DKONGU ENGINEERING COLLEGE
PERUNDURAI ERODE – 638 060
(Autonomous)

VISION

To be a centre of excellence for development and dissemination of knowledge in Applied Sciences, Technology, Engineering and Management for the Nation and beyond.

MISSION

We are committed to value based Education, Research and Consultancy in Engineering and Management and to bring out technically competent, ethically strong and quality professionals to keep our Nation ahead in the competitive knowledge intensive world.

QUALITY POLICY

We are committed to

- Provide value based quality education for the development of students as competent and responsible citizens.
- Contribute to the nation and beyond through research and development
- Continuously improve our services

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

To be a centre of excellence for development and dissemination of knowledge in Mechanical Engineering for the Nation and beyond.

MISSION

Department of Mechanical Engineering is committed to:

MS1: Establish itself as an excellent academic centre through expert pedagogical methods and modern laboratories to produce world class mechanical engineers.

MS2: Disseminate knowledge through seminar, conferences and continuing education programs.

MS3: Make tie-ups with industries, research centres and renowned institutions to synergize the benefit.

MS4: Contribute towards the upliftment of the society.

2018 REGULATIONS
PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Graduates of M.E. Engineering Design will

PEO1: Practice Engineering Design in the general stems of design and development of engineering products.

PEO2: Habituate continuous learning and carryout research and development in science, engineering and technology that support career growth.

PEO3: Exhibit ethical code of conduct in a professional manner to solve real-time multidisciplinary engineering design problems.

MAPPING OF MISSION STATEMENTS (MS) WITH PEOs

MS\PEO	PEO1	PEO2	PEO3
MS1	3	3	3
MS2	2	3	2
MS3	2	3	2
MS4	1	1	2

1 – Slight, 2 – Moderate, 3 – Substantial

PROGRAM OUTCOMES (POs)	
Engineering Post Graduates will be able to:	
PO1	carry out research /investigation and development work to solve practical problems.
PO2	write and present a substantial technical report/document.
PO3	use of modern engineering techniques, skills and tools for design and development of engineering products and services.

MAPPING OF PEOs WITH POs

PEO\PO	PO1	PO2	PO3
PEO1	3	3	3
PEO2	3	3	3
PEO3	3	2	2

1 – Slight, 2 – Moderate, 3 – Substantial

CURRICULUM BREAKDOWN STRUCTURE UNDER REGULATION 2018

Curriculum Breakdown Structure(CBS)	Curriculum Content (% of total number of credits of the program)	Total number of contact hours	Total number of credits
Program Core(PC)	47.22	600	34
Program Electives(PE)	25	270	18
Project(s)/Internships(PR)/Others	27.78	600	20
		Total	**72**

KEC R2018: SCHEDULING OF COURSES – M.E. (Engineering Design)

Semester	Theory/ Theory cum Practical / Practical							Internship & Projects	Special Courses	Credits
	1	2	3	4	5	6	7	8	9	
I	18AMC11 Applied Mathematics (PC-3-1-2-4)	18EDT11 Finite Element Method (PC-3-1-0-4)	18EDT12 Applied Materials Engineering (PC-3-0-0-3)	18EDT13 Engineering Design Methodology (PC-3-0-0-3)	18EDT14 Advanced Strength of Materials (PC-3-1-0-4)	18GET01 Introduction to Research (PC-3-0-0-3)	18EDL11 Design and Analysis Laboratory (PC-0-0-2-1)			22
II	18EDT21 Optimization Techniques in Design and Manufacturing (PC-3-0-0-3)	18EDC21 Mechanical Vibrations (PC-3-0-2-4)	18EDT22 Mechanism Design and Analysis (PC-3-1-0-4)	Elective-I (Professional) (PE-3-0-0-3)	Elective-II (Professional) (PE-3-0-0-3)	Elective-III (Professional) (PE-3-0-0-3)	18EDL21 Mechanism Synthesis Laboratory (PC-0-0-2-1)	18EDP21 Mini Project (PR-0-0-4-2)		23
III	Elective-IV (Professional) (PE-3-0-0-3)	Elective-V (Professional) (PE-3-0-0-3)	Elective-VI (Professional) (PE-3-0-0-3)					18EDP31 Project Work – Phase I (PR-0-0-12-6)		15
IV								18EDP41 Project Work – Phase II (PR-0-0-24-12)		12

Total Credits: 72

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M.E. DEGREE IN ENGINEERING DESIGN

CURRICULUM

(For the candidates admitted from academic year 2018-19 onwards)

SEMESTER – I

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Theory/Theory with Practical								
18AMC11	Applied Mathematics	3	1*	2*	4	50	50	100	PC
18EDT11	Finite Element Method	3	1	0	4	50	50	100	PC
18EDT12	Applied Materials Engineering	3	0	0	3	50	50	100	PC
18EDT13	Engineering Design Methodology	3	0	0	3	50	50	100	PC
18EDT14	Advanced Strength of Materials	3	1	0	4	50	50	100	PC
18GET01	Introduction to Research	3	0	0	3	50	50	100	PC
	Practical								
18EDL11	Design and Analysis Laboratory	0	0	2	1	100	0	100	PC
	Total				**22**				

*Alternate week

CA – Continuous Assessment, ESE – End Semester Examination, CBS – Curriculum Breakdown Structure

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M.E. DEGREE IN ENGINEERING DESIGN

CURRICULUM
(For the candidates admitted from academic year 2018-19 onwards)

SEMESTER – II

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Theory/Theory with Practical								
18EDT21	Optimization Techniques in Design and Manufacturing	3	0	0	3	50	50	100	PC
18EDC21	Mechanical Vibrations	3	0	2	4	50	50	100	PC
18EDT22	Mechanism Design and Analysis	3	1	0	4	50	50	100	PC
	Elective - I	3	0	0	3	50	50	100	PE
	Elective - II	3	0	0	3	50	50	100	PE
	Elective - III	3	0	0	3	50	50	100	PE
	Practical								
18EDL21	Mechanism Synthesis Laboratory	0	0	2	1	100	0	100	PC
18EDP21	Mini Project	0	0	4	2	100	0	100	PR
	Total				**23**				

CA – Continuous Assessment, ESE – End Semester Examination, CBS – Curriculum Breakdown Structure

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638 060
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M.E. DEGREE IN ENGINEERING DESIGN

CURRICULUM

(For the candidates admitted from academic year 2018-19 onwards)

SEMESTER – III

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Theory/Theory with Practical								
	Elective - IV	3	0	0	3	50	50	100	PE
	Elective - V	3	0	0	3	50	50	100	PE
	Elective - VI	3	0	0	3	50	50	100	PE
	Practical								
18EDP31	Project Work Phase I	0	0	12	6	50	50	100	PR
	Total				**15**				

CA – Continuous Assessment, ESE – End Semester Examination, CBS – Curriculum Breakdown Structure

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638 060
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M.E. DEGREE IN ENGINEERING DESIGN

CURRICULUM

(For the candidates admitted from academic year 2018-19 onwards)

SEMESTER – IV

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Practical								
18EDP41	Project Work Phase II	0	0	24	12	50	50	100	PR
	Total				**12**				

CA – Continuous Assessment, ESE – End Semester Examination, CBS – Curriculum Breakdown Structure

Total Credits: 72

LIST OF PROFESSIONAL ELECTIVES						
Course Code	**Course Title**	**Hours/Week**			**Credit**	**CBS**
		L	**T**	**P**		
SEMESTER II						
18CCE02	Safety in Engineering Industry	3	0	0	3	PE
18CCE04	Design for Manufacture and Assembly	3	0	0	3	PE
18MTE01	Fluid Power System Design	3	0	2	4	PE
18EDE01	Applied Finite Element Analysis	3	1	0	4	PE
18EDE02	Mechanical Behaviour of Materials	3	0	0	3	PE
18EDE03	Experimental Stress Analysis	3	0	2	4	PE
18EDE04	Fracture Mechanics	3	0	0	3	PE
18EDE05	Designing with Newer Materials	3	0	0	3	PE
18EDE06	Tribology in Design	3	0	0	3	PE
18EDE07	Advanced Tool Design	3	0	0	3	PE
18EDE08	Design of Material Handling Equipment	3	0	0	3	PE
SEMESTER III						
18CCE05	Product Data Management	3	0	0	3	PE
18CCE06	Modeling and Analysis of Manufacturing Systems	3	0	0	3	PE
18CCE08	Reliability Engineering	3	0	0	3	PE
18MTC11	Computer Numerically Controlled Machines	3	0	2	4	PE
18MTT13	Sensors and Instrumentation	3	0	0	3	PE
18MTE13	MEMS Design	3	0	0	3	PE
18EDE09	Vibration and Noise Control	3	0	2	4	PE
18EDE10	Instrumentation and Measurements	3	0	0	3	PE
18EDE11	Design of Heat Exchangers	3	0	0	3	PE
18EDE12	Productivity Management and Reengineering	3	0	0	3	PE
18EDE13	Mechanics of Composite Materials	3	0	2	4	PE
18EDE14	Applied Engineering Acoustics	3	0	0	3	PE

18AMC11 APPLIED MATHEMATICS

(Common to Engineering Design & CADCAM branches)

L	T	P	Credit
3	1*	2*	4

Preamble	This course will help the students to identify, formulate and solve problems in mechanical engineering using mathematical tools such as probability, transforms and numerical techniques.
Prerequisites	Probability, Calculus, Laplace and Fourier Transform.

UNIT – I **9**

Random Variables and Probability Distributions: Random variable – Probability mass function – Probability density function – Moments – Moment generating functions – Discrete distributions – Binomial distribution – Poisson distribution – Geometric distribution – Continuous distributions - Uniform distribution – Exponential distribution – Normal distribution.

UNIT – II **9**

Two Dimensional Random Variables: Joint distributions – Marginal and conditional distributions - Covariance – Simple linear correlation – Rank Correlation – Linear Regression.

UNIT – III **9**

Calculus of Variations: Concept of variation and its properties – Euler's equation – Functional dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries – Isoperimetric problems - Direct methods : Ritz and Kantorovich methods.

UNIT – IV **9**

Transform Methods: Laplace transform methods: Solution of one-dimensional wave equation - Solution of one-dimensional heat equation – **Fourier transform methods:** Solution of Diffusion equation – Solution of one-dimensional wave equation – Solution of Laplace equation.

UNIT – V **9**

Numerical Solution of Partial Differential Equations: Solution of one dimensional wave equation – Solution of diffusion equation – Explicit and implicit methods – Solution of Elliptic equation: Solution of Laplace equation – Solution of Poisson equation.

List of Experiments:

1. Finding probability using discrete distributions
2. Identifying probability by means of continuous distributions
3. Determine the marginal and conditional distributions
4. Correlation and Regression lines
5. Finding extremum of a functional
6. Integrals involving more than one independent variable
7. Finding solution of the functional.
8. Solution of Parabolic and Hyperbolic equations by Laplace transform techniques
9. Solution of Laplace equation by Fourier Transform
10. Numerical solution of wave equation
11. Solution of Laplace equation by numerical technique
12. Numerical solution of Poisson's equation

Lecture:45, Tutorial & Practical:15, Total: 60

REFERENCES:

1. Richard Johnson, Miller & Freund's, "Probability and Statistics for Engineers", 9th Edition, Pearson Education, 2016.
2. Gupta A.S., "Calculus of Variations with Applications", 12th Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2015.
3. Sankara Rao K., "Introduction to Partial Differential Equations", 3rd Edition, PHI Learning Pvt. Ltd., 2011.
4. Curtis F. Gerald, Patrick O.Wheatley, "Applied Numerical Analysis", 7th Edition, Pearson Education India, 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	apply probabilistic concepts in engineering problems	Applying (K3)
CO2:	measure the relationship between variables	Applying (K3)
CO3:	solve variational problems that appear in engineering design	Applying (K3)
CO4:	apply Laplace and Fourier transforms to solve initial and boundary value problems in Partial differential equations	Applying (K3)
CO5:	use numerical techniques to solve partial differential equations	Applying (K3)
CO6:	apply MATLAB to identify the probability and association between random variables	Applying (K3), Manipulation (S2)
CO7:	use MATLAB to handle engineering problems involving functional and Partial differential equations	Applying (K3), Manipulation (S2)
CO8:	use MATLAB to find numerical solution of PDE	Applying (K3), Manipulation (S2)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1			1
CO2			1
CO3	1		1
CO4	1		2
CO5	3		2
CO6	1		1
CO7	3		2
CO8	1		2

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

* Alternate Week

18EDT11 FINITE ELEMENT METHOD
(Common to Engineering Design & CADCAM Branches)

L	T	P	Credit
3	1	0	4

Preamble	To familiarize the fundamental concepts of finite element analysis with the principles involved in discretization and to assemble stiffness matrices and force vectors for simple/advanced elements.
Prerequisites	Strength of Materials

UNIT – I **9**

One Dimensional Applications: Historical Background - Weighted Residual Methods - Basic Concept of FEM - Variational Formulation - Ritz Method - Finite Element Modelling - Element Equations - Linear and Quadratic Shape functions - Bar and Beam Elements - Galerkin‟s method - Application of structural bar and heat transfer.

UNIT – II **9**

Two Dimensional Scalar Variable Applications: Basic boundary value problems in two dimensions - Constant Strain Triangular element - Higher order elements – Poisson’s and Laplace’s Equation - Weak Formulation - Element Matrices and Vectors - Load consideration: Point load and Pressure - Plane stress and Plane strain conditions. Two dimensional heat transfer: Finite element equation - Potential energy approach - Conduction - Side and face convection - Internal heat generation. Application of Structural and Heat transfer.

UNIT – III **9**

Two Dimensional Vector Variable Problems: Introduction to Axi-symmetric Formulation - linear element - Elemental Element Matrices and Vectors - Load Consideration - Application of Structural and Heat Transfer Problems - Application of Plane Trusses.

UNIT – IV **9**

Iso-Parametric Formulation: Natural Co-ordinate Systems - Lagrangian Interpolation Polynomials - Isoparametric Elements - Formulation - Numerical Integration - Gauss Quadrature - One and two dimensional Integration - Rectangular elements - Serendipity elements - Finite element modeling - Illustrative Examples.

UNIT – V **9**

Structural Dynamics and Refinements: Dynamic Analysis - Equation of Motion – Mass and damping matrices - Free vibration analysis - Natural frequencies of Longitudinal, Transverse and Torsional vibration - Introduction to transient field problems. Refinement techniques - h and p elements.

Lecture:45, Tutorial:15, Total: 60

REFERENCES:

1. Rao Singiresu S., “The Finite Element Method in Engineering”, 6th Edition, Butterworth-Heinemann, 2017.
2. Reddy J.N., “An Introduction to the Finite Element Method”, 3rd Edition, McGraw Hill, Edition, 2009.
3. Logan D.L., “A First Course in the Finite Element Method”, 6th Edition, Cengage Learning, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	comprehend the finite element concepts and derive the element matrix equation for solving one dimensional structural problems used for designing engineering components	Analyzing (K4)
CO2:	compute the results for a 3D domain using simple two dimensional assumptions for different applications	Analyzing (K4)
CO3:	solve and analyze the engineering problems using axisymmetric assumptions	Analyzing (K4)
CO4:	comprehend the effective usage of isoparametric elements and numerical integration techniques used in FEM	Analyzing (K4)
CO5:	solve the structural dynamic problems in various applications	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3	1	3
CO2	2		2
CO3	2		2
CO4	2		2
CO5	2		2

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

18EDT12 APPLIED MATERIALS ENGINEERING

(Common to Engineering Design & CADCAM Branches)

L	T	P	Credit
3	0	0	3

Preamble	The course deals with the study on structure –property relationship of ferrous metals, analysis on their morphological and technical characteristics, purpose of heat treatment and related techniques.
Prerequisites	Fundamentals of Material Science and Engineering

UNIT – I **9**

Introduction of Physical Metallurgy: Concept of phase diagram - phases and micro constituents in steels and cast irons - Equilibrium and non-equilibrium cooling of various Fe-C alloys - Effects of alloying elements and cooling rate on structure and properties of steels and cast irons.

UNIT – II **9**

Introduction to Heat Treatment and Specifications: Time Temperature Transformation (TTT) diagram and Continuous Cooling Transformation (CCT) diagram - hardenability, measurement, annealing - normalizing - hardening and tempering - heat treatment furnaces - atmospheres - quenching media - case hardening techniques. Types of steels: plain carbon steels - alloy steels - tool steels - stainless steels - types of cast iron – compositions - properties and applications.

UNIT – III **9**

Characterization of Materials: Stereographic projections - X-ray diffraction - Crystal structure and phase identification - Residual stress measurement and other applications. Scanning Electron Microscopy (SEM) – Optics and performance of SEM - Image interpretation - Crystallographic information - Analytical microscopy. Transmission Electron Microscopy (TEM) - Construction and operation of TEM - Electron diffraction - Image interpretation.

UNIT – IV **9**

Corrosion Engineering: Degradation of Materials: Oxidation - Corrosion and wear. Basics of thermodynamics and kinetics of oxidation and corrosion - Pourbaix diagram – Polarization - Different types of corrosion - Atmospheric, galvanic, pitting, crevice corrosion, intergranular and de-alloying - Stress corrosion cracking - Season cracking - Hydrogen damage and radiation damage - Hydrogen embrittlement - Corrosion rate measurement.

UNIT – V **9**

Metallurgical Failure Analysis and Plastic Deformation: Stages of failure analysis - Classification and identification of various types of fracture. Overview of fracture mechanics - Characteristics of ductile and brittle fracture. General concepts - Fracture characteristics revealed by microscopy - Factors affecting fatigue life – Creep - Stress rupture - Elevated temperature fatigue - Metallurgical instabilities - Environmental induced failure - Some case studies on failures - Basics of plastic deformation: Mohr's circle - yield theories - plastic stress - strain relationship - mechanical working - work hardening.

Total: 45

REFERENCES:

1. Avner, S. H., "Introduction to Physical Metallurgy", 2nd Edition, McGraw Hill, 2017.
2. Philips V. A., "Modern Metallographic Techniques and their Applications", Wiley Interscience, 1972.
3. Fontana. M.G., "Corrosion Engineering", 3rd Edition, Tata McGraw Hill, 2005.
4. Colangelo V.J. and Heiser F.A., "Analysis of Metallurgical Failures", John Wiley and Sons Inc. New York, USA, 1987.
5. Hosford W.F. and Caddell R.M., "Metal Forming Mechanics and Metallurgy", Printice Hall, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	demonstrate the microstructures of steels and cast irons	Analyzing (K4)
CO2:	apply heat treatment processes for various applications	Applying (K3)
CO3:	determine the microstructure for utilizing the material characterization	Applying (K3)
CO4:	analyze the causes and impacts of corrosion	Analyzing (K4)
CO5:	solve the problems in plastic deformation of materials and to analyse the failures	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	1	1	3
CO2	3	2	3
CO3	3	2	3
CO4	3	3	3
CO5	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom’s Taxonomy

18EDT13 ENGINEERING DESIGN METHODOLOGY

L	T	P	Credit
3	0	0	3

Preamble	To impart knowledge on various concepts in engineering design like product design process, tools for engineering design, material selection & processing, and ethical issues in design.
Prerequisites	Quality Engineering, Total quality managements, Fundamentals of design and manufacturing courses

UNIT – I **9**

The Product Design Process: Importance of Product Design - Design Process - Consideration of a Good Design - Morphology of Design - Concurrent Engineering - CAD and CAM - Product and Process Cycle. Need identification- Identifying customer needs – Benchmarking - Customer requirements. Case study.

UNIT – II **9**

Tools in Engineering Design: Concept Generation - Creativity and Problem solving - Creative methods. Embodiment Design - Product Architecture - Configuration Design - Parametric Design - Design Guidelines - Industrial Design - Human factors in Design. Modeling - Role of models in Engineering Design - Mathematical modeling - Geometric modeling - Finite element modeling - Rapid Prototyping. Case study.

UNIT – III **9**

Material Selection and Materials in Design: Relation of Material selection to Design – Performance characteristics of Materials - Material selection process - Value analysis – Recycling - Design for brittle fracture - Design for fatigue failure - Design for corrosion resistance - Design with plastics.

UNIT – IV **9**

Material Processing and Design: Classification of manufacturing processes and their role in design - Factors determining the process selection - Design for manufacturing - Design for casting - Design for forging - Design for sheet metal forming - Design for machining - Design for welding - Design for heat treatment - Design for plastic processing. Case study.

UNIT – V **9**

Design and Quality Engineering, Legal and Ethical Issues in Design: Design for environment - Design for Reliability - Design for safety - Quality Design - Optimisation Methods. The origin of laws - Contracts - Liability - Tort Law - Product Liability - Protecting Intellectual Property - Legal and Ethical Domains - Codes of ethics - Solving ethical conflicts. Case study.

Total: 45

REFERENCES:

1. Dieter George E., “Engineering Design: A Materials and Processing Approach”, 3rd Edition, McGraw-Hill, International Edition, Singapore, 2000.
2. Ulrich Karl T. and Eppinger Steven D., “Product Design and Development”, 5th Edition, McGraw-Hill, International Edition, 2011.
3. Martyn S. Ray, “Elements of Engineering Design”, Printice Hall Incorporation, USA, 1985.
4. Gerhard Pahl and Beitz W., “Engineering Design: A Systematic Approach”, Springer - Verlag, NewYork, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	apply the knowledge on various design process and methods for product design	Applying (K3)
CO2:	implement the various design modeling, design methods and optimization tools for tool design.	Applying (K3)
CO3:	apply the knowledge on the material selection process by considering the various design factors.	Analyzing (K4)
CO4:	implement the various manufacturing process with design of materials for various applications.	Applying (K3)
CO5:	implement the knowledge on legal aspect, environmental, quality and safety aspect for designing of materials.	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2	2	2
CO2	3	3	3
CO3	3	3	2
CO4	2	2	2
CO5	2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom’s Taxonomy

18EDT14 ADVANCED STRENGTH OF MATERIALS

(Approved Data book may be permitted)

L	T	P	Credit
3	1	0	4

Preamble	Advanced Strength of Materials takes this important subject into areas of greater difficulty, masterfully bridging its elementary aspects and its most formidable advanced reaches. The concepts here explored in depth include the three-dimensional theory of elasticity, Stress and strain relations and Compatibility equations. It also covers the Shear center estimation, Unsymmetrical bending, stress analysis on Curved beams, torsion on non-Circular members and membrane stresses in shells, rotating discs, buckling of plates, and the contact stresses.
Prerequisites	Strength of Materials, Engineering Mechanics

UNIT – I **9**

Elasticity: Stress - Strain relation and General equation of elasticity in Cartesian , polar ,cylindrical and Spherical coordinates - Differential equation of equilibrium - Compatibility equation - Boundary conditions - Representations of three dimensional stress in tension - Generalized Hooke's law - St.Vennant's Principle - Plane strain, plane stress – Airy's stress function.

UNIT – II **9**

Unsymmetrical Bending and Shear Centre: Stresses and deflection in beams subjected to unsymmetrical loading - Kern of a section. Location of shear centre for various sections - shear flow.

UNIT – III **9**

Curved Beams: Curved flexural members - Circumferential and radial stresses - Deflection and radial curved beam with re-strained ends - Closed ring subjected to concentrated load and uniform load - Chain link and Crane hooks.

UNIT – IV **9**

Stresses due to Rotation and Contact Stresses: Stresses due to rotation **-** Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness - Allowable speed. Contact Stresses - Hertz equation for contact stresses - Applications to rolling contact elements.

UNIT – V **9**

Stresses in Flat Plates and Torsion of Non Circular Sections: Stresses in circular and rectangular plates due to various types of loading and end conditions - Buckling of plates. Torsion of rectangular cross section - St.Vennant Theory - ElasticMembrane analogy - Torsional stresses in hollow thin walled tubes.

Lecture:45, Tutorial:15, Total: 60

REFERENCES:

1. Timoshenko S., "Strength of Materials", 3rd Edition, CPS Publishers, 2008.
2. Timoshenko and Goodler, "Theory of Elasticity", 3rd Edition, McGraw-Hill, 2006.
3. Den Hartog J.P., "Advanced Strength of Materials", Dover Publications, New York, 1987.
4. Sadhu Singh, "Applied Stress Analysis", Khanna Publishers, New Delhi, 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	calculate the stresses and strains at a point in three dimensional load	Evaluating (K5)
CO2:	calculate analytically the shear center and stresses in unsymmetrical bending	Evaluating (K5)
CO3:	determine the stresses and deflections in curved beams, chains and links	Evaluating (K5)
CO4:	determine the stresses due to rotation and contact stresses	Evaluating (K5)
CO5:	estimate the stresses & deflection in plates and the torsion in noncircular members	Evaluating (K5)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3
CO4	3	2	3
CO5	3	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom’s Taxonomy

18GET01 INTRODUCTION TO RESEARCH

(Common to Engineering and Technology Branches)

L	T	P	Credit
3	**0**	**0**	**3**

Preamble	To familiarize the fundamental concepts/techniques adopted in research, problem formulation and patenting and to disseminate the process involved in collection, consolidation of published literature and rewriting them in a presentable form using latest tools.
Prerequisites	Nil

UNIT – I **9**

Concept of Research: Meaning and Significance of Research: Skills, Habits and Attitudes for Research - Time Management - Status of Research in India. Why, How and What a Research is? - Types and Process of Research - Outcome of Research - Sources of Research Problem - Characteristics of a Good Research Problem - Errors in Selecting a Research Problem - Importance of Keywords - Literature Collection – Analysis - Citation Study - Gap Analysis - Problem Formulation Techniques.

UNIT – II **9**

Research Methods and Journals: Interdisciplinary Research - Need for Experimental Investigations - Data Collection Methods - Appropriate Choice of Algorithms / Methodologies / Methods - Measurement and Result Analysis - Investigation of Solutions for Research Problem - Interpretation - Research Limitations. Journals in Science/Engineering - Indexing and Impact factor of Journals - Citations - h Index - i10 Index - Journal Policies - How to Read a Published Paper - Ethical issues Related to Publishing - Plagiarism and Self-Plagiarism.

UNIT – III **9**

Paper Writing and Research Tools: Types of Research Papers - Original Article/Review Paper/Short Communication/Case Study - When and Where to Publish? - Journal Selection Methods. Layout of a Research Paper - Guidelines for Submitting the Research Paper - Review Process - Addressing Reviewer Comments. Use of tools / Techniques for Research - Hands on Training related to Reference Management Software - EndNote, Software for Paper Formatting like LaTeX/MS Office. Introduction to Origin, SPSS, ANOVA etc., Software for detection of Plagiarism.

UNIT – IV **9**

Effective Technical Thesis Writing/Presentation: How to Write a Report - Language and Style - Format of Project Report - Use of Quotations - Method of Transcription Special Elements: Title Page - Abstract - Table of Contents - Headings and Sub-Headings - Footnotes - Tables and Figures - Appendix - Bibliography etc. - Different Reference Formats. Presentation using PPTs.

UNIT – V **9**

Nature of Intellectual Property: Patents - Designs - Trade and Copyright. Process of Patenting and Development: Technological research - innovation - patenting - development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents.

Total: 45

REFERENCES:

1. DePoy, Elizabeth, and Laura N. Gitlin, “Introduction to Research-E-Book: Understanding and Applying Multiple Strategies”, Elsevier Health Sciences, 2015.
2. Walliman, Nicholas, “Research Methods: The basics”, Routledge, 2017.
3. Bettig Ronald V., “Copyrighting culture: The political economy of intellectual property”, Routledge, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	list various stages in research/patenting and categorize the quality of journals	Analyzing (K4)
CO2:	formulate a research problem from published literature/journal papers	Evaluating (K5)
CO3:	write, present a journal paper/ project report using latest tools in proper format	Creating (K6)
CO4:	select suitable journal and submit a research paper	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3	2	1
CO2	3	2	3
CO3	3	3	1
CO4	3	2	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

18EDL11 DESIGN AND ANALYSIS LABORATORY

(Common to Engineering Design & CADCAM Branches)

L	T	P	Credit
0	**0**	**2**	**1**

Preamble	Design and analysis laboratory is the use of computer systems to aid in the creation, Modification, analysis, or optimization of a design. Analysis software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing.
Prerequisites	Strength of materials, Design of machine elements, Modeling skill, Technical drawing reading skill, Knowledge in modeling and analysis software.

List of Exercises / Experiments :

1. Modeling and Assembly of component using Creo
2. Modeling a component using Creo, Importing to ANSYS and Meshing
3. Finding shear Force and Bending Moment diagram using ANSYS APDL
4. Meshing a component using ANSYS WORKBENCH
5. Structural Analysis using ANSYS WORKBENCH
6. Non-Linear structural contact analysis of a component using ANSYS
7. Thermal Analysis of a component using ANSYS APDL
8. Modal Analysis of a structure using ANSYS APDL
9. Harmoic Analysis using ANSYS APDL
10. Coupled Field Analysis using ANSYS APDL

Total: 30

REFERENCES / MANUALS / SOFTWARES:

1.	Laboratory manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	analyze the problem boundary conditions with various fields using analysis software	Applying (K3), Manipulation(S2)
CO2:	model and analyze the structural members with external load for different applications	Applying (K3), Precision(S3)
CO3:	analyze the non-linear structural, thermal and coupled field problems for various applications	Applying (K3), Precision(S3)
CO4:	analyze the mode shape and critical frequency of the structural component	Applying (K3), Precision(S3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3	3	3
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

18EDT21 OPTIMIZATION TECHNIQUES IN DESIGN AND MANUFACTURING

(Common to Engineering Design & CADCAM branches)

L	T	P	Credit
3	0	0	3

Preamble	This course emphasis the application of optimization techniques, tools and methods in the field of Engineering.
Prerequisite	Fundamentals of Operation Research and Mathematical knowledge.

UNIT – I **9**

Introduction: Introduction to optimum design-global and local – Problems - General Characteristics of mechanical elements-adequate and optimum design-general principles of optimization, formulation of objective function, design constraints – Classification of optimization problem -Saddle point-Single variable optimization-Multi variable optimization with no constraints.

UNIT – II **9**

Unconstrained Optimization Techniques: Single variable and multivariable optimization with constraints, Techniques of unconstrained minimization -Golden section, pattern and gradient search methods - Interpolation methods -Quadratic function method.

UNIT – III **9**

Constrained and Advanced Optimization Techniques: Optimization with equality and inequality constraints - Indirect methods using penalty functions, Lagrange multipliers; Geometric programming-Constrained, mixed inequality and unconstrained minimization; Introduction - GA, SA and NN based on optimization - Fuzzy systems - Taguchi Technique - Parallel processing.

UNIT – IV **9**

Static Applications: Structural applications – Design of simple truss members-Reanalysis techniques Design applications -Design of simple axial, transverse loaded members for minimum cost, maximum weight - Design of shafts and torsionally loaded members – Design of springs.

UNIT – V **9**

Dynamic Applications: Optimum design of single and two degree of freedom systems, vibration absorbers. Optimum design of simple linkage mechanisms. Case study: optimization of process parameters in production operation.

Total: 45

REFERENCES:

1. Rao Singaresu S., “Engineering Optimization – Theory and Practice”, 4th Edition, New Age International Pvt. Ltd., New Delhi, 2009.
2. Kalyanamoy Deb, “Optimization for Engineering Design Algorithms and Examples”, 2nd Edition, Prentice Hall of India Pvt. Ltd., 2012.
3. Goldberg D.E., “Genetic algorithms in search, optimization and machine”, 4th Edition, Barnen, Addison Wesley, New York, 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	build an optimization problems for design and manufacturing applications	Evaluating (K5)
CO2:	compute the optimum value for unconstrained optimization problem	Evaluating (K5)
CO3:	solve the optimization problem by various techniques	Evaluating (K5)
CO4:	design the stress members and shafts using reanalysis techniques	Applying (K3)
CO5:	optimize the influencing parameters for linkages and vibratory systems	Evaluating (K5)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3
CO4	3	2	3
CO5	2	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

18EDC21 MECHANICAL VIBRATIONS

L	T	P	Credit
3	0	2	4

Preamble	Mechanical vibration is the measurement of a periodic process of oscillations with respect to an equilibrium point. This syllabus provides essential concepts involving vibration analysis, uncertainty modeling, and vibration control. It also gives good fundamental vibrating systems such as beams, strings, plates and membranes, vibration isolation, critical speeds, the balancing of rotating and reciprocating machinery.
Prerequisites	Fundamentals of Mathematics, Fundamentals of Dynamics of Machines and Fundamentals of strength of materials

UNIT – I **9**

Fundamentals of Vibration and Single Degree of Freedom System: Review of Single degree freedom systems – Response to arbitrary periodic, Excitations- Duhamel's Integral – Impulse Response function – Virtual work – Lagrange's equation – Single degree freedom forced vibration with elastically coupled viscous dampers – System Identification from frequency response – Transient Vibration.

UNIT – II **9**

Two Degree Freedom System: Free vibration of spring-coupled system – mass coupled system – Vibration of two degree freedom system – Forced vibration – Vibration Absorber – Vibration isolation.

UNIT – III **9**

Multi-Degree Freedom System: Normal mode of vibration – Flexibility Matrix and Stiffness matrix – Eigen values and Eigen vectors – Orthogonal properties – Modal matrix-Modal Analysis – Forced Vibration by matrix inversion – Modal damping in forced vibration – Numerical methods for fundamental frequencies.

UNIT – IV **9**

Vibration of Continuous Systems: Systems governed by wave equations – Vibration of strings – vibration of rods – Euler Equation for Beams – Effect of Rotary inertia and shear deformation – Vibration of plates.

UNIT – V **9**

Experimental Methods in Vibration Analysis: Vibration instruments – Vibration exciters Measuring Devices – Analysis – Vibration Tests – Free and Forced Vibration tests. Examples of Vibration tests – Industrial, case studies.

List of Experiments:

1. Determination of natural frequency of a steel beam.
2. Fault identification of ball bearing through time domain and frequency signal.
3. Model analysis of plates and beams.
4. Condition monitoring on spur gear using vibration signal.
5. Condition monitoring on lathe machines.

Lecture:45, Practical:30, Total: 75

REFERENCES:

1. Singh V.P., "Mechanical Vibrations", Dhanpat Rai & Co. Ltd., New Delhi, 2014.
2. Den Hartog J.P., "Mechanical Vibrations," 3rd Edition, Crastre Press, 2013.
3. Rao S.S., "Mechanical Vibrations", 5th Edition, Prentice Hall, 2004.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	solve and identify the frequency response of single degree of freedom system	Analyzing (K4)
CO2:	solve and design vibration absorber for the two degrees of freedom system	Analyzing (K4)
CO3:	solve and determine the natural frequency of Multi degrees of freedom system	Analyzing (K4)
CO4:	solve and analyse the vibration characteristics of continuous system	Evaluating (K5)
CO5:	analyse and understand the vibration measuring instruments and machine signature	Evaluating (K5)
CO6:	determine the natural frequency of steel beam	Analyzing (K4), Manipulation (S2)
CO7:	identify the defects in bearing using vibration signals	Evaluating (K5), Precision (S3)
CO8:	identify the defects in gear using vibration signals	Evaluating (K5), Precision (S3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	1	2	1
CO2	1	3	2
CO3	1	3	2
CO4	1	3	1
CO5	1	3	2
CO6	1	3	2
CO7	1	3	2
CO8	1	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

18EDT22 MECHANISM DESIGN AND ANALYSIS

L	T	P	Credit
3	1	0	4

Preamble	To study the displacement, velocity and acceleration of various complex mechanisms through various acceleration methods and to develop the various mechanisms through design, analysis and simulation with an ability to use the various mechanisms in real life problems effectively.
Prerequisites	Fundamentals of kinematic and kinetic, Basic of vector loop equation, Basic drawing skill.

UNIT – I **9**

Fundamental of Kinematics: Review of fundamentals of kinematics - Mobility Analysis – Formation of one D.O.F of Complex Mechanism - Kinematic Inversion. Position Analysis – Vector loop equations for Four bar, Slider crank, Inverted slider crank, Geared five bar and Six bar linkages.

UNIT – II **9**

Kinematic Analysis: The velocity and acceleration Analysis– simple four bar linkage mechanism and Plane complex mechanism – Normal acceleration-Goodman‟s indirect method- Auxiliary point method.

UNIT – III **9**

Path Curvature Theory: Fixed and moving centrodes, inflection points and inflection circle. Euler Savary equation, graphical constructions – cubic of stationary curvature – Bobillier theorem.

UNIT – IV **9**

Synthesis of Mechanisms: Type synthesis – Number synthesis – Associated linkage concept. Dimensional synthesis – Function generation, Path generation, Motion generation. Two, Three and Four position synthesis- Graphical methods. Cognate Linkages -Coupler curve synthesis-Bloch‟s method of synthesis- Design of six-bar mechanisms.

UNIT – V **9**

Dynamics and Spatial Mechanism Analysis: Static force and Inertia force analysis of simple mechanism - Graphical method. Mobility of four bar spatial linkage – Wobble plate mechanism - Kinematic analysis of spatial RSSR mechanism – Denavit – Hartenberg parameters. Forward and Inverse kinematics of robotic manipulators.

Lecture:45, Tutorial:15, Total: 60

REFERENCES:

1. Shigley J.E., Pennock G.R. and Uicker J.J., “Theory of Machines and Mechanisms”, 4th Edition, McGraw Hill, New York, 2016.
2. Rattan S.S., “Theory of Machines”, 3rd Edition, Tata McGraw Hill Education, New York, 2014.
3. Ghosh Amitabha and Mallik Asok Kumar, “Theory of Mechanism and Machines”, 3rd Edition, East West Press, New Delhi, 2015.
4. Nortron R.L., “Design of Machinery”, 3rd Edition, Tata McGraw Hill, New Delhi, 2005.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	construct the one D.O.F of the complex mechanism by changing the links and find out the position of links in various mechanisms	Analyzing (K4)
CO2:	analyze the velocity and acceleration of the various plane complex mechanisms by using various methods	Evaluating (K5)
CO3:	determine the path of curvature of the various plane mechanisms	Evaluating (K5)
CO4:	synthesis the various mechanism links by different synthesis methods	Creating (K6)
CO5:	analyze the static and dynamics force of the mechanism and different spatial robotics mechanisms	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3	3	2
CO2	3	2	3
CO3	3	2	1
CO4	3	2	1
CO5	3	2	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18EDL21 MECHANISM SYNTHESIS LABORATORY

L	T	P	Credit
0	0	2	1

Preamble	The aim of this course is to design, synthesis and simulate the various possible mechanisms using analysis tools.
Prerequisites	Engineering mechanics, kinematics and dynamics of links, Strength of materials, Modeling skill, Technical drawing reading skill, Knowledge in modeling and analysis software.

List of Exercises / Experiments:

1. Static force analysis of simple mechanisms using ANSYS.
2. Static force analysis of plane complex mechanism using ANSYS.
3. Kinematic analysis of slider crank using ADAMS.
4. Kinematic analysis of four bar mechanism using ADAMS.
5. Kinematic analysis of one degree of freedom of pendulum using ADAMS.
6. Kinematic Analysis of the press mechanism using ADAMS.
7. Kinematic Analysis of lift mechanism using ADAMS.
8. Kinematic Analysis of the Atkinson mechanism using ADAMS.

Total: 30

REFERENCES / MANUALS / SOFTWARES:

1. Norton R.L., "Design of Machinery", 5th Edition, Tata McGrawHill, New Delhi, 2011.
2. www.mscsoftware.com/product/adams

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	analyze the static force distribution in simple and complex mechanism	Evaluating (K5), Manipulation (S2)
CO2:	analyze the kinematics parameters in simple and complex mechanisms for improving the output motions	Evaluating (K5), Manipulation (S2)
CO3:	analyze the velocity and acceleration of simple and complex mechanisms	Analyzing (K4), Manipulation (S2)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2	2	3
CO2	3	2	3
CO3	3	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

18CCE02 SAFETY IN ENGINEERING INDUSTRY

(Common to CADCAM, Engineering Design & Mechatronics branches)

L	T	P	Credit
3	0	0	3

Preamble	The course deals with the study on hazards involved in performing several machining operations, safety precautions and guidelines to be followed while handling machines and industrial equipments utilizing safety devices for specified operations and types of guarding systems in machines for safe operation.
Prerequisites	Manufacturing Technology, Material Removal Processes, Thermal Engineering.

UNIT – I **9**

Safety in Metal Working Machinery and Wood Working Machines: General safety rules, principles, maintenance, Inspections of turning machines, boring machines, milling machine, planning machine and grinding machines, CNC machines, Wood working machinery, types, safety principles, electrical guards, work area, material handling, inspection, standards and codes- saws, types, hazards.

UNIT – II **9**

Principles of Machine Guarding: Guarding during maintenance, Zero Mechanical State (ZMS), Definition, Policy for ZMS – guarding of hazards - point of operation protective devices, machine guarding, types, fixed guard, interlock guard, automatic guard, trip guard, electron eye, positional control guard, fixed guard fencing- guard construction- guard opening. Selection and suitability: lathe-drilling-boring-milling-grinding-shaping-sawing-shearing-presses- forgehammer – flywheels - shafts couplings-gears-sprockets wheels and chains- pulleys and belts-authorized entry to hazardous installations-benefits of good guarding systems.

UNIT – III **9**

Safety in Welding and Gas Cutting: Gas welding and oxygen cutting, resistances welding, arc welding and cutting, common hazards, personal protective equipment, training, safety precautions in brazing, soldering and metalizing – explosive welding, selection, care and maintenance of the associated equipment and instruments – safety in generation, distribution and handling of industrial gases - colour coding – flashback arrestor – leak detection - pipe line safety - storage and handling of gas cylinders.

UNIT – IV **9**

Safety in Cold Forming and Hot Working of Metals: Cold working, power presses, point of operation safe guarding, auxiliary mechanisms, feeding and cutting mechanism, hand or foot-operated presses, power press electric controls, power press set up and die removal, inspection and maintenance-metal sheers-press brakes. Hot working safety in forging, hot rolling mill operation, safe guards in hot rolling mills – hot bending of pipes , hazards and control measures. Safety in gas furnace operation, cupola, crucibles, ovens, foundry health hazards, work environment, material handling in foundries, foundry production cleaning and finishing foundry processes.

UNIT – V **9**

Safety in Finishing, Inspection and Testing: Heat treatment operations, electro plating, paint shops, sand and shot lasting, safety in inspection and testing, dynamic balancing, hydro testing, valves, boiler drums and headers, pressure vessels, air leak test, steam testing, safety in radiography, personal monitoring devices, radiation hazards, engineering and administrative controls, Indian Boilers Regulation. Health and welfare measures in engineering industry-pollution control in engineering industry- industrial waste disposal.

Total: 45

REFERENCES:

1. John V. Grimaldi and Rollin H. Simonds, "Safety Management", 5th Edition, All India Travelers Book Seller, New Delhi, 1991.
2. Krishnan N.V., "Safety Management in Industry", Jaico Publishers, 1996.
3. Jane Blunt, Nigel C. Balchin, "Health and Safety in Welding and Allied Processes", 5th Edition, Woodhead Publishing Ltd., U.K., 2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	work safely in metal and wood working machines	Applying (K3)
CO2:	identify proper guarding for different applications	Analyzing (K4)
CO3:	work safely in welding and allied process	Analyzing (K4)
CO4:	work safely in cold and hot working metals	Applying (K3)
CO5:	handle safely testing and inspection instruments	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1:			2
CO2:			3
CO3:			2
CO4:			2
CO5:			3

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

18CCE04 DESIGN FOR MANUFACTURE AND ASSEMBLY

(Common to CADCAM & Engineering Design branches)

L	T	P	Credit
3	0	0	3

Preamble	Products cannot be manufactured directly from the basic design by a manufacturing process, So the design is to be modified as manufacture and assembly oriented. This knowledge is necessary to get a defect free product.
Prerequisites	Machine drawing, Manufacturing Technology.

UNIT – I **9**

DFMA Guidelines and Geometric Tolerance: General design principles for manufacturability - Design for assembly - strength and mechanical factors - Geometric tolerances – Worst case method - Assembly limits – Design and Manufacturing Datum – Conversion of design datum into manufacturing datum -Tolerance stacks- Process capability.

UNIT – II **9**

Form Design: Principal materials - Selection of materials and processes - Mechanisms selection - Possible solutions - Evaluation method - Influence of materials on form design - form design of grey iron, malleable iron, steel and aluminium castings, welded members and forgings.

UNIT – III **9**

Machining Considerations: Design features to facilitate machining – Single point and multipoint cutting tools - Design for turning operation- Design for machining round holes – Design for Parts produced by milling, planning, shaping and slotting- Reduction of machined area- Simplification by separation - Simplification by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility.

UNIT – IV **9**

Casting Considerations: Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes – Design rules for sand castings – Investment casting: Introduction, Design consideration of Investment casting -The die casting cycle, Determination of number of cavities and appropriate machine size in die casting- Identification of uneconomical design - Modifying the design - Computer applications in DFMA.

UNIT – V **9**

Design for the Environment: Environmental objectives – Basic DFE methods – Lifecycle assessment – AT&T's environmentally responsible product assessment - Weighted sum assessment method – Techniques to reduce environmental impact – Design to minimize material usage – Design for recyclability – Design for remanufacture – Design for energy efficiency – Design to regulations and standards.

Total: 45

REFERENCES:

1. Boothroyd G., "Product Design for Manufacture and Assembly", 3rd Edition, New York, CRC Press, London, 2013.
2. Peck Harry, "Design For Manufacture", Pitman Publications, London 1983.
3. Otto Kevien and Wood Kristin, "Product Design", 1st Edition, Pearson Publication, New Delhi, 2004.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	analyze the given component and identify the suitable geometrical tolerances for manufacturing oriented design	Analyzing (K4)
CO2:	propose design guidelines for form design of castings, welded members and forgings	Applying (K3)
CO3:	suggest suitable design modifications to facilitate machining of components	Applying (K3)
CO4:	identify uneconomical design and modify component design for sand and die castings	Analyzing (K4)
CO5:	perform the lifecycle assessment for a component to achieve eco-friendly design	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2	1	3
CO2	1	1	3
CO3	1	1	3
CO4	1	1	3
CO5	2	1	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom’s Taxonomy

18MTE01 FLUID POWER SYSTEM DESIGN
(Common to Mechatronics, Engineering Design & CADCAM branches)

L	T	P	Credit
3	0	2	4

Preamble	This course deals with the design of a system which generate, control and transmission of power using pressurized fluids.
Prerequisites	Nil

UNIT – I **9**

Fundamentals and Power Source of Hydraulic System: Basics, Types and structure of fluid power systems – Pascal's Law and its application –Fluid properties – Losses in pipes, valves and fittings – Advantages and applications of Fluid power systems. Fluid power symbols – Hydraulic pumps: Gear, Vane and Piston pumps, Pump Performance, Characteristics and Selection - Sizing of hydraulic pumps.

UNIT – II **9**

Control Components of Hydraulic System: Direction control valves: Three-way valve, Four way valve, Check valve and shuttle valve – Actuation mechanism of DCV – Pressure control valves: Pressure relief, Pressure Reducing, Counter balance, Sequencing and Unloading Valves – Flow control valves and its types – Proportional Valves – Servo valves and its types.

UNIT – III **9**

Fundamentals of Pneumatic System: Perfect Gas laws – Compressors: piston, screw and vane compressor – Fluid conditioning Elements: Filter, Regulator and Lubricator unit, Pneumatic silencers, After coolers, Air dryers – Air control valves – Fluid power actuators: Linear and Rotary actuators – types – Cushioning mechanism in cylinders – Sizing of Actuators.

UNIT – IV **9**

Fluid Power Circuit Design: Circuit design methods: Cascade method, Step counter method and KV Map method (two / three-cylinder circuits) – Basic pneumatic circuits – Electrical components and electrical controls for Fluid power circuits – Introduction to Fluid logic devices and applications – Accumulator: Types and application circuits – Pressure intensifier circuits – PLC applications in Fluid power circuit.

UNIT – V **9**

Industrial Circuits and Maintenance: Industrial circuits: Speed control circuits – Regenerative cylinder circuits – Pump unloading circuit – Double pump circuit – Counter balance valve circuit – Hydraulic cylinder sequencing circuit – Automatic cylinder reciprocating circuit – Cylinder synchronizing circuits – Fail safe circuits - Sealing devices: Types and materials – Installation, Maintenance and trouble shooting of Fluid Power systems.

List of Experiments:

1. Design and testing of Electro-hydraulic circuit with pressure sequence valve
2. Design of hydraulic circuit for speed control of hydraulic motor and cylinder
3. Circuits with logic controls – AND valve and OR valve
4. Sequential Circuit with pneumatic control without pneumatic timers
5. Sequential Circuit with pneumatic control with pneumatic timers
6. Cylinder synchronizing circuits

7. Circuits with multiple cylinder sequence – Electrical control
8. Circuit with rod less cylinder – Electrical control
9. Proportional and Servo control of Pressure and Flow in hydraulic Circuits
10. Simulation and analysis of fluid power circuits using fluid power simulation software

Lecture: 45, Practical: 30, Total: 75

REFERENCES / MANUALS / SOFTWARES:

1. Esposito Anthony, “Fluid Power with Applications”, 7^{th} Edition, Pearson Education Ltd., New York, 2013.
2. Majumdar S.R., “Pneumatic Systems – Principles and Maintenance”, 1^{st} Edition, McGraw-Hill, New Delhi, 2017.
3. Majumdar S.R., “Oil Hydraulic Systems – Principles and Maintenance”, 28^{th} Edition, McGraw-Hill, New Delhi, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	identify the fluid power components, their symbols and functions	Applying (K3)
CO2:	select the required fluid power control components for a given application	Applying (K3)
CO3:	apply the pneumatic technology to design a system with low cost automation	Analyzing (K4)
CO4:	design and develop a fluid power circuit with different methodologies for an industrial environment	Creating (K6)
CO5:	design and analyze the fluid power circuit for a given application using simulation software	Creating (K6)
CO6:	identify the fluid power components and their symbols used in industry	Applying (K3), Manipulation (S2)
CO7:	design, construct and test fluid power circuits with pneumatic, electrical, PLC and logic control for low cost automation	Creating (K6), Precision (S3)
CO8:	develop and simulate fluid power circuit using simulation software for industrial application	Creating (K6), Precision (S3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3
CO4	3	2	3
CO5	3	2	3
CO6	3	3	3
CO7	3	3	3
CO8	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom’s Taxonomy

18EDE01 APPLIED FINITE ELEMENT ANALYSIS

L	T	P	Credit
3	1	0	4

Preamble	To familiarize the advanced concepts in finite element analysis and to understand the principles involved in solving non-Linear and dynamic problems using finite element approach.
Prerequisites	Finite Element Method

UNIT – I **9**

Bending of Plates and Shells: Review of Elasticity Equations – Bending of Plates and Shells – Finite Element Formulation of Plate and Shell Elements - Conforming and Non-Conforming Elements – C_0 and C_1 Continuity Elements – Application and Examples.

UNIT – II **9**

Non-Linear Problems: Introduction – Iterative Techniques – Material Non-linearity – Elasto Plasticity – Plasticity – Visco Plasticity – Geometric Non linearity – Large displacement formulation – Application in Metal Forming Process and Contact Problems.

UNIT – III **9**

Dynamic Problems: Direct Formulation – Free, Transient and Forced Response – Solution Procedures – Subspace Iterative Technique – Houbolt, Wilson, Newmark – Methods – Examples.

UNIT – IV **9**

Fluid Mechanics and Heat Transfer Analysis: Governing Equations of Fluid Mechanics – Inviscid and Incompressible Flow – Potential Formulations – Slow Non-Newtonian Flow – Metal and Polymer Forming – Navier Stokes Equation – Steady and Transient Solution.

UNIT – V **9**

Error Estimates and Adaptive Refinement: Error norms and Convergence rates – h-Refinement with Adaptivity – Adaptive Refinement Techniques.

Lecture:45, Tutorial:15, Total: 60

REFERENCES:

1. Bathe K.J., “Finite Element Procedures”, Prentice Hall, New Jersey, 2006.
2. Cook, Robert Davis et al, “Concepts and Applications of Finite Element Analysis”, 4^{th} Edition, Wiley, John & Sons, 2007.
3. Ramamurthy G., “Applied Finite Element Analysis”, 2^{nd} Edition, I K International Publishing House, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	formulate and analyse the finite element equation using plate and shell elements for various applications	Applying (K3)
CO2:	analyze the behaviour of non-linear materials	Analyzing (K4)
CO3:	solve and compute the responses under dynamics conditions	Analyzing (K4)
CO4:	calculate the fluid flow phenomena of various applications	Analyzing (K4)
CO5:	estimate the error and remesh the given structure for reducing the discretization error	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2		3
CO2	1		2
CO3	1		2
CO4	1		2
CO5	2		3

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18EDE02 MECHANICAL BEHAVIOUR OF MATERIALS

(Common to Engineering Design & CADCAM branches)

L	T	P	Credit
3	0	0	3

Preamble	This course provides the necessary knowledge of behaviour under loads which is needed in manufacture and design.
Prerequisites	Fundamentals of material sciences, Fundamental of physical properties of the materials, Basic type of metal and non-metallic materials

UNIT – I **9**

Elasticity of the Materials: Analysis of stress-definition and notation of stress - equation of equilibrium - description of stress at a point- principal stresses - two and three dimensional Mohr's circles diagram. Boundary condition in terms of surface forces. Analysis of stress-strain components- description of strain at a point - compatibility equations of elasticity: Generalized Hooke's law-formulations of elastic problems - two and three dimensional Mohr‟s circles diagram - strain energy.

UNIT – II **9**

Plane Stress and Plane Strain Problems: The governing differential equations - bending of narrow cantilever beam of rectangular cross section under an end load - General equations in cylindrical co-ordinates – effect of small circular holes in strained plates-stress concentration

UNIT – III **9**

Elements of the Theory of Plasticity: Introduction - flow curves-tensile test - true stress/true strain-yield criteria for ductile metals- plastic stress-strain relations. Creep definition-creep tests and properties of creep. Theories of failure.

UNIT – IV **9**

Fracture: Overview of problem of fracture and fatigue in structures-stress analysis for members with cracks-stress intensity equations- Relationship between stress intensity factor and fracture toughness. Experimental determination -K_{IC} and Kc values-effect of temperature, loading rate and plate thickness on fracture toughness.

UNIT – V **9**

Fracture Mechanics Design: Fatigue crack initiation- fatigue crack propagation under constant load and variable load - fatigue damage tolerance, Elastic - plastic fracture mechanics.

Total: 45

REFERENCES:

1. George E. Dieter, "Mechanical Metallurgy", 3rd Edition, McGraw Hill Education (India) Pvt. Ltd., 2013.
2. Wang C.T., "Applied Elasticity", McGraw-Hill, New York, 1953.
3. Barsoom M. John and Rolte T. Stanley, "Fracture and Fatigue Control in Structures", Prentice-Hall, New Jersey, 1987.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	understand the elastic behaviours of the materials.	Understanding (K2)
CO2:	analyze the problems of plane stress and strain conditions.	Analyzing (K4)
CO3:	understand the plastic behaviours of the materials.	Understanding (K2)
CO4:	implement the various fracture stress analysis under various conditions.	Analyzing (K4)
CO5:	implement the fracture mechanics and the design under various conditions	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3		2
CO2	3		3
CO3	3	2	2
CO4	3	2	2
CO5			2

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom’s Taxonomy

18EDE03 EXPERIMENTAL STRESS ANALYSIS

L	T	P	Credit
3	0	2	4

Preamble	The course introduces the physical principle used by various experimental techniques and also provides a guideline to select an experimental technique for a given application. It also explore two-dimensional photo elasticity, the frozen stress method and surface coating techniques, structural model analysis, special instruments for dynamic stress analysis and analogue methods for dealing with stress problems.
Prerequisites	Stress and strain principles, Metal coating techniques, Metrology and measurement techniques

UNIT – I — **9**

Strain Gauges and Circuits: Choice of experimental methods –standards and accuracy of measurements – principles of modal analysis- P1 Theorem direct and indirect models. Mechanical, optical and acoustic and pneumatic strain gauges – Electrical strain gauges – gauge factor types of Resistance gauges - gauge materials - backing materials adhesives – protective coatings – semiconductor gauges. Introduction Wheatstone bridge– constant – current resistance bridge balancing Reference Bridge –Potentiometer circuit – temperature compensation effects of lead wires.

UNIT – II — **9**

Strain Analysis Methods: Introduction – Two - element rectangular rosette- three- element rectangular rosette – Three - Element Delta rosette – Four -Element rectangular rosette and Tee Delta rosette – Correction for transverse strain effects, Stress gauge, Plane shear gauge, Stress intensity factor gauge.

UNIT – III — **9**

Brittle Coating Method Bi-Refringent Coating Techniques: Introduction –relation between the state of stress in coating and that on model –Isostatics and Isoentacties - Types of brittle coating materials relative merits of stress – coat and all - temp coatings - crack detection Techniques –variables influencing accuracy of brittle coating application-model – surface preparation and application of coating calibration of brittle coating materials - brittle coatings technique applied to a specific Problem. Reflection plariscope - sensitivity of the method principle stress – separation - comparison of brittle coating and bi
refringent coating techniques.

UNIT – IV — **9**

Photo Elasticity: Background optics - plane and circular polarization –stress optic law photo elastic materials - casting and Modeling techniques – calibration methods -Isoclinic, Isochromatic and stress trajectories - stress separation Methods, Fringe sharpening-stress freezing-three dimensional analysis from models slicing –axisymmetric Stress –torsion problem Plane and spherical waves –coherence.

UNIT – V — **9**

Morie Methods: Moire fringes produced by mechanical interference. Geometrical approach, Displacement field approach to Moire fringe analysis, out of plane displacement measurements, Out of plane slope measurements. Applications and advantages. Holography and Thermography.

List of Exercises / Experiments :

1. Application of strain gauge techniques: Lecture on strain gauge based methods, Cantilever beam and Portal frame experiments.
2. Application of Strain Gauge techniques: experiment on combined bending and torsion.
3. Applications of photo elasticity: demonstration of photo elastic techniques.
4. Applications of photo elasticity: Calibration of the photo elastic constant, Determination of the stress field in a beam under bending.

5.	Applications of Digital Image Correlation: Demonstration of DIC techniques, determination of strain fields in the gauge section of a polymeric dog-bone specimen under tension.
6.	Applications of DIC: Determination of thermo elastic stress and strain fields using DIC.
7.	Torsion on Hollow shafts.

Lecture:45, Practical:30, Total: 75

REFERENCES:

1. Srinath L.S., Raghavan M.R., Lingaiah K., Gargesa G., Pant B., and Ramachandra K., "Experimental Stress Analysis", Tata McGraw Hill, 1984.
2. Dally J.W. and Riley W.F., "Experimental Stress Analysis", 3rd Edition, McGraw-Hill, 1991.
3. Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, 2009.

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

		BT Mapped (Highest Level)
CO1:	handle to measure strain by different methods for various applications	Applying (K3)
CO2:	conduct the strain analysis of different systems	Applying (K3)
CO3:	identify, calibrate and recommend the different coating techniques	Analyzing (K4)
CO4:	measure the Stress trajectories and stress separation using photo elasticity	Applying (K3)
CO5:	conduct the different experiment to measure the thermo elastic stress	Applying (K3)
CO6:	measure the strain on various applications	Applying (K3), Precision (S3)
CO7:	measure and calibrate the photoelasticity	Applying (K3), Precision (S3)
CO8:	analyze the thermoelastic stress and digital image correlation	Applying (K3), Precision (S3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3	1	2
CO2	3	2	1
CO3	2	1	3
CO4	3	3	3
CO5	3	3	3
CO6	3	3	3
CO7	3	3	3
CO8	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18EDE04 FRACTURE MECHANICS

L	T	P	Credit
3	0	0	3

Preamble	Fracture mechanics makes it possible to determine whether a crack of given length in a material of known fracture toughness is safe or not.
Prerequisites	Strength of materials

UNIT – I — **9**

Elements of Solid Mechanics: The geometry of stress and strain, elastic deformation, plastic and elasto-plastic deformation - limit analysis. Theory of Elasticity- Stress – Strain relations, equilibrium equations, compatibility, stress functions.

UNIT – II — **9**

Stationary Crack under Static Loading: Two dimensional elastic fields – Analytical solutions yielding near a crack front – Irwin's approximation - plastic zone size – Dugdaale model – J integral and its relation to crack opening displacement.

UNIT – III — **9**

Energy Balance and Crack Growth: Griffith analysis – Linear Fracture Mechanics-Crack Opening displacement – Dynamic energy balance – crack arrest.

UNIT – IV — **9**

Fatigue Crack Growth Curve: Empirical relation describing crack growth by fatigue – Life calculations for a given load amplitude – effects of changing the load spectrum – Effects of calculations for a given load amplitude –effects of changing Environment.

UNIT – V — **9**

Elements of Applied Fracture Mechanics: Examples of crack-growth Analysis for cyclic loading - leak before break – crack Initiation under large scale yielding – Thickness as a Design parameter – crack instability in Thermal or Residual – stress fields.

Total: 45

REFERENCES:

1. George E. Dieter, "Mechanical Metallurgy", 3rd Edition, McGraw Hill Education (India) Pvt. Ltd., 2013.
2. Hellan Kare, "Introduction of Fracture Mechanics", Tata McGraw-Hill Book Company, New Delhi, 1985.
3. Prashant Kumar, "Elements of Fracture Mechanics", McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	know the behaviour of material under load	Analyzing (K4)
CO2:	know the linear fracture mechanics and crack propagation	Analyzing (K4)
CO3:	know on fatigue crack growth under the various types of loads	Evaluating (K5)
CO4:	apply fracture mechanics for the design of components	Applying (K3)
CO5:	know the analysis of crack growth with large scale yielding	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3		3
CO2	3		
CO3	3		
CO4			3
CO5			3

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

18EDE05 DESIGNING WITH NEWER MATERIALS

(Common to Engineering Design & CADCAM branches)

L	T	P	Credit
3	0	0	3

Preamble	The course deals with the study on structure – property relationship of non metals, processing techniques involved in fabrication of components and related applications.
Prerequisites	Introduction to material science and engineering

UNIT – I **9**

Modern Materials in Design and Plastics: Modern materials in design plastics composites and smart materials Polymers - classification - Thermoplastics and thermosetting plastics –structure-property relationship- Thermoforming processes - compression and transfer molding - injection molding - extrusion - blow molding - calendaring - lamination and pultrusion. Design consideration in manufacturing of plastic components

UNIT – II **9**

Rubber: Rubber - additives - applications. Stages in raw rubber and latex rubber technology-structure-property relationship -Processing of rubbers –Manufacturing techniques - tyres - belts - hoses - foot wears - cellular products - cables. Manufacture of latex based products

UNIT – III **9**

Glass: Glass - characteristics - application - glass making - Glass forming machines - hollow waresflat glasses, fiberglass, bulbs, bottles, heat absorbing glasses, amber glass and their manufacturing methods, general plant layouts for manufacture of different types of glasses

UNIT – IV **9**

Ceramics: Ceramics - classification - traditional ceramics - structural ceramics - fine ceramics - bioceramics - ceramic super conductors. Ceramic processing techniques - hot pressing - hot isostatic pressing (HIP) - Sintering - injection molding - slip casting - tape casting - gel casting – extrusion

UNIT – V **9**

Composites: Composites - requirements of reinforcement and matrix - Manufacturing of composites -casting - solid state diffusion - cladding – Hot Isostaic Pressing - liquid metal infiltration - liquid phase sintering - preparation of molding compounds and prepregs - hand layup method - autoclave method - filament winding method – functionally graded materials-features-processing methods-applications

Total: 45

REFERENCES:

1.	Brydson J. A. and Newnes-Butterwarths, “Plastic Materials”, 8th Edition, London, 2016.
2.	Barsoum M.W., “Fundamentals of Ceramics”, 2nd Edition, McGraw-Hill Co. Inc., 2002.
3.	George Lubin, “Handbook of Composites”, 1st Edition, Springer, 1982.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	demonstrate the manufacturing and design aspects of plastics	Applying (K3)
CO2:	present processing properties and applications of rubber products	Applying (K3)
CO3:	demonstrate processing and applications of glasses	Applying (K3)
CO4:	demonstrate processing and applications of ceramics	Analyzing (K4)
CO5:	demonstrate processing and applications of composites	Analyzing (K4)

Mapping of COs with POs

COs/Pos	PO1	PO2	PO3
CO1	3	1	3
CO2	3	1	3
CO3	2	1	2
CO4	3	1	3
CO5	3	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT –Bloom's Taxonomy

18EDE06 TRIBOLOGY IN DESIGN

L	T	P	Credit
3	0	0	3

Preamble	This course will familiarize the fundamental concepts of friction wear and lubrications. Surface effects in tribology, bearing design and contact mechanics will be the key aspects of this course which will improve the functionality and life of the components.
Prerequisites	Nil

UNIT – I **9**

Introduction to Surfaces and Friction: Topography of surfaces – Surface features – Experimental determinations of surface structures – Chemical analysis of surfaces – Surface effects in Tribology – Analysis of surface roughness – Surface topography measurements. Surface treatments, Surface modifications and Surface coating. Friction – Mechanism of friction, Equations and models of friction, Friction measurements, Friction properties of metallic and non metallic materials, Friction in extreme conditions.

UNIT – II **9**

Fundamentals of Wear and Lubrication: Wear – Types, Mechanism, Mapping, Measurements, Wear resistance materials – Lubricants – selection criteria – lubrication regimes. Hydrodynamic, Elasto and plasto hydrodynamic lubrication, Basic equations, Reynold's equation, Boundary lubrication, Boundary lubricating films and its properties.

UNIT – III **9**

Design of Hydrodynamic Bearings: Dynamic analysis of hydrodynamic bearing performance, thrust and journal bearings– full, partial, fixed and pivoted – mass flow rate, friction, power loss, heat and temperature difference, dynamic loads, oil film thickness, stiffness of squeeze film - problems.

UNIT – IV **9**

Hydrostatic and Rolling Element Bearings: Hydrostatic lubrication -hydrostatic bearing design. Slider bearings – Self acting finite bearings, Failure modes, Materials for rolling element bearings – Types, Bearing geometry and kinematics, load ratings and life prediction.

UNIT – V **9**

Contact Mechanics and Tribo Measurements: Contact mechanics, Analysis of contacts, Elastic plastic contact of frictionless solids, problems. Bearing torque calculation, temperature analysis, endurance testing and failure analysis, bearing performance measurements, bearing vibration measurements

Total: 45

REFERENCES:

1. Bharat Bhushan, "Principles and Applications of Tribology", 2nd Edition, John Wiley & Sons, New York, 2013.
2. Williams J.A., "Engineering Tribology", Oxford University Press, 2005.
3. Sahoo P., "Engineering Tribology", PHI Learning, India, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	comprehend the surface effects in tribology	Applying (K3)
CO2:	apply the basic concepts of friction, wear and lubrication in industrial components	Evaluating (K5)
CO3:	design the hydrodynamic bearings with realistic constraints	Analyzing (K4)
CO4:	design the hydrostatic bearings with appropriate assumptions and basics about rolling element bearings	Analyzing (K4)
CO5:	apply the principles of tribo measurement techniques and contact mechanics in industrial applications	Evaluating (K5)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	1		2
CO2	2		3
CO3			2
CO4			2
CO5	1		3

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18EDE07 ADVANCED TOOL DESIGN
(Common to Engineering Design & CADCAM branches)

L	T	P	Credit
3	**0**	**0**	**3**

Preamble	This course provides concepts and techniques for designing the elements of tool engineering and appropriate materials. Also, explore the important of press tools, jigs and fixtures and tool maintenance.
Prerequisites	Manufacturing Technology, Design for manufacture and assembly

UNIT – I **9**

Tool Design Methods: Introduction – The Design Procedure – Statement of the problem – The Need Analysis – Research and Ideation – Tentative Design Solutions – The Finished Design – Drafting and Design Techniques in Tooling drawings – Screws and Dowels – Hole location – Jig-boring practice – Installation of Drill Bushings – Punch and Die Manufacture – Electro-discharge machining – Electro-discharge machining for cavity.

UNIT – II **9**

Tooling Materials: Properties of Materials – Ferrous Tooling Materials – Tool steels – Cast Iron – Mild, or low-carbon Steel – Nonmetallic Tooling Materials – Nonferrous Tooling Materials – Metal cutting Tools – Single-point cutting tools – Milling cutters – Drills and Drilling – Reamer classification – Taps – Tap classification- the selection of carbide cutting tools – Determining the insert thickness for carbide tools.

UNIT – III **9**

Design of Drill Jigs and Fixtures: Introduction – Fixed Gages – Gage Tolerances – The selection of material for Gages – Indicating Gages – Automatic gages – Principles of location – Locating methods and devices – Principles of clamping – Drill jigs – Chip formation in drilling – General considerations in the design of drill jigs – Drill bushings – Methods of construction – Drill jigs and modern manufacturing. Fixtures and economics – Types of Fixtures – Vise Fixtures – Milling Fixtures – Boring Fixtures – Broaching Fixtures – Lathe Fixtures – Grinding Fixtures.

UNIT – IV **9**

Dies and Tool Design: Types of Die construction – Die-design fundamentals – Blanking and Piercing die construction – Pilots – Strippers and pressure pads- Presswork materials – Strip layout – Short-run tooling for Piercing – Bending dies – Forming dies – Drawing operations

UNIT – V **9**

Numerically Controlled Machine: The need for numerical control – A basic explanation of numeric control – Numerical control systems in use today – Fixture design for numerically controlled machine tools – Cutting tools for numerical control – Tool holding methods for numerical control – Automatic tool changers and tool positioners – Tool presetting – Introduction – General explanation of the brown and sharp machine – tooling for Automatic screw machines

Total: 45

REFERENCES:

1. Donaldson Cyrll, LeCain H. George, Goold V.C., “Tool Design”, 3rd Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2002.
2. Society of Manufacturing Engineers, “Manufacturing Engineers Handbook”, 1998.
3. Mikell P. Groover, “Fundamentals of Modern Manufacturing”, John Wiley & Sons, Singapore, 2004.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	classify the concepts and working principles of latest developments in tool design	Applying (K3)
CO2:	categorize the tooling materials	Analyzing (K4)
CO3:	summarize the design and development of drilling jigs and fixtures	Evaluating (K5)
CO4:	decide on the selection of dies for press working	Evaluating (K5)
CO5:	recommend tool holding methods for A/C machines	Evaluating (K5)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3		2
CO2	3		2
CO3	3		3
CO4	3		3
CO5	3		3

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18EDE08 DESIGN OF MATERIAL HANDLING EQUIPMENT

(Common to Engineering Design & CADCAM branches)

(Use of approved data book is permitted)

L	T	P	Credit
3	0	0	3

Preamble	Most of accidents occurring in industries due to improper design of material handling equipments. In order to avoid this, the design engineer should be familiar with principle and design concepts in material handling equipments.
Prerequisites	Fundamentals of Material Handling Equipment Knowledge on Machine Element and Transmission System

UNIT – I **9**

Flexible Hoisting Appliances: Type, selection and applications of material handling equipment's, choice of material handling equipment – hoisting equipment – components and theory of hoisting equipment – chain and ropes – selection of ropes, pulleys, pulley systems, sprockets and drums.

UNIT – II **9**

Load Handling Equipments and Brakes: Forged standard hooks – forged Ram shorn hooks – solid triangular eye hooks – crane grabs, electric lifting magnetic – grabbing attachments for loose materials, arresting gear – brakes: shoe, band and cone types – elements of shoe brakes – thermal calculation in shoe brakes.

UNIT – III **9**

Surface and Overhead Transportation Equipment: Hand operated trucks – powered trucks – tractors – electronically controlled tractors - hand truck on rails – industrial railroad equipment's: locomotives - winches – capstans – turntables – monorail conveyors –pipe rail systems – flat bar monorails. Rail travelling mechanism, cantilever and monorail cranes, cogwheel drive, Monocable tramways- reversible tramways.

UNIT – IV **9**

Elevating Equipment: Continuous-motion vertical conveyors – reciprocating-motion vertical conveyors – stackers – work levelers and tail gates – industrial lifts – passenger lifts – freight elevators – mast type elevators – vertical skip hoist elevators, bucket elevators: design, loading and bucket arrangements.

UNIT – V **9**

Conveying Equipment: Belt conveyors - chain conveyors – apron conveyors – escalators – flight conveyors – roller conveyors - oscillating conveyors. Design of belt conveyors, screw conveyors and pneumatic conveyors.

Total: 45

REFERENCES:

1. Rudenko N., "Materials Handling Equipment", 2nd Edition, MIR Publishers, Moscow, 1970.
2. Spivakovsky A.O. and Dyachkov V.K., "Conveying Machines", Volume I & II, MIR Publishers, Moscow, 1985.
3. Lingaiah K., "Machine Design Data Book", 2nd Edition, McGraw Hill, New York, 2003.
4. Chowdary R.B. and Tagore G.R.N., "Materials Handling Equipment", Khanna Publishers, New Delhi, 2003.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	understand the basic concepts of flexible hoisting equipment	Applying (K3)
CO2:	demonstrate the basic concepts and design the braking system for load handling equipment	Applying (K3)
CO3:	solve the problems in surface and overhead transportation equipment	Analyzing (K4)
CO4:	solve the problems and understanding the basic of elevators	Analyzing (K4)
CO5:	recognize the concepts and solve the problems of conveying equipment	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2	1	3
CO2	2	1	3
CO3	3	1	3
CO4	3	1	2
CO5	3	1	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom’s Taxonomy

18CCE05 PRODUCT DATA MANAGEMENT

(Common to CAD/CAM and Engineering Design branches)

L	T	P	Credit
3	0	0	3

Preamble	This course will help the students to capture and maintain detailed information on products through its development and the whole lifecycle of the product. It have the advantages of Track and manage all changes to product related data, spend less time organizing and tracking design data and improve productivity through reuse of product design data.
Prerequisites	Knowledge in bill of materials, Knowledge on product life cycle.

UNIT – I **9**

Description of PDM: Definition, Basic functionality, Typology of PDM functions. Information architecture: Document management, creation and viewing of documents, creating parts, versions and version control of parts and documents. System architecture: Client server system in PDM. Trends in PDM, Collaborative Product Development, Case studies.

UNIT – II **9**

Configuration Management: Base lines, meta data, Configuration management: CM function, CM ladder, interchangeability. Structuring the Bill of Material, product structure, Engineering structure, Manufacturing Structure. Case studies

UNIT – III **Change Management** **9**

Change issue, change requests: production problem, origination of change, change request, request process, concept of Engineering change order. Change Cost: Costing a change, Design and Development Cost, Manufacturing and Field Costs, Materials and Parts Costs, Cost policy, Charge Back of Costs. Case studies.

UNIT – IV **9**

Change Control and Work Flow: Types of change, Class of change, software changes, Revision drafting, change impacts, customer review and approval. Projects and Roles: life cycle of a product, life cycle management. Work flows - creation of work flow templates, life cycle, work flow integration. Case studies.

UNIT – V **9**

Configurators and Variants: Configurators: Product configurator, sales configurator, comparison between product configurator and sales configuration, Types of configurator solutions, Product configurator engine. Variant configuration. Case studies.

Total: 45

REFERENCES:

1. IvicaCrnkovic, Ulf Asklund, AnnitaPersson Dahlqvist, “Implementing and Integrating Product Data Management and Software Configuration Management”, Artech House, USA, 2003.
2. Frank B. Watts, “Engineering Documentation Control Handbook – Configuration Management”, 4th Edition, William Andrew, Norwich, NY USA, 2011.
3. AnttiSaaksvuori, AnselmiImmonen, “Product Lifecycle Management”, 3rd Edition, Springer, New York, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	summarize the concept of PDM	Understanding (K2)
CO2:	develop a configuration management in a PLM environment	Applying (K3)
CO3:	classify the various workflows and roles in a project	Analyzing (K4)
CO4:	identify the product life cycle in change management and its issues	Applying (K3)
CO5:	make use of different configurators for product selection	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	1	2	1
CO2	3	3	3
CO3	2	3	2
CO4	2	3	2
CO5	2	1	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

18CCE06 MODELING AND ANALYSIS OF MANUFACTURING SYSTEMS

(Common to CADCAM, Engineering Design & Mechatronics branches)

L	T	P	Credit
3	0	0	3

Preamble	This course provides knowledge of modeling and analysis of manufacturing systems which ensures a very good performance.
Prerequisites	Industrial Engineering

UNIT – I **9**

Manufacturing Systems and Models: Types and principles of manufacturing systems, types and uses of manufacturing models, physical models, mathematical models, model uses, model building.

UNIT – II **9**

Material Flow Systems: Assembly lines-Reliable serial systems, approaches to line balancing, sequencing mixed models. Transfer lines and general serial systems-paced lines without buffers, unpaced lines. Shop scheduling with many products. Flexible manufacturing systems-system components, planning and control. Group technology-assigning machines to groups, assigning parts to machines. Facility layout-Quadratic assignments problem approach, graphic theoretic approach.

UNIT – III **9**

Supporting Components: Machine setup and operation sequencing-integrated assignment and sequencing. Material handling systems-conveyor analysis, AGV systems. Warehousing-storage and retrieval systems, order picking.

UNIT – IV **9**

Generic Modeling Approaches: Analytical queuing models, a single workstation, open networks, closed networks. Empirical simulation models-event models, process models, simulation system, example manufacturing system

UNIT – V **9**

Synchronization Manufacturing and Petri Nets: Synchronization Vs Optimization, defining the structure, identifying the constraint, exploitation, buffer management. Basic definitions-dynamics of Petri nets, transformation methods, event graphs, modeling of manufacturing systems

Total: 45

REFERENCES:

1. Ronald G. Askin, and Charles R. Standridge, "Modeling and Analysis of Manufacturing Systems", John Wiley & Sons, New York, 1993.
2. Mengchu Zhou, "Modeling, Simulation, and Control of Flexible Manufacturing Systems: A Petri Net Approach", World Scientific Publishing Co. Pvt. Ltd., 2000.
3. Jean Marie Proth and XiaolanXie, "Petri Nets: A Tool for Design and Management of Manufacturing Systems", John Wiley & Sons, New York, 1996.
4. Brandimarte P. and Villa A., "Modeling Manufacturing Systems", Springer Verlag, Berlin, 1999.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	select the appropriate type of manufacturing system and model	Analyzing (K4)
CO2:	know about the assembly line transfer line and FMS	Understanding (K2)
CO3:	usage of various materials handling systems	Applying (K3)
CO4:	know the generic modeling systems	Understanding (K2)
CO5:	use the theory of constraints for manufacturing a component	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1			2
CO2	3		
CO3	2		2
CO4	2		3
CO5			2

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

18CCE08 RELIABILITY ENGINEERING

(Common to CADCAM & Engineering Design branches)

L	T	P	Credit
3	0	0	3

Preamble	This course provides advanced topics of reliability measurements, monitoring and improvement techniques for reliability engineering.
Prerequisites	Total Quality Management, Process planning and cost estimation.

UNIT – I **9**

Reliability Concept: Reliability definition – Quality and Reliability– Reliability mathematics – Reliability functions – Hazard rate – Measures of Reliability – Design life –A priori and posterior probabilities – Mortality of a component – Bath tub curve – Useful life.

UNIT – II **9**

Failure Data Analysis: Data collection – Empirical methods: Ungrouped/Grouped, Complete/Censored data – Time to failure distributions: Exponential, Weibull – Hazard plotting – Goodness of fit tests-problems and case study.

UNIT – III **9**

Reliability Assessment: Different configurations – Redundancy – m/n system – Complex systems: RBD – Baye‘s method – Cut and tie sets – Fault Tree Analysis – Standby system **-**problems and case study.

UNIT – IV **9**

Reliability Monitoring: Life testing methods: Failure terminated – Time terminated – Sequential Testing – Reliability growth monitoring – Reliability allocation – Software reliability- problems and case study.

UNIT – V **9**

Reliability Improvement: Analysis of downtime – Repair time distribution – System MTTR – Maintainability prediction – Measures of maintainability – System Availability – Replacement theory-problems and case study.

Total: 45

REFERENCES:

1. Charles E. Ebeling, “An Introduction to Reliability and Maintainability Engineering”, Tata McGraw Hill, 2012.
2. Roy Billington and Ronald N. Allan, “Reliability Evaluation of Engineering Systems”, Springer, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	discuss the fundamentals of reliability measures	Understanding (K2)
CO2:	summarize reliability engineering through product life cycle	Evaluating (K5)
CO3:	analyze the reliability configuration using assessment techniques	Analyzing (K4)
CO4:	apply and test product using reliability monitoring methods for given case	Evaluating (K5)
CO5:	examine system downtime and maintainability measures for given case	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2	2	3
CO2	2	2	3
CO3	2	2	3
CO4	2	2	3
CO5	2	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

18MTC11 COMPUTER NUMERICALLY CONTROLLED MACHINES

(Common to Mechatronics, Engineering Design & CADCAM Branches)

L	T	P	Credit
3	0	2	4

Preamble	To impart the fundamental knowledge and programming concepts of CNC machines.
Prerequisites	Nil

UNIT – I **9**

Construction Features of CNC Machines: Introduction - CNC Machine Building, Drives and Controls: Drive Mechanism, Spindle Drives, Axes drives, Feed drives, Linear Motors and Actuators, Magnetic Levitation. Power transmission elements - Spindle bearing – Arrangement and installation - Guide ways – Configuration and design, friction and anti-friction LM guide ways, Retrofitting.

UNIT – II **9**

Control Systems for CNC Machines and CAD/CAM Integration: Interfacing – Monitoring – Diagnostics – Machine data – Sources of errors - Compensations for Machine accuracy – DNC – Adaptive control CNC systems. Concepts of High speed Machining and micro machining. Networking - networking techniques, LAN, components - Graphics standards – Data exchange format, evolution - features of various interfaces GKS, IGES, DXF, PDES, STEP etc., Process planning, Computer Aided process planning (CAPP) - Variant, generative Approaches.

UNIT – III **9**

CNC Programming: Structure of CNC program, Part Program Terminology Coordinate system, G & M codes, cutter radius compensation, tool nose radius compensation, tool wear compensation, canned cycles, sub routines, mirroring features, Manual part programming for CNC turning and machining centre – APT programming for various machines in FANUC - Computer aided part programming - Post processing.

UNIT – IV **9**

Tooling System and Management: Tooling system - Interchangeable tooling system – Preset, Qualified and semi-qualified tools – Coolant fed tooling system – Modular fixturing – Quick change tooling system – Automatic head changers – Tooling requirements for Turning and Machining centers – Tool holders – Tool assemblies – Tool Magazines – ATC Mechanisms – Tool management.

UNIT – V **9**

Economics of CNC Operations and Special Purpose CNC Machines: Factors influencing selection of CNC machines - Cost of operation of CNC machines - Practical aspects of introducing CNC machines - Maintenance features of CNC machines - Preventive and other maintenance requirements. CNC grinding machines, CNC bending machines - pipe bending, CNC turret Press, CNC EDM - Wire cut EDM, CNC ECM - Electrochemical grinding machines.

List of Exercises:

1. Study of G codes and M codes for machining centre and turning centre
2. Programming and machining of given component using HMT VMC 200T
3. Programming and machining of given component using HMT CNC T70
4. Programming and machining of given component using CNC turning centre
5. Programming and simulation of given component using MASTER CAM (Lathe)

Lecture:45, Practical:30, Total: 75

REFERENCES:

1. Michael Fitzpatrick N.E., and Arlington W.A., "Machining and CNC Technology", 3rd Edition, Mc Graw Hill Education, 2014.
2. Sehrawat M.S. and Narang J.S., "CNC Machines (Computer Numerical Control)", Dhanpat Rai and Co., Pvt. Ltd., New Delhi, 2014.
3. Alan Overby, "CNC Machining Handbook: Building, Programming and Implementation", The McGraw-Hill Companies Inc., 2011.
4. Adithan M. and Pabla B.S., "CNC Machines", 3rd Edition, New Age International (P) Ltd., 2010.
5. Madison J., "CNC Machining Handbook: Basic theory, Production data and Machining process", Industrial Press Inc., 2005.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	explain the basic components and mechanisms of CNC system	Understanding (K2)
CO2:	interpret the control system concepts used in CNC machine	Understanding (K2)
CO3:	formulate part programming for turning and milling processes	Creating (K6)
CO4:	select proper tooling systems and fixtures for holding the work piece	Applying (K3)
CO5:	infer the economic concepts of CNC machine and selection of special purpose CNC machine	Understanding (K2)
CO6:	develop CNC programming using different G codes and M codes	Applying (K3), Precision (S3)
CO7:	develop part program and perform machining in Turning Centre	Creating (K6), Precision (S3)
CO8:	develop part program and perform machining in Machining Centre	Creating (K6), Precision (S3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2	1	1
CO2	3	3	1
CO3	3	2	2
CO4	3	1	1
CO5	2	3	3
CO6	2	1	2
CO7	2	1	2
CO8	2	1	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MTT13 SENSORS AND INSTRUMENTATION

(Common to Mechatronics, Engineering Design and CAD/CAM Branches)

L	T	P	Credit
3	0	0	3

Preamble	To impart basic knowledge about sensors used to measure various physical quantities like resistance, pressure, flow, level, humidity and so on and convert them into electronic signals (digital or analog) that can be easily read by the user or any other instrument.
Prerequisites	Physics

UNIT – I **9**

Introduction to Measurement: Units and Standards - Instrument classification - Calibration techniques - Characteristics of Instruments - Static and dynamic - Classification of errors - Error analysis - Statistical methods - Uncertainty.

UNIT – II **9**

Non-electrical Transducers: Classification of transducers - Temperature Measurement: Filled system thermometer - Bimetallic thermometer - Pressure Transducers: Elastic transducers - Bourdon gauge - Bellows - Diaphragm. Vacuum: McLeod gauge, thermal conductivity gauge - Ionization gauge.

UNIT – III **9**

Electrical Transducers: Turbine flow meter, Electromagnetic flow meter - Hot wire anemometer - Ultrasonic Meter - Resistive transducers - Potentiometer - RTD - Thermistor - Thermocouple - Radiation Pyrometer.

UNIT – IV **9**

Force, Displacement, Magnetic and Digital Sensors: Strain gauges - Force measurement - Inductive transducer - LVDT - RVDT - Capacitive transducer - Piezo electric transducer – Magnetic Sensor- Types – Magneto resistive – Hall effect – Current sensor - Digital displacement transducers. Digital transducers: Encoders – Fiber optic sensors – Film sensors - Introduction to MEMS and Nano sensors.

UNIT – V **9**

Signal Conditioning and Data Acquisition: Need for Signal Conditioning - Amplification - Filtering - Sample and Holding - Data logging and Acquisition - Distributed Data Acquisition and control systems - Interface system and standards.

Total: 45

REFERENCES:

1. Doebelin E.O., “Measurement Systems – Applications and Design”, 6th Edition, Tata McGraw Hill, New Delhi, 2017.
2. Sawhney A.K., “A course in Electrical and Electronic Measurement and Instrumentation”, Dhanpat Rai and Co. Pvt. Ltd., New Delhi, 2017.
3. Beckwith, Marangoni and Lienhard, “Mechanical Measurements”, 6th Edition, Addison–Wesley, New York, 2009.
4. Roy Choudry D., and Sheil Jain, “Linear Integrated Circuits”, New Age International Pvt. Ltd., New Delhi, 2014.
5. Patranabis D., “Sensor and Actuators”, Prentice Hall of India, 2005.
6. Manabendra Bhuyan, “Intelligent Instrumentation: Principles and Applications”, CRC Press, Newyork, 2011.
7. Barney G.C.V., “Intelligent Instrumentation”, Prentice Hall of India Pvt. Ltd., New Delhi, 1988.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	demonstrate the basic concepts of measurement system and error analysis	Understanding (K2)
CO2:	categorize the different type of non-electrical transducers based on the applications	Applying (K3)
CO3:	correlate the different type of electrical transducers for various applications	Applying (K3)
CO4:	infer the role of sensors in evolving technologies	Understanding (K2)
CO5:	analyze the need for signal conditioning, filters and acquiring data in real time systems	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	1	2	3
CO2	3	2	1
CO3	2	3	3
CO4	3	2	1
CO5	2	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18MTE13 MEMS DESIGN

(Common to Mechatronics, CADCAM, Engineering Design, VLSI Design, Applied Electronics, Power Electronics and Drives & Control and Instrumentation Engineering branches)

L	T	P	Credit
3	0	0	3

Preamble: This course equips the students to understand the concepts of Micro mechatronics and apply the knowledge of micro fabrication techniques for various applications.

Prerequisites: Sensors and Instrumentation and Bridge course mechanical

UNIT – I **9**

Materials for MEMS and Scaling Laws: Overview - Microsystems and microelectronics - Working principle of Microsystems - Si as a substrate material - Mechanical properties - Silicon compounds - Silicon piezo resistors - Gallium arsenide - Quartz-piezoelectric crystals - Polymer - Scaling laws in Miniaturization.

UNIT – II **9**

Micro Sensors, Micro Actuators: Micro sensors - Micro actuation techniques - Micro actuators – Micromotors – Microvalves – Micro grippers – Micro accelerometer: introduction, types, actuating principles, design rules, modeling and simulation, verification and testing, applications.

UNIT – III **9**

Mechanics for Microsystem Design: Static bending of thin plates - Mechanical vibration - Thermo mechanics - Thermal stresses - Fracture mechanics - Stress intensity factors, fracture toughness and interfacial fracture mechanics-Thin film Mechanics-Overview of Finite Element Stress Analysis.

UNIT – IV **9**

Fabrication Process and Micromachining: Photolithography - Ion implantation - Diffusion – Oxidation – CVD - Physical vapor deposition - Deposition by epitaxy - Etching process- Bulk Micro manufacturing - Surface micro machining – LIGA –SLIGA.

UNIT – V **9**

Micro System Design, Packaging and Applications: Design considerations - Process design - Mechanical design – Mechanical Design using Finite Element Method-Micro system packaging – Die level - Device level - System level – Packaging techniques - Die preparation - Surface bonding - Wire bonding – Sealing - Applications of micro system in Automotive industry: Bio medical, Aerospace and Telecommunications – CAD tools to design a MEMS device.

Total: 45

REFERENCES:

1. Tai-Ran Hsu, "MEMS and Microsystems Design and Manufacture", Tata McGraw-Hill, New Delhi, 2008.
2. Mohamed Gad-el-Hak, "The MEMS Handbook", CRC Press, 2009.
3. Bao M.H., "Micromechanical Transducers: Pressure sensors, accelrometers, and gyroscopes", Elsevier, New York, 2000.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	interpret the concepts of MEMS materials and scaling laws	Remembering (K1)
CO2:	explain the principles of micro sensors and actuators	Understanding (K2)
CO3:	apply the mechanics for micro system design	Applying (K3)
CO4:	design and fabrication of microsystem	Applying (K3)
CO5:	design of microsystem packaging and application	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2	2	2
CO2	2	2	3
CO3	2	2	3
CO4	3	2	3
CO5	3	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

18EDE09 VIBRATION AND NOISE CONTROL

L	T	P	Credit
3	0	2	4

Preamble	Vibration and noise control is the measurement of a periodic process of oscillations with respect to an equilibrium point. Basic principles of control theory will be presented from feedback control systems. Finally, chapters will include numerous example problems and possibly projects.
Prerequisites	Fundamentals of Mathematics, Fundamentals of Dynamics of Machines, Fundamentals of Strength of Materials

UNIT – I **9**

Basics of Vibration: Introduction, classification of vibration: free and forced vibration, undamped and damped vibration, linear and non-linear vibration, response of damped and undamped systems under harmonic force, analysis of single degree and two degree of freedom systems, torsional Vibration, determination of natural frequencies.

UNIT – II **9**

Basics of Noise: Introduction, amplitude, frequency, wavelength and sound pressure level, addition, subtraction and averaging decibel levels, noise dose level, legislation, measurement and analysis of noise, measurement environment, equipment, frequency analysis, tracking analysis, sound quality analysis.

UNIT – III **9**

Automotive Noise Sources: Noise - Characteristics of engines, engine overall noise levels, assessment of combustion noise, assessment of mechanical noise, engine radiated noise, intake and Exhaust noise, engine accessory contributed noise, transmission noise, aerodynamic noise, tyre noise, brake noise.

UNIT – IV **9**

Control Techniques: Vibration isolation, tuned absorbers, untuned viscous dampers, damping treatments, applications dynamic forces generated by IC engines, engine isolation, crank shaft damping, modal analysis of the mass elastic model shock absorbers.

UNIT – V **9**

Source of Noise and Control: Methods for control of engine noise, combustion noise, mechanical Noise, predictive analysis, palliative treatments and enclosures, automotive noise control principles, sound in enclosures, sound energy absorption, sound transmission through barriers.

List of Experiments :

1. Determination of natural frequency of a steel beam
2. Fault identificaiton of ball bearing through time domain and frequency domain signal
3. Fault identificaiton of ball bearing through acoustic signals
4. Condition monitoring of Spur gear using vibration signals
5. Condition monitoring of Spur gear using acoustic signals
6. Condition monitoring of Bevel gear using acoustic signals
7. Condition monitoring of Bevel gear using vibration signals

Lecture: 45, Practical: 30, Total: 75

REFERENCES:

1. Rao Singiresu S., "Mechanical Vibrations", 5th Edition, Pearson Education, New Delhi, 2010.
2. Pujara Kewal, "Vibrations and Noise for Engineers", 4th Edition, Dhanpat Rai & Sons, New Delhi, 2004.
3. Challen Bernard and Baranescu Rodica, "Diesel Engine Reference Book", 2nd Edition, SAE International, Warrendale, 2006.
4. Happian-Smith, Julian, "An Introduction to Modern Vehicle Design", Butterworth-Heinemann, Boston, 2011.
5. Fenton John, "Handbook of Automotive Body Construction and Design Analysis", Professional Engineering Publishing, UK, 1998.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	solve and identify the frequency response of the system	Applying (K3)
CO2:	analyze the noise related parameters	Analyzing (K4)
CO3:	solve and design the automobile related noise systems	Analyzing (K4)
CO4:	solve and analyze the vibration isolation and control systems	Evaluating (K5)
CO5:	identify and analyze the sources of vibration, noise and control	Evaluating (K5)
CO6:	determine the natural frequency of steel beam	Analyzing (K4), Manipulation (S2)
CO7:	identify the defects in bearing using vibration and acoustic signals	Evaluating (K5), Precision (S3)
CO8:	identify the defects in gear using vibration and acoustic signals	Evaluating (K5), Precision (S3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3	2	2
CO2	3	2	1
CO3	2	1	1
CO4	3	3	3
CO5	3	2	2
CO6	3	2	2
CO7	3	2	2
CO8	3	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy

18EDE10 INSTRUMENTATION AND MEASUREMENTS

(Common to Engineering Design & CADCAM branches)

L	T	P	Credit
3	0	0	3

Preamble	Knowledge of instrument characteristics enables right choice of various measurement system components. This course helps in the design of measurement system for various applications.
Prerequisites	Basic knowledge of measurement system and its characteristics, Basic knowledge statistical mathematics.

UNIT – I **9**

Introduction to Instruments and their Representation: Typical Application of Instrument Systems, Functional Elements of a measurement System, Classification of Instruments, Standards and Calibration. Static and Dynamic characteristics of Instruments: Introduction, Accuracy, Precision, Resolution, Threshold, Sensitivity, Linearity, Hysteresis, Dead Band, Backlash, Drift, Formulation of Differential Equations for Dynamic Performance- Zero Order, First Order and Second order systems, Response of First and Second Order Systems to Step, Ramp, Impulse and Harmonic Functions, Problems including the characteristics study, Error Analysis.

UNIT – II **9**

Transducer Elements: Analog and Digital Transducers, Variable Capacitance, Piezo-Electric Transducer and Associated Circuits, Unbonded and Bonded Resistance Strain Gages. Strain Gage Bridge circuits, Digital Transducers, Frequency Domain Transducer, Vibrating String Transducer, Binary codes, Digital Encoders. Modern Transducer

UNIT – III **9**

Intermediate, Indicating and Recording Elements: Amplifiers, Mechanical, Hydraulic, Pneumatic, Optical, Electrical Amplifying elements, Compensators, Differentiating and Integrating Elements, Filters, Classification of Filters, A-D and D-A Converters, Digital Voltmeters (DVMs), Cathode Ray Oscillo scopes (CROs), Galvanometric Recorders, Magnetic Tape recorders, Data Acquisition Systems, Data Display and Storage.Modern trends in intermediate elements

UNIT – IV **9**

Motion, Force and Torque Measurement: Relative motion Measuring Devices, Electromechanical, Optical, Photo Electric, Moire-Fringe, Pneumatic, Absolute Motion Devices, Seismic Devices, Spring Mass and Force Balance Type, Hydraulic Load Cell, Pneumatic Load Cell, Elastic Force Devices, Separation of Force Components, Electro Mechanical Methods, Strain Gage, Torque Transducer, and Torque Meters. Methods used in modern research

UNIT – V **9**

Pressure, Flow and Temperature Measurement: Pressure Measurement: Moderate Pressure Measurement, Monometers, Elastic Transducer, Dynamic Effects of Connecting Tubing, High Pressure Transducer, Low Pressure Measurement, Calibration and Testing Flow Measurement: Quantity and rate meters, Flow visualization and its techniques, Modern Trends. Measurement of Temperature: Non Electrical Methods – Solid Rod Thermometer, Bimetallic Thermometer, Pressure Thermometer, Electrical Methods – Electrical Resistance Thermometers-RTDs, Semiconductor Resistance Sensors (Thermistors), Thermo– Electric Sensors, Thermocouple Materials and circuitry, Modern Trends

Total: 45

REFERENCES:

1. Ernest O. Doebelin, "Measurement System: Application and Design", 5th Edition, McGraw Hill, 2003.
2. Alan S. Morris and Reza Langari, "Measurement and Instrumentation – Theory and Application", Elsevier, 2015.
3. Nakra B.C. and Chaudhary K.K., "Instrumentation, Measurement and Analysis", Tata McGraw Hill, 2003.
4. Kumar D.S., "Mechanical Measurements and Control Engineering", Metropoliton Book Company, 1979.
5. Tayal A.K., "Instrumentation, Mechanical Measurements and Controls", Galgotia Publisher, Reprint 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	carryout characteristic analysis of instrument	Analyzing (K4)
CO2:	select transducers at different stages of a measurement system and relate them to manipulation and presentation devices	Applying (K3)
CO3:	identify and relate manipulating and presentation elements	Applying (K3)
CO4:	apply concepts of motion, force and torque measurement in research/modern application	Applying (K3)
CO5:	plan and use pressure, flow and temperature measuring instruments in day to day and modern application	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3	1	2
CO2	2	1	2
CO3	2	1	2
CO4	3	1	2
CO5	3	1	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18EDE11 DESIGN OF HEAT EXCHANGERS

L	T	P	Credit
3	0	0	3

Preamble	This course intends to build design skills in the field of heat exchangers among the Post Graduate Students of Engineering Design and CADCAM.
Prerequisites	Heat Transfer

UNIT – I **9**

Classification of Heat Exchangers: Parallel flow, Counter flow and Cross flow, Shell and tube and Plate type, Single pass and multi pass, Once through steam generators, Analysis of heat exchangers – LMTD and NTU Methods

UNIT – II **9**

Process Design of Heat Exchangers: Heat transfer correlations, Overall heat transfer coefficient, Effect of baffles, Effect of turbulence, Sizing of finned tube heat exchangers, Fouling factors, Pressure drop calculations.

UNIT – III **9**

Mechanical Design of Shell and Tube Heat Exchangers: Thickness calculations, Tube sheet design using TEMA formula, Flow induced vibration risks including acoustic issue and remedies, Tube to tube sheet joint design, Buckling of tubes, Thermal stresses.

UNIT – IV **9**

Compact and Plate Heat Exchangers: Types – Merits and Demerits – Design of Compact heat exchangers, Plate heat exchangers, Performance influencing parameters, Limitations.

UNIT – V **9**

Condensers and Cooling Towers: Design of surface and evaporative condensers – Design of Cooling tower – Approach, Range, Performance characteristics.

Total: 45

REFERENCES:

1. Kuppan Thulukkanam, “Heat Exchanger Design Handbook”, 2nd Edition, CRC Press (Taylor & Francis Group), 2013.
2. Ray Sinnot, Gavin Towler, “Chemical Engineering Design”, 6th Edition, Coulson & Richardson’s Chemical Engineering Series, Elsevier, 2019.
3. Ramesh K. Shah, DuŠan P. Sekulić, “Fundamentals of Heat Exchanger Design”, John Wiley & Sons Inc., 2003.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	recognize the type of heat exchanger and also design and analyze the heat exchanger using LMTD and NTU methods	Analyzing (K4)
CO2:	design a heat exchanger by considering the effects of baffles, turbulence, finned tubes, fouling and pressure drop	Evaluating (K5)
CO3:	apply TEMA standards for designing shell and tube heat exchanger mechanically	Applying (K3)
CO4:	classify the compact and plate heat exchangers and also design and evaluate the same	Evaluating (K5)
CO5:	design and evaluate the condensers and cooling towers with appropriate procedures	Evaluating (K5)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3	1	1
CO2	3	1	1
CO3	3	1	1
CO4	3	1	2
CO5	3	1	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18EDE12 PRODUCTIVITY MANAGEMENT AND REENGINEERING

(Common to Engineering Design & CADCAM branches)

L	T	P	Credit
3	0	0	3

Preamble	This course provides advanced topics for productivity concepts & measurements, steps & procedures of reengineering procedures and improvement models.
Prerequisites	Fundamentals of production and process, Knowledge in basics of mathematics, Fundamentals steps of software, Essentials knowledge of various production resources

UNIT – I **9**

Introduction of Productivity Concepts: Definitions and various factors for productivity – problems in productivity and production –comparison of productivity measures- Productivity concepts – Macro and Micro factors of productivity, Productivity benefit model-case study- productivity cycle.

UNIT – II **9**

Productivity Measurement: Productivity measurement at International, National and Organizational level- External Environment Economic utility model with productivity index, Total productivity models- problems - Strategies for productivity improvement.

UNIT – III **9**

Productivity Management and Organizational Transformation: Productivity management in manufacturing and service sector-case study -Productivity evaluation models, Productivity improvement models and techniques – laboratory -case study. Principles of organizational transformation and re-engineering, fundamentals of process reengineering, preparing the work force for transformation and reengineering, methodology and guidelines.

UNIT – IV **9**

Productivity Models: PMI models, Edosomwan model, Moen and Nolan strategy for process improvement, LMICIP model, NPRDC model –Case studies and applications -DSMCQ and PMP model-case study.

UNIT – V **9**

Re-Engineering Process Improvement Models, Re-Engineering Tools and Implementation: Analytical and process tools and techniques process tools and packages - Information and communication technology - Enabling role of IT.RE-opportunities, process redesign - cases. Software methods in BPR tools and techniques matrix-case study based on information resources - specification of BP, case study - Order, processing, user interfaces, maintainability and reusability-case study from few information resources-application models.

Total: 45

REFERENCES:

1. Sumanth D.J., "Productivity Engineering and Management", Tata McGraw-Hill, New Delhi, 2008.
2. Edosomwan J.A., "Organizational Transformation and Process Re-engineering", CRC Press, 1995.
3. Rastogi P.N., "Re-Engineering and Re-inventing the Enterprise", Wheeler Publishing, New Delhi, 2003.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	recollect macro and micro factors affecting productivity	Understanding (K2)
CO2:	categorize the productivity measurement models	Evaluating (K5)
CO3:	prepare workforce by incorporating transformation and reengineering techniques	Evaluating (K5)
CO4:	dramatize productivity models for applications and cases	Applying (K3)
CO5:	summarize the reengineering process tools and models	Evaluating (K5)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3
CO4	3	2	3
CO5	3	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18EDE13 MECHANICS OF COMPOSITE MATERIALS

(Approved Data book may be permitted)

L	T	P	Credit
3	0	2	4

Preamble	This course provides knowledge of mechanical properties, manufacturing technology and design characteristics of composite materials.
Prerequisites	Advanced Strength of Materials

UNIT – I **9**

Basics of Composites and Manufacturing: Basics of fibers, matrices and composites: Definition – Need – General Characteristics, Applications. Fibers – Glass, Carbon, Ceramic and Aramid fibers. Matrices – Polymer, Ceramic and Metal Matrices – Characteristics of fibers and matrices. Fiber surface treatments. Manufacturing: Bag Moulding – Compression Moulding – Pultrusion – Filament Winding.

UNIT – II **9**

Performance: Static Mechanical Properties – Fatigue and Impact Properties – Environmental effects– Long term properties, Fracture Behavior and Damage Tolerance – Quality Inspection Methods.

UNIT – III **9**

Mechanics: Rule of mixture -volume and mass fractions – density - void content, Evaluation of four elastic moduli based on strength of materials approach and Semi-Empirical model-Longitudinal Young‟s modulus-transverse Young‟s modulus–major Poisson‟s ratio-In-plane shear modulus, Ultimate strengths of a unidirectional lamina. Characteristics of Fiber reinforced lamina–laminates– lamination theory.

UNIT – IV **9**

Design Analysis and Thermal Behaviour: Failure Predictions, Laminate Design Consideration-design criteria-design allowable -design guidelines, Joint design-Bolted and Bonded Joints, Design Examples-Design of a tension member – design of a compression member – design of a beam-design of a torsional member, Application of FEM for design and analysis of laminated composites. Assumption of Constant Coefficient of Thermal expansion. Modification of Hooke‟s law. Orthotropic Lamina C.T.E‟s. C.T.E‟s for special laminate configurations, Zero C.T.E laminates.

UNIT – V **9**

Particulate Based MMC and PMC: Processing Of MMC –Diffusion Bonding – Stir Casting – Squeeze Casting. Basics Of Graphite, Carbon Nanotube, Nanoclay, Nanosilica. Particulate Reinforced Polymer Composites – Processing, Interactions, Morphological, Rheological, Mechanical Properties.

List of Experiments :

1. Testing of fibers: Determination of tensile strength of glass fiber, Measurement of fiber diameter.
2. Determination of Critical fiber length
3. Determination of tensile strength, flexural strength,
4. Determination of impact strength, fatigue strength
5. Test on resin : Determination of viscosity, shrinkage and gel time
6. Determination of longitudinal modulus ,transverse modulus.
7. Determination of Bearing strength of bolted joints,
8. Preparation of Al_2O_3 - SiC composites by stir casting process
9. Determination of Coefficient of thermal expansion of composite
10. Determination of major and minor Poisson’s ratios and rigidity modulus

Lecture:45, Practical:30, Total: 75

REFERENCES:

1. Mallick P.K., "Fiber Reinforced Composites: Materials, Manufacturing and Design", Marcel Dekker Inc, 1993.
2. Autar K. Kaw, "Mechanics of Composite Materials", CRC Press, 2006.
3. Agarwal B.D. and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley & Sons New York, 1990.
4. Gibson Ronald, "Principles of Composite Material Mechanics", Tata McGraw-Hill, New Delhi, 1994.
5. Chawla K.K., "Composite Materials", Springer Verlag, Boston, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	demonstrate the knowledge on the fundamentals and manufacturing of composites	Understanding (K2)
CO2:	understand the performance of fiber reinforced composites	Understanding (K2)
CO3:	understand and solve problems related to the mechanics of composite materials	Applying (K3)
CO4:	understand the design concepts and thermal behavior of composite materials	Analyzing (K4)
CO5:	demonstrate the knowledge on the fundamentals of particulate reinforced composite	Understanding (K2)
CO6:	measure the various mechanical properties of composite materials and fibers	Applying (K3), Precision (S3)
CO7:	measure the various physical properties of resin	Applying (K3), Precision (S3)
CO8:	prepare a metal – matrix composite	Applying (K3), Precision (S3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1			
CO2			3
CO3	3		
CO4	3		3
CO5	3		3
CO6			3
CO7			3
CO8			3

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18EDE14 APPLIED ENGINEERING ACOUSTICS

L	T	P	Credit
3	0	0	3

Preamble	This course provides the basic concepts of acoustics, characteristics of sound, transmission phenomena, assessment & measurement of sound and basic concepts of noise control.
Prerequisites	Fundamentals of Mathematics, Fundamentals of Acoustics, Fundamentals of Vibrations

UNIT – I **9**

Basic Concepts of Acoustics: Scope of Acoustics – Sound pressure – Sound intensity – Sound power level Sound power – Wave motion – Alteration of wave paths –Measurement of sound waves – sound spectra – Sound fields – Interference – Standing waves – Acoustic energy density and intensity – Specific acoustic impedance.

UNIT – II **9**

Characteristics of Sound: The one dimensional wave equation – Solution of 1D wave equation – Velocity in gaseous medium – Velocity of plane progressive sound wave through a thin solid rod – Velocity of plane wave in a bulk of solid – Transverse wave propagation along a string stretched under tension – Wave equation in two dimension.

UNIT – III **9**

Transmission Phenomena: Changes in media – Transmission from one fluid medium to another, normal incidence, oblique incidence - Reflection at the surface of a solid, normal incidence, oblique incidence – Standing wave pattern – Transmission through three media.

UNIT – IV **9**

Introduction to the Assessment and Measurement of Sound: Introduction – The decibel scale for the measurement of sound power – Sound level meter – Weighted sound pressure level – Equal Loudness contours – Perceived noisiness – Loudness, Loudness level, perceived noise, perceived noise level – Equivalent sound level – Identified level – Frequency and Amplitude measurement.

UNIT – V **9**

Basic Concepts of Noise Control: Noise Control at source, path, receiver – Noise control by acoustical treatment – Machinery noise – Types of machinery involved – Determination of sound power and sound power level – Noise reduction procedures – Acoustic enclosures.

Total: 45

REFERENCES:

1. Lawrence E. Kinsler, Austin R. Frey, Alan B. Coppens and James V. Sanders, “Fundamentals of Acoustics”, 4th Edition, John – Wiley & Sons Inc., 1999.
2. David A. Bies, Colin H. Hansen and Carl Q. Howard, “Engineering Noise Control: Theory and Practice”, 5th Edition, CRC Press, Taylor & Francis Group, London, 2017.
3. Colin H. Hansen, “Active Control of Sound and Vibration”, 2nd Edition, CRC Press, London, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	identify and analyze the fundamentals of acoustic and wave motion	Analyzing (K4)
CO2:	identify and analyses the characteristics of sound	Analyzing (K4)
CO3:	solve and design the transmission phenomenon of sound	Analyzing (K4)
CO4:	measure and assessment of sound system for various applications	Applying (K3)
CO5:	control the level of vibration and noise in the machines operating under different situations	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3
CO4	3	2	3
CO5	3	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT – Bloom's Taxonomy