, derating, stress-strength and analysis, failure analysis, identification determination of causes, assessments of effects, computation of criticality index, corrective action, system safety – analysis of down-time – the repair time distribution, stochastic point processes system repair time, reliability under preventive maintenance state dependent system with repair. MTTR – mean system down time, repair vs replacement, replacement models, proactive, preventive, predictive maintenance maintainability and availability, optimization techniques for system reliability with redundancy heuristic methods applied to optimal system reliability

UNIT-V SUSTAINABLE DESIGN **9**

Industrial ecology, multiple life cycle design, principles of design, green engineering, cradle to cradle design, The Natural Step, biomimicry, design for reuse, dematerialization, modularization, Design to minimize material usage – Design for disassembly – Design for recyclability – design for flexibility, design for disassembly, design for inverse manufacturing, design for the environment, – Design for energy efficiency – Design to regulations and standards etc

TOTAL : 45 PERIODS

COURSE OUTCOMES

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

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

REFERENCES

1. Boothroyd, G, 1980 Design for Assembly Automation and Product Design. New York, Marcel Dekker.
2. Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994.
3. Bralla, Design for Manufacture handbook, McGraw hill, 1999.
4. Dickson, John. R, and Corroda Poly, Engineering Design and Design for Manufacture and Structural Approach, Field Stone Publisher, USA, 1995.
5. “Maintenance Engineering and Management”: K.Venkataraman-PHI Learning - 2007 2. David J. Smith, “Reliability and Maintainability in Perspective”, McMillan,2nd Edition, 1985.
6. Fixel, J. Design for the Environment McGraw Hill., 1996.
7. Finster, Mark P., 2013. Sustainable Perspectives to Design and Innovation.

CO-PO MAPPING

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

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

OBJECTIVES:

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

UNIT I INTRODUCTION AND ARCHITECTURE OF IoT 9

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

UNIT II INDUSTRIAL IoT 9

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

UNIT III IIOT ANALYTICS 9

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

UNIT IV IOT SECURITY 9

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

UNIT V CASE STUDY 9

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

TOTAL : 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, student will be able to

CO1: Understand the basic concepts and Architectures of Internet of Things.
CO2: Understand various IoT Layers and their relative importance.
CO3: Realize the importance of Data Analytics in IoT.
CO4: Study various IoT platforms and Security
CO5: Understand the concepts of Design Thinking.

REFERENCES

1. Industry 4.0: The Industrial Internet of Things", by Alasdair Gilchrist (Apress), 2017
2. "Industrial Internet of Things: 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.

ED4094	VEHICLE DYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

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

UNIT - I BASIS OF VIBRATION 9

Definitions, Modeling and Simulation, Global and Vehicle Coordinate System, Free, Forced, Undamped and Damped Vibration, Response Analysis of Single DOF, Two DOF, Multi DOF, Magnification factor, Transmissibility, Vibration absorber, Vibration measuring instruments, Torsional vibration, Critical speed

UNIT-II TYRES 9

Tyre forces and moments, Tyre structure, Longitudinal and Lateral force at various lip angles, rolling resistance, Tractive and cornering property of tyre. Performance of tyre on wet surface. Ride property of tyres. Magic formulae tyre model, Estimation of tyre road friction. Teston Various road surfaces. Tyre vibration

UNIT-III VERTICAL DYNAMICS 9

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

UNIT-IV LONGITUDINAL DYNAMICS AND CONTROL 9

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

UNIT-V LATERAL DYNAMICS 9

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

TOTAL= 45 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

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

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

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

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

CO5 Understand the concepts in lateral dynamics of vehicles.

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

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

ED4092 ENGINEERING FRACTURE MECHANICS L T P C
3 0 0 3

COURSE OBJECTIVES:

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

UNIT-I ELEMENTS OF SOLID MECHANICS 9

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

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

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

UNIT-III STATIONARY CRACK UNDER STATIC LOADING 9

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

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

UNIT-IV FATIGUE FAILURE AND ENVIRONMENTAL-ASSISTED FRACTURE 9

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

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

UNIT-V APPLICATIONS OF FRACTURE MECHANICS 9

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

TOTAL (L: 45)=45 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

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

REFERENCES:

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

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

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

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

COURSE OBJECTIVES:

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

UNIT I INTRODUCTION 9

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

UNIT II DESIGN FOR ADDITIVE MANUFACTURING 9

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

UNIT III VAT POLYMERIZATION AND SHEET LAMINATION PROCESSES 9

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

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

UNIT IV MATERIAL EXTRUSION AND POWDER BED FUSION PROCESSES 9

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

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

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

UNIT V JETTING AND DIRECT ENERGY DEPOSITION PROCESSES 9

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

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

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

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

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

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

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

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

REFERENCES:

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

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

ED4080 TRIBOLOGY IN DESIGN L T P C
3 0 0 3

COURSE OBJECTIVES:

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

UNIT I SURFACE INTERACTION AND FRICTION 9

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

UNIT II WEAR AND SURFACE TREATMENT 9

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

UNIT III LUBRICANTS AND LUBRICATION REGIMES 9

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

UNIT IV THEORY OF HYDRODYNAMIC AND HYDROSTATIC LUBRICATION 9

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

UNIT V HIGH PRESSURE CONTACTS AND ELASTO HYDRODYNAMIC LUBRICATION 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

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

REFERENCES:

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

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

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

COURSE OBJECTIVES:

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

UNIT I INTRODUCTION **9**

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

UNIT II WEARABLE SENSORS **9**

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

UNIT III FLEXIBLE ELECTRONICS **9**

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

UNIT VI ENERGY HARVESTING SYSTEMS **9**

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

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

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

COURSE OUTCOMES:

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

TOTAL: 45 PERIODS

REFERENCES

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

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

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

COURSE OBJECTIVES

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

UNIT-I BENDING OF PLATES AND SHELLS 9

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

UNIT-II NON-LINEAR PROBLEMS 9

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

UNIT-III DYNAMIC PROBLEM 9

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

UNIT-IV FLUID MECHANICS AND HEAT TRANSFER 9

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

UNIT-V ERROR ESTIMATES AND ADAPTIVE REFINEMENT 9

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

TOTAL= 45PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

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

REFERENCES:

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

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

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

ED4071 DESIGN OF HYBRID AND ELECTRIC VEHICLES

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

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

UNIT– I INTRODUCTION TO ELECTRIC VEHICLES **9**

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

UNIT– II ENERGYSOURCE **9**

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

UNIT–III SERIES HYBRID ELECTRIC DRIVE TRAIN DESIGN **9**

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

UNIT– IV PARALLEL HYBRID ELECTRIC DRIVE TRAIN DESIGN 9

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

UNIT–V ELECTRIC VEHICLE DRIVE TRAIN 9

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

TOTAL:45 PERIODS

COURSEOUTCOMES:

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

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

REFERENCES:

1. Ehsani,M, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”,CRC Press, 2005
2. “Hybrid Electric Vehicle Technology Assessment: Methodology, Analytical Issues, and Interim Results, ”Center for Transportation Research Argonne National Laboratory, United States Department of Energy.
3. Iqbal Hussain,“Electric & Hybrid Vehicles–Design Fundamentals” ,Second Edition, CRC Press,2011.
4. JamesLarminie,“ElectricVehicleTechnologyExplained”,JohnWiley&Sons,2003.
5. Sandeep Dhameja, “Electric Vehicle Battery Systems”, Newnes, 2000 .http://nptel.ac.in/courses/108103009/

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

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

ED4003 BEARING DESIGN AND ROTOR DYNAMICS L T P C
3 0 0 3

COURSE OBJECTIVES:

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

1. Apply and develop mathematical model of a system
2. Applying the design and suggest bearings for specific applications
3. Applying a fatigue life calculations 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 6

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 10

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 – powerloss, 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 10

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 dynamicInstability-HalffrequencywhirlandResonancewhip-bearinginstabilityandOilWhirlTechnologies to Improve the Stability of Rotor-bearing Systems--Design configurations of stable journal bearings

UNIT-V DYNAMICS OF ROTORS MOUNTED ON HYDRO DYNAMIC BEARINGS 10

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

- **CO1** Understand application of various types of bearings and their operating principles
- **CO2** Design and suggest bearings for specific applications
- **CO3** Perform fatigue life calculations for various types of bearings,
- **CO4** understand and analyze bearing behavior
- **CO5** study the dynamics of rotors mounted on Hydrodynamic Bearings

REFERENCES:

1. Neale,M.J. “Tribology Hand Book”, Butterworth Heinemann, United Kingdom2001
2. Cameron,A.“BasicLubricationTheory”,EllisHerwardLtd.,UK,1981
3. Halling,J.(Editor)–“Principles of Tribology“,Macmillian–1984
4. WilliamsJ.A.“EngineeringTribology”,OxfordUniv.Press,1994
5. S.K.Basu, S. N. Sengupta & B. B.Ahuja ,”Fundamentals of Tribology”, Prentice – Hall of India Pvt Ltd, New Delhi,2005

6 G.W.Stachowiak&A.W.Batchelor,EngineeringTribology,Butterworth-Heinemann,UK,2005

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

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

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

COURSE OBJECTIVES:

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

UNIT– I INTRODUCTIONS AND DESIGN OF HOISTS 9

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

UNIT– II DRIVES OF HOISTING GEAR 9

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

UNIT–III CONVEYORS 9

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

UNIT– IV ELEVATORS 9

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

UNIT– V INTEGRATED DESIGN 9

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

TOTAL:45 PERIODS

COURSEOUTCOMES:

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

CO1 Design hoists and brakes used in any handling applications.

CO2 Design drive mechanisms and hoisting gear for different handling applications.

CO3 Design different conveyor systems for material handling applications.

CO4 Design bucket, cage and fork lift elevators for to and fro transportation of materials in vertical direction.

CO5 Design of integrated mechanical system for machine tools, power transmission and engine parts

REFERENCES:

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

APPROVED DATA BOOKS:

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

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

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

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

COURSE OBJECTIVES:

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

UNIT I INTRODUCTION TO ESSENTIAL THEORY OF CREATIVITY 9

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

UNIT II METHODS AND TOOLS FOR CREATIVITY 9

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

UNIT III DESIGN AND APPLICATION OF CREATIVITY 9

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

UNIT IV INNOVATION PRINCIPLES & PRACTICES 9

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

UNIT V INNOVATION MANAGEMENT 9

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

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

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

REFERENCES:

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

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

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

IC4291 COMPUTATIONAL FLUID DYNAMICS L T P C
3 0 0 3

COURSE OBJECTIVES:

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

UNIT – I GOVERNING DIFFERENTIAL EQUATIONS AND DISCRETISATION TECHNIQUES 9

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

UNIT – II DIFFUSION PROCESSES: FINITE VOLUME METHOD 9

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

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

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

UNIT – IV FLOW PROCESSES: FINITE VOLUME METHOD 9

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

UNIT – V TURBULENCE MODELS 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

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

PO &CO Mapping:

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

REFERENCES:

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

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

OBJECTIVES:

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

UNIT I INTRODUCTION SUPPLY CHAIN MANAGEMENT 9

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

UNIT II SUPPLY CHAIN NETWORK DESIGN 9

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

UNIT III DEMAND AND SUPPLY IN SUPPLY CHAIN 9

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

UNIT IV SOURCING AND INVENTORY DECISIONS IN SUPPLY CHAIN 9

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

UNIT V SUPPLYCHAIN AND INFORMATION SYSTEMS 9

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

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

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

REFERENCES

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

CO-PO MAPPING:

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

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

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

OBJECTIVES:

The students will be able to

- Understand Industry 4.0
- Apply IoT and IIoT for Industry 4.0
- Understand CPS for Industry 4.0

UNIT I **9**

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

UNIT II **9**

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

UNIT III **9**

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

UNIT IV **9**

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

UNIT V **9**

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

TOTAL:45 PERIODS

OUTCOMES:

The students will be able to

- Use Industry 4.0 for Industrial Applications
- Use IoT and IIoT for Industry 4.0
- Apply smart devices Industrial Applications

TEXT BOOKS

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

AUDIT COURSES

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

OBJECTIVES

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

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6

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

UNIT IV RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6

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

TOTAL: 30 PERIODS

COURSE OUTCOMES

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

REFERENCES

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

AX4092 **DISASTER MANAGEMENT** **L T P C**
2 0 0 0

OBJECTIVES

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

UNIT I INTRODUCTION 6

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

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

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

UNIT III DISASTER PRONE AREAS IN INDIA 6

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

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

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

UNIT V RISK ASSESSMENT 6

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

TOTAL : 30 PERIODS

COURSE OUTCOMES

CO1: Ability to summarize basics of disaster
CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES

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

AX4093	CONSTITUTION OF INDIA	L	T	P	C
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COURSE OBJECTIVES

Students will be able to:

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

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

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

UNIT IV ORGANS OF GOVERNANCE

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

UNIT V LOCAL ADMINISTRATION

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION

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

TOTAL: 30 PERIODS

COURSE OUTCOMES

Students will be able to:

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

SUGGESTED READING

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

AX4094 **நற்றமிழ் இலக்கியம்** **L T P C**
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UNIT I சங்க இலக்கியம் **6**

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

UNIT II அறநெறித் தமிழ் **6**

1. அறநெறி வகுத்த திருவள்ளுவர்
   - அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புரவறிதல் 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
2. சமூகசேவை இலக்கியம் மணிமேகலை
   - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை

UNIT IV அருள்நெறித் தமிழ் **6**

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

UNIT V நவீன தமிழ் இலக்கியம் **6**

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

TOTAL: 30 PERIODS

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

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