P.S.R. ENGINEERING COLLEGE

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

Sevalpatti (P.O), Sivakasi – 626140.

Department of Mechanical Engineering

M.E. Engineering Design

CURRICULUM
AND
SYLLABI

PG
Regulations 2019

Department of Mechanical Engineering

CANDIDATES ADMITTED DURING 2019-2020 AND ONWARDS

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DEPARTMENT VISION & MISSION

Vision

- To provide broad-based education and training in mechanical engineering and its applications to enable the graduates to meet the demands in a rapidly changing needs in industry, academia and society.

Mission

- To impart high quality technical education and training that encompasses both theory and practices with human and social values
- To equip the students to face tomorrows technology embedded global changes
- To create, explore, and develop innovations in mechanical engineering research

Programme Specific Outcomes (PSOs)

- Ability to critical analysis and problem-solving skills required in the field of Thermal, Production and design engineering for carrying out research activities.
- Ability to conduct experiment and simulate the real life situations involved in engineering using computational techniques and instrumentation; and can work independently in research or industrial environments.
- Capability to present the acquired knowledge coherently both in oral and written discourse.
- Capability to compete the available employment opportunities and solve complex engineering problems related to production, Design, Thermal and allied industries using systematic tools.

PROGRAMME OUTCOMES (POs)

Engineering Graduates will be able to:

PO:1 Critical Thinking Ability to identify, critically analyze, formulate and solve complex engineering problems.

PO:2 Problem Solving Use research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions in mechanical engineering.

PO:3 Social and Environmental Sustainability An ability to design, operate, control and maintain a mechanical system and process to meet desired needs within realistic constraints such as health, safety, legal, cultural, environmental and security issues related to manufacturability.

PO:4 Modern Tool Usage An ability to innovate and incorporation of novel research techniques with usage of the techniques, IT skills, and modern engineering tools for various changes in manufacturing engineering practice.

PO:5 Ethics Apply ethical principles and commit to professional ethics and responsibilities and norms of the mechanical engineering practice.

PO:6 Leadership Function affectively as an individual, and as a member or team leader in diverse and inter-disciplinary fields.

PO:7 Communication Communicate effectively through written and oral mediums; make effective presentations and exchanges clear instructions.

PO:8 Life-long Learning Ability to engage in independent research and lifelong learning in the broadest contest of technological changes in Mechanical engineering and allied fields.

P.S.R. ENGINEERING COLLEGE, SIVAKASI-626 140
U.G REGUALTION-2019 (CBCS)
M.E. ENGINEERING DESIGN
CURRICULUM
[I – IV SEMESTER]

Total Credits:69

SEMESTER – I

S.No.	Category	Course Code	Course Title	Hours Per week			Credits
				L	T	P	
THEORY							
1	PC	192ED11	Advanced Stress Analysis	3	0	0	3
2	PC	192ED12	Computer Aided Design	3	0	0	3
3	MC	192SE13	Research Methodology and IPR	3	0	0	3
4	PE		Programme Elective-I	3	0	0	3
5	PE		Programme Elective-II	3	0	0	3
6	MC		Audit Course - 1	2	0	0	0
PRACTICAL							
7	PC	192ED17	Design and Modeling Laboratory	0	0	4	2
8	PC	192ED18	Analysis Laboratory	0	0	4	2
Total Number of Credits							19

SEMESTER –II

S.No.	Category	Course Code	Course Title	Hours Per week			Credits
				L	T	P	
THEORY							
1	PC	192ED21	Finite Element Method	3	0	0	3
2	PC	192ED22	Advanced Vibrations and Acoustics	3	0	0	3
3	PE		Programme Elective-III	3	0	0	3
4	PE		Open Elective-I	3	0	0	3
5	MC		Audit Course - 2	2	0	0	0
PRACTICAL							
7	PC	192ED27	Advanced Simulation Laboratory	0	0	4	2
8	PC	192ED28	Dynamics and Vibration Laboratory	0	0	4	2
9	PROJ	192ED29	Mini Project	0	0	4	2
Total Number of Credits							18

SEMESTER – III

S.No.	Category	Course Code	Course Title	Hours Per week			Credit
				L	T	P	
THEORY							
1.	PE		Programme Elective-IV	3	0	0	3
2	OE		Open Elective-II	3	0	0	3
PRACTICAL							
3	PROJ	192ED31	Project Phase – I	0	0	20	10
Total Number of Credits							16

SEMESTER – IV

S.No.	Category	Course Code	Course Title	Hours Per week			Credit
				L	T	P	
1	PROJ	192ED41	Project Phase – II	0	0	32	16
Total Number of Credits							16

PROGRAMME ELECTIVES

S.No.	Category	Course Code	Course Title	Hours Per week			Credit
				L	T	P	
1.	PE	192EDE01	Applied Mathematics for Design Engineers	3	0	0	3
2.	PE	192EDE02	Advanced Engineering Materials	3	0	0	3
3.	PE	192EDE03	Advanced Machine Design	3	0	0	3
4.	PE	192EDE04	Advanced Machining Processes	3	0	0	3
5.	PE	192EDE05	Analysis and Synthesis of Mechanisms	3	0	0	3
6.	PE	192EDE06	Concepts of Engineering Design	3	0	0	3
7.	PE	192EDE07	Condition Based Monitoring	3	0	0	3
8.	PE	192EDE08	Design for Manufacturing and Assembly	3	0	0	3
9.	PE	192EDE09	Fracture Mechanics	3	0	0	3
10.	PE	192EDE10	Industrial Robotics and Expert Systems	3	0	0	3
11.	PE	192EDE11	Integrated Manufacturing Systems	3	0	0	3
12.	PE	192EDE12	Mechanical Behavior of Materials	3	0	0	3
13.	PE	192EDE13	Mechanical Testing of Materials	3	0	0	3
14.	PE	192EDE14	Multi-body Dynamics	3	0	0	3
15.	PE	192EDE15	Nano materials and Nanotechnology	3	0	0	3
16.	PE	192EDE16	Optimization Techniques in Design	3	0	0	3
17.	PE	192EDE17	Product Design and Development	3	0	0	3
18.	PE	192EDE18	Productivity Management and Re-engineering	3	0	0	3
19.	PE	192EDE19	Quality Concepts in Design	3	0	0	3
20.	PE	192EDE20	Rapid Prototyping and Tooling	3	0	0	3
21.	PE	192EDE21	Reverse Engineering	3	0	0	3
22.	PE	192EDE22	Supply Chain Management	3	0	0	3
23.	PE	192EDE23	Tribology in Design	3	0	0	3

OPEN ELECTIVES

S.No.	Category	Course Code	Course Title	Hours Per week			Credit
				L	T	P	
1.	OE	192OE01	Business Analytics	3	0	0	3
2.	OE	192OE02	Industrial Safety	3	0	0	3
3.	OE	192OE03	Operations Research	3	0	0	3
4.	OE	192OE04	Design of Experiments	3	0	0	3
5.	OE	192OE05	Cost Management of Engineering Projects	3	0	0	3
6.	OE	192OE06	Composite Materials	3	0	0	3
7.	OE	192OE07	Waste to Energy	3	0	0	3
8.	OE	192OE08	Nanomaterials and Nanotechnology	3	0	0	3

AUDIT COURSES

S.No.	Category	Course Code	Course Title	Hours Per week			Credit
				L	T	P	
1.	MC	192AC01	Constitution of India	2	0	0	0
2.	MC	192AC02	Disaster Management	2	0	0	0
3.	MC	192AC03	English For Research Paper Writing	2	0	0	0
4.	MC	192AC04	Sanskrit for Technical Knowledge	2	0	0	0
5.	MC	192AC05	Value Education	2	0	0	0
6.	MC	192AC06	Pedagogy Studies	2	0	0	0
7.	MC	192AC07	Stress Management by Yoga	2	0	0	0
8.	MC	192AC08	Personality Development through Life Enlightenment Skills	2	0	0	0

PC – Programme Core, PE – Programme Elective, OE – Open Elective, AC – Audit Course,
EEC – Employability and Enhancement Course

192ED11	ADVANCED STRESS ANALYSIS				L-T-P	C
					3-0-0	3
Programme:	**M.E ENGINERING DESIGN**	**Sem:**	**I**	**Category:**	**PC**	
Aim:	To impart knowledge in Mechanisms Design, Kinematic analysis and Simulation.					

Course Outcomes:

CO1: Students will understand the tonsorial approach of continuum mechanics and comprehend modern research material.
CO 2: Student will learn basic field equations such as equilibrium equations, compatibility and constitutive relationship.
CO 3: Students will be able to apply basic field equations to torsion, bending and two dimensional elasticity problems, and energy methods.
CO 4: Students will be able to solve problems in unsymmetrical bending and shear center, contact stresses and pressurized cylinders and rotating discs.

THEORY OF ELASTICITY — **9**

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

UNSYMMETRICAL BENDING AND SHEAR CENTER — **9**

Concept of shear center in symmetrical and unsymmetrical bending, stress and deflections in beams subjected to unsymmetrical bending, shear center for thin wall beam cross section, open section with one axis of symmetry, general open section, and closed section

CURVED FLEXIBLE MEMBERS AND STRESSES IN FLAT PLATES — **9**

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

THEORY OF TORSION — **9**

Torsion of prismatic bars of solid section and thin walled section. Analogies for torsion, membrane analogy, fluid flow analogy and electrical analogy. Torsion of conical shaft, bar of variable diameter, thin walled members of open cross section in which some sections are prevented from warping, Torsion of noncircular shaft

STRESSES IN ROTARY SECTIONS AND CONTACT STRESSES — **9**

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

TOTAL= 45 PERIODS

REFERENCE BOOKS

1. Arthur P Boresi, Richard J. Schmidt, "Advanced mechanics of materials", John Wiley, (2002)
2. Borg.S.F., "Matrix-Tensor methods in continuum Mechanics", World Scientific pub. Co., 2nd edition, (1990)
3. Robert D. Cook, Warren C. Young, "Advanced Mechanics of Materials", Mc-millan pub. Co., (1985)
4. Srinath. L.S., "Advanced Mechanics of solids", Tata McGraw Hill, (1992)
5. Timoshenko and Goodier, "Theory of Elasticity", McGraw Hil, 3rd edition, (2010)

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1		3		3					3		2	
CO2	3	2							3		2	
CO3	3	2							3	2		
CO4	2	3							3	2		
CO5												
CO6												

192ED12	COMPUTER AIDED DESIGN			L-T-P	C
				3-0-0	3
Programme:	**M.E ENGINERING DESIGN**	**Sem:**	**I**	**Category:**	**PC**
Aim:	To provide an overview of how computers are being used in mechanical component design				

Course Outcomes:

The Students will be able to

CO1: Have a conceptual understanding of the principles of CAD systems, the implementation of these principles, and its connections to CAM and CAE systems.

CO2: Understand 2D, 3D transformations and projection transformations

CO3: Get knowledge of various approaches of geometric modeling

CO4: Understand mathematical representation of 2D and 3D entities

CO5: Understand the CAD standards

FUNDAMENTALS OF CAD — **9**

CAD Hardware and Software, Types of systems and system considerations, input and output devices, hardware integration and networking, hardware trends, Software modules, Computer Communications, Principle of networking, classification networks, network wring, methods, transmission media and interfaces, network operating systems,

COMPUTER GRAPHICS — **9**

Introduction, transformation of geometric models: translation, scaling, reflection, rotation, homogeneous representation, concatenated transformations; mappings of geometric models, translational mapping rotational mapping, general mapping, mappings as changes of coordinate system; inverse transformations and mapping;

GEOMETRIC MODELING — **9**

Representation of curves- Hermite curve- Bezier curve- B-spline curves-rational curves-Techniquesfor surface modeling – surface patch- Coons and bicubic patches- Bezier and B-spline surfaces.

SOLID MODELING, — **9**

Fundamentals, boundary representation (B-rep), Constructive Solid Geometry (CSF), sweep representation, Analytic Solid Modeling (ASM), other representations; solid manipulations, solid modeling based applications: mass properties calculations, mechanical tolerancing, etc.

CAD STANDARDS — **9**

Standards for computer graphics- Graphical Kernel System (GKS) - standards for exchangeimages- Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, CALSetc. - communication standards.

TOTAL= 45 PERIODS

REFERENCE BOOKS

1. Chris McMahon and Jimmie Browne “CAD/CAM Principles", "Practice and Manufacturingmanagement “ Second Edition, Pearson Education, 1999.
2. Donald Hearn and M. Pauline Baker “Computer Graphics”’. Prentice Hall, Inc, 1992. Education - 2003.
3. Foley, Wan Dam, Feiner and Hughes - "Computer graphics principles & practice" Pearson
4. Ibrahim Zeid “Mastering CAD CAM” Tata McGraw-Hill Publishing Co.2007
5. William M Neumann and Robert F.Sproul “Principles of Computer Graphics”, McGraw Hill Book Co. Singapore, 1989.

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3		2	2					3	2		
CO2	3								3		2	
CO3	2	2	3	3					2	3		2
CO4	3	2		2					3	2		2
CO5												
CO6												

192SE13	RESEARCH METHODOLOGY AND IPR				L-T-P	C
					3-0-0	3
Programme:	**M.E ENGINERING DESIGN**	**Sem:**	**I**	**Category:**	**PC**	
Aim:	To develop the research skills of the students in investigating into the research problems with a view to arriving at objective findings and conclusions and interpreting the results of their investigation in the form of systematic reports.					

Course Outcomes:

The Students will be able to

CO1: Understand the basics elements in research.

CO2: Discuss the various faces of experimental design methodology.

CO3: illustrate the data collection methods with its aspects.

CO4: Apply the knowledge of multivariate statistical techniques and develop research report as a model

CO5: Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D

CONCEPT OF RESEARCH AND ITS APPLICATION **9**

Concept of research and its Application - types of research - Quantitative and Qualitative Research Techniques - Types of problems Encountered by the Researcher - Process of Research - Steps Involved in Research Process - Hypothesis development – Hypothesis testing with quantitative data. Research design – Purpose of the study: Exploratory, Descriptive, Hypothesis Testing.

EXPERIMENTAL DESIGN **9**

Laboratory and the Field Experiment –Internal and External Validity –Factors affecting Internal validity. Measurement of variables –Scales and measurements of variables. Developing scales – Rating scale and attitudinal scales –Validity testing of scales –Reliability concept in scales being developed –Stability Measures.

DATA COLLECTION METHODS **9**

Concept of Sample, Sample Size and Sampling Procedure - Various Types of Sampling Techniques - Determination and Selection of Sample Member - Types of Data: Secondary and Primary - Precautions in Preparation of Questionnaire and Collection of Data - Various Methods of Data Collection - Preparation of Questionnaire and Schedule - Types of Questions, Sequencing of Questions - Check Questions, Length of Questionnaire.

ANALYSIS OF DATA AND REPORT PREPARATION **9**

Data Analysis - Coding, Editing and Tabulation of Data - Various Kinds of Charts and Diagrams Used in Data Analysis - Factor Analysis –Cluster Analysis –Discriminant Analysis –Multiple Regression and Correlation –Canonical Correlation – Use of SPSS in Data Analysis - Application and Analysis of Variance (ANOVA) - Measurement and Central Tendency - Measure of Dispersion and their advantages. Report Preparation and it's Significance - Types and Layout of Research Report - Precautions in Preparing the Research Report - Integral parts of a report.

INTELLECTUAL PROPERTY RIGHTS **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, Patenting under PCT , Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

TOTAL= 45 PERIODS

REFERENCE BOOKS

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International.
3. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016
4. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.
5. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing.

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3		2						3		2	
CO2	2	2	3	2					3	3	2	2
CO3			2		3	2	2		2		2	
CO4		3		2	2	2			3	2		
CO5			2		3	2	2				2	3
CO6												

192ED14	DESIGN AND MODELLING LABORATORY				L-T-P	C
					0-0-2	1
Programme:	**M.E ENGINERING DESIGN**	**Sem:**	**I**	**Category:**	**PC**	
Aim:	To communicate knowledge in Solid Modeling by using relevant CAD software					

Course Outcomes:

The Students will be able to

CO1. Interpret the fundamentals of the Computer Aided Design
CO2. Determine the basic concepts of graphics like CSG, B-Rep approaches in solid modeling
CO3. Create the basic shapes of engineering components by using CAD software package
CO4. Identify the different sheet metal modeling tools in computeraided modeling of complex structural problems
CO5. Illustrate the solid part modelling to join together using weldment
CO6. Built assembly models

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

SYSTEM REQUIRMENTS (for a batch of 25 Students)

Descriptionof Equipment	**Quantity Required**
HARDWARE	
Computer Server	1 No.
Computer System 17" VGA Color Monitor Pentium IVProcessor 40GBHDD 512MBRAM	25 Nos.
SOFTWARE	
Suitable modeling software like Pro-E/Solid Works/Solid Edge/CATIA	25 licenses

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1		3		2			3			3	3	
CO2		2		3					2	3	2	
CO3				3		2				3	3	2
CO4				3			2			2	3	2
CO5	2	2		3						2	3	
CO6	2		2	3			2	2		3	2	2

191ED15	ANALYSIS LABORATORY			L-T-P	C
				0-0-4	2
Programme:	**M.E. ENGINEERING DESIGN**	**Sem:**	**I**	**Category:**	**PC**
Prerequisites:	-				
Aim:	To gain knowledge in analyzing various structures by using relevant software				

Course Outcomes:

The students will be able to

CO1. Demonstrate the features of ANSYS software
CO2. Validate the stress analysis in beam problems with empirical formulas
CO3. Explicit the stress analysis of a plate with a circular hole and axi-symmetric component
CO4. Identify the need of mode frequency analysis in 2D component
CO5. Realize the Thermal analysis of a 2D component
CO6. Import any solid model to ANSYS for contact analysis

List of Exercises

1. Static Analysis of 2-D beam problems
2. Static Analysis of Plane stress problems
3. Static Analysis of Axisymmetric problems
4. Mode frequency analysis of a 2D plate
5. Mode frequency analysis of beams
6. Harmonic analysis of a 2D component
7. Transient Heat Transfer Analysis of 2D problems
8. Heat Transfer Analysis of Axisymmetric Problems
9. Contact Analysis of a simple solid model
10. Buckling Analysis of a column

SYSTEM REQUIREMENTS

Hardware:

1. Intel i3 core due processor with 4GB ram with 500GB hard disk – 25 Nos.
2. Laser Printer – 1 No.

Software:

1. ANSYS V14.5/equivalent – 25 licenses

TotalPeriods:45

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO 2	PSO 3	PSO 4
CO1	3	2		2					2	3		
CO2	2	3		3					2	3	2	3
CO3	2	2		3						2	3	2
CO4	2	2		3			2			2	3	2
CO5	2	2		3			2			2	3	
CO6	2	2		3	2		2		2	2	3	

192ED21	FINITE ELEMENT METHOD				L-T-P	C
					3-0-0	3
Programme:	**M.E ENGINERING DESIGN**	**Sem:**	**II**	**Category:**	**PC**	
Aim:	To introduce the fundamentals of vibrations finite element methods used in mechanical design.					

Course Outcomes:

The Students will be able to

CO1: Study the general steps in finite element analysis and derive the basic finite element equation

CO2: Study the various finite element methods, concepts, types of elements and element matrices

CO3: Solve the linear elasticity problems in the field of heat transfer and fluid mechanics.

CO4: Assemble the finite element structural dynamics and vibrational matrices, and also determine the design response to those conditions

CO5: Solve the transient non-linear problems and find out the stresses and strains through post processing.

GENERAL INTRODUCTION **9**

Introduction – structural element and system – assembly and analysis of a structure – boundary conditions – general pattern – standard discrete system – transformation of coordinates – examples – direct physical approach to problems in elasticity – direct formulation – displacement approach – minimization of total potential – convergence criteria – discretization error – nonconforming elements and patch test – solution process.

GENERALIZATION OF FINITE ELEMENT CONCEPTS AND ELEMENT SHAPE FUNCTIONS **9**

Boundary value problems – integral or weak statements – weighted residual methods – Galerkin method – virtual work as weak form of equations in solid and fluid mechanics – variational principles – establishment of natural variational principles for linear self-adjoint differential equations – standard and hierarchical elements – shape functions – rectangular elements – completeness of polynomials – Lagrange family – Serendipity family – rectangular prisms – tetrahedral elements – global and local finite element approximation – mapped elements – coordinate transformations – geometrical conformity of elements – evaluation of element matrices – order of convergence – numerical integration.

APPLICATIONS TO FIELD PROBLEMS **9**

Solution to problems in linear elasticity – plane problems in elasticity – plates and shells – solution of problems in heat-transfer and fluid mechanics – numerical examples – discussion on error estimates.

FINITE ELEMENTS IN STRUCTURAL DYNAMICS AND VIBRATIONS **9**

Dynamic equations – stiffness, mass and damping matrices – consistent and diagonal mass matrices – Extraction of natural frequencies and modes – Reduction of number of degrees of freedom – modal methods – component mode synthesis – harmonic analysis – response history – explicit and implicit direct integration – stability and accuracy – analysis of response spectra.

NON-LINEAR ANALYSIS **9**

Non-linear problems in elasticity – some solution methods – plasticity: introduction, general formulation for small strains – formulation for von Mises theory – computational procedure – problems of gaps and contact – geometric non-linearity – modelling considerations.

TOTAL= 45 PERIODS

REFERENCE BOOKS:

1. Charles E.Knight, "The Finite Element Method in Mechanical Design", PWS-Kent publishing company, (1993)
2. Cook, R.D., Malkus, D. S., Plesha,M.E., and Witt,R.J., "Concepts and Applications of Finite Element Analysis", Wiley Student Edition, 4th Edition, New Delhi, 1st Reprint (2007)
3. Huebner, K.H., Dewhirst, D.L., Smith, D.E & Byron,T.G., "The Finite Element Method for Engineers", Wiley Student Edition, 4 th Edition, John Wiley & Sons Pvt. Ltd., (2004)
4. Ramamurthi, V., "Finite Element Method in Machine Design", Narosa Publishing House, (2009)
5. Zienkiewicz.O.C, Taylor.R.L., "The Finite Element Method", McGraw Hill International Editions, 4th Edition, Volume 2, (1991)

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	3	2							3	2	2	
CO2	3	2							3	2	2	
CO3	3	3		2					3	2	2	
CO4	3	3		2					3	2		2
CO5	3	3		2					3	2		
CO6												

192ED22	ADVANCED VIBRATIONS AND ACOUSTICS			L-T-P	C
				3-0-0	3
Programme:	**M.E ENGINERING DESIGN**	**Sem:**	**II**	**Category:**	**PC**
Aim:	To introduce the fundamentals of vibrations, study effect of vibration of different degree of freedom systems.				

Course Outcomes:

The Students will be able to

CO1: Study the fundamentals of vibrations

CO2: Understand the vibrations of different degrees of freedom system

CO3: Know the methods of vibration analysis, controlling the effect of vibration.

CO4: Discuss the effect of vibrations on important mechanical elements

CO5: Know various terminologies used in acoustics and acoustic wave transmission, derive plane and spherical wave equations, and obtain sound pressure level at a given distance from a simple sound source of known strength.

FUNDAMENTALS OF VIBRATION **9**

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

TWO DEGREE FREEDOM SYSTEM AND MULTI-DEGREE FREEDOM SYSTEM **9**

Introduction-Free Vibration Of Undamped And Damped- Forced Vibration With Harmonic , Excitation System – Coordinate Couplings And Principal Coordinates -Multi Degree Freedom System – Influence Coefficients and stiffness coefficients – Flexibility Matrix and Stiffness Matrix – Eigen Values and Eigen Vectors – Matrix Iteration Method – Approximate Methods: Dunkerley, Rayleigh's, and Holzer Method – Geared Systems – Eigen Values & Eigen vectors for large system of equations using sub space, Lanczos method – Continuous System: Vibration of String, Shafts and Beams.

CONTINUOUS SYSTEM **9**

Continuous Systems, Natural Vibrations of beams – Differential equation of motion, solution by the method of separation of variables, frequency parameter, natural frequencies and mode shapes, forced vibration of simply supported beam subjected to concentrated harmonic force at a point, Mode summation method, discretized models of continuous systems and their solutions using Rayleigh – Ritz method

VIBRATION CONTROL **9**

Specification of Vibration Limits – Vibration severity standards – Vibration as condition Monitoring tool – Vibration Isolation methods – Dynamic Vibration Absorber, Torsional and Pendulum Type Absorber – Damped Vibration absorbers – Static and Dynamic Balancing – Balancing machines – Field balancing – Vibration Control by Design Modification – Active Vibration Control.

ACOUSTICS **9**

Plane acoustic waves, Sound speed, characteristic acoustic impedance of elastic media, sound intensity, dB scale, Transmission Phenomena, transmission from one fluid medium to another, normal incidence, reflection at the surface of a solid, standing wave patterns, Symmetric Spherical waves, near and far fields, simple models of sound sources, sound power, determination of sound power and intensity levels at a point due to a simple source.

TOTAL= 45 PERIODS

REFERENCE BOOKS

1. Graham Kelly, S. & Shashidar K. Kudari, "Mechanical Vibrations", Tata McGraw Hill Publishing, New Delhi, (2007)
2. Lawrence E. Kinsler and Austin R.Frey, "Fundamentals of acoustics", Wiley Eastern Ltd., 1987.
3. Ramamurti, V., "Mechanical Vibration Practice with Basic Theory", Narosa, New Delhi, (2000)
4. Rao, S.S., "Mechanical Vibrations", Addison Wesley Longman, (1995)
5. Thomson, W.T., "Theory of Vibration with Applications", CBS Publishers and Distributors, New Delhi, (1990)

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	3	2							3			
CO2	3	2			2				3	2	2	
CO3	3	2			2				3	2	2	
CO4	3	2			2				3	2	2	
CO5	3	3			2				3	2	2	
CO6												

192ED23	ADVANCED SIMULATION LABORATORY			L-T-P	C
				0-0-4	2
Programme:	**M.E ENGINERING DESIGN**	**Sem:**	**II**	**Category:**	**PC**
Aim:					

Course Outcomes:

The Students will be able to

CO1. Determine the various static loads of machine elements
CO2. Analyze the thermal related mechanical systems
CO3. Get knowledge on modal analysis of various elements
CO4. Investigate the boilers by using axisymmetric problems
CO5. Understanding the nature of machine elements under dynamic loads
CO6. Acquire knowledge on analysis of various non linear systems:

Analysis of Mechanical Components – Use of FEA Packages like ANSYS/ NASTRAN etc., Exercises shall include analysis of

1. Force and Stress analysis using link elements in Trusses, cables etc.
2. Stress and deflection analysis in beams with different support conditions.
3. Stress analysis of flat plates and simple shells.
4. Stress analysis of axi – symmetric components.
5. Thermal stress and heat transfer analysis of plates.
6. Thermal stress analysis of cylindrical shells.
7. Vibration analysis of spring-mass systems.
8. Model analysis of Beams.
9. Harmonic, transient and spectrum analysis of simple systems.

SYSTEM REQUIRMENTS
(for a batch of 25 Students)

Descriptionof Equipment	**Quantity Required**
HARDWARE	
Computer Server	1 No.
Computer System	
30 17” VGA Color Monitor Pentium IVProcessor 40GBHDD 512MBRAM	25 Nos.
Printer	1 No.
SOFTWARE	
Suitableanalysissoftware	25 licenses

TOTAL : 45PERIODS

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3		3					2	3	2	
CO2	3	3		3					2	3	2	2
CO3	3	3		3					2	3	2	2
CO4	3	3		3	2	2	2		2	3	2	2
CO5	3	2		3					2	3	2	
CO6	3	2		2								

192ED24	DYNAMICS AND VIBRATION LABORATORY			L-T-P	C
				0-0-4	2
Programme:	M.E., Engineering Design	**Sem:**	**II**	**Category:**	**PC**
Prerequisites:	Advanced Vibration and Acoustics				
Aim:	To educate the students to apply the kinetic solutions to various experiments				

Course Outcomes:

The students will be able to

CO1. Know the functions of kinematic links and its mechanisms
CO2. Interpret the fundamentals of the natural frequency of free vibration of fixed beam
CO3. Find the gyroscopic effect
CO4. Determine the basic concepts of governor apparatus
CO5. Identify the different cam profile mechanisms
CO6. Enumerate the critical speed of shaft

LISTOFEXPERIMENTS

1. To study the forced vibration of the beam for different damping.
2. To determine the radius of gyration 'k' of a given compound pendulum.
3. To determine the radius of gyration of given bar using bi-filler suspension.
4. To verify the dunker lay's rule viz.
5. To determine the natural frequency of undamped torsional vibration of a single rotor shaft system.
6. To determine the natural frequency of undamped torsional vibration of two rotor shaft system.
7. To determine the frequency of undamped free vibration of an equivalent spring mass system.
8. To determine the frequency of damped force vibration of a spring mass system

TotalPeriods:45

LIST OF EQUIPMENTS

1. Frequency of undamped free vibration set-up of an equivalent spring mass system - 1
2. Frequency of damped forced vibration set-up of an spring-mass system – 1
3. Natural Frequency of undamped torsional vibration set-up of single rotor shaft system – 1
4. Natural Frequency of undamped torsional vibration set-up of two rotor shaft system – 1
5. Forced vibration set-up of a beam with different damping coefficients – 1
6. Compound pendulum set-up for determination of its radius of gyration -1
7. Bar with bi-filar suspension set-up determination of its radius of gyration – 1
8. Beam with point loads set-up under any support condition - 1

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3			2		2		3	3	2	
CO2	3	3			2		2		3	3	2	
CO3	3	3			2		2		3	3	2	
CO4	3	3			2		2		3	3	2	
CO5	3	3			2		2		3	3	2	
CO6	3	3			2		2					

Programme Elective Courses

192EDE01	APPLIED MATHEMATICS FOR DESIGN ENGINEERS				L-T-P	C
					3-0-0	3
Programme:	**M.E ENGINERING DESIGN**	**Sem:**	**I**	**Category:**	**PE**	
Prerequisites:	Nil					
Aim:	To develop the mathematical skill in the area of Applications in Engineering Design					

Course Outcomes:

The Students will be able to

CO1: Understand Joint distributions and random variables

CO2: Solve the Finite difference methods and – Numerical solution of partial differential equations

CO3: Familiarize with the tensor analysis

CO4: Understand the calculus of variation

CO5: Use fast Fourier transform

RANDOM VARIABLES **9**

Joint distributions – Marginal and Conditional distributions – functions of two – dimensional random variables – Regression curve – Correlation.

COMPUTATIONAL METHODS IN ENGINEERING **9**

Boundary value problems for ODE – Finite difference methods – Numerical solution of PDE – Solution of Laplace's and Poisson equation – Liebmann's iteration process – Solution of heat conduction equation by Schmidt explicit formula and Crank-Nicolson implicit scheme – Solution of wave equation.

TENSOR ANALYSIS **9**

Summation convention – Contra variant and covariant vectors – contraction of tensors – inner product – quotient law – metric tensor – Christoffel symbols – covariant differentiation – gradient, divergence and curl.

CALCULUS OF VARIATION **9**

Variation and its properties – Euler's equation – functionals dependent on first and higher order derivatives – functionals dependent on functions of several independent variables – problems with moving boundaries – direct methods – Ritz and Kantorovich methods.

FAST FOURIER TRANSFORM **9**

Discrete Fourier transform – linearity and periodicity – inverse N-point DFT – DFT approximation of Fourier coefficients – sampled Fourier series – Approximation of Fourier transform by an N-point DFT – FFT – Computational efficiency of FFT.

TOTAL= 45 PERIODS

REFERENCE BOOKS:

1. Andrews, L.C. and Philips, R. L. "Mathematical Techniques for Engineers and Scientists", Prentice Hall of India, (2006)
2. Grewal, B.S., "Higher Engineering Mathematics", 40th edition, Khanna Publishers, (2007)
3. Grewal, B.S., "Numerical methods in Engineering and Science", 7th edition, Khanna Publishers, (2005)
4. Gupta, A.S., "Calculus of variations with applications", Prentice-Hall of India, New Delhi, (1997)
5. James, G., "Advanced Modern Engineering Mathematics", 3rd edition, Pearson Education, (2004)

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	2						2	3			2
CO2	3	2						2	3			2
CO3	3	2						2	3			2
CO4	3	2						2	3			2
CO5	3	2						2	3			2
CO6												

192EDE02	ADVANCED ENGINEERING MATERIALS	L-T-P	C
		3-0-0	3

Programme:	M.E ENGINERING DESIGN	Category:	PE
Aim:	To impart the knowledge on properties and the applications of materials		

Course Outcomes:

The Students will be able to

CO1. Demonstarte an understanding of mechanics, physical and chemical properties of materials including metals, ceramics, polymers and composites

CO2:Understand existence of imperfections and their effects on mechanical properties of materials and cause of failure

CO3: Demonstrate understanding of phase diagrams and their use in predicting phase transformation and microstructure

CO4: Understand and predict various types of failures using concept of fracture mechanics, creep and effect of impact

CO5:Know Electrical, Thermal, Optical and Magnetic Properties of metals, ceramics, polymers and composites

CO6: Understand the economic considerations in usage and recycling of materials in humen use

INTRODUCTION **9**

Historical perspective of Materials Science. Why study properties of materials? Classification of materials. Advanced Materials, Future materials and modern materials, Atomicstructure. Atomic bonding in solids, Crystal structures, Crystalline and noncrystalline materials. Miller indices. Anisotropic elasticity. Elastic behaviour of composites. Structure and properties of polymers. Structure and properties of ceramics.

IMPERFECTIONS AND STRENGTHENING MECHANISMS **9**

Point defects. Theoretical yield point. Line defects and dislocations. Interfacial defects. Bulk or volume defects. Atomic vibrations; Elastic deformation. Plastic deformation. Interpretation of tensile stress-strain curves Yielding under multiaxial stress. Yield criteria and macroscopic aspects of plastic deformation. Property variability and design factors, Diffusion mechanisms. Steady and non-steady state diffusion. Factors that influence diffusion. Non-equilibrium transformation and microstructure, Dislocation and plastic deformation. Mechanisms of strengthening in metals. Recovery, recrystallization and grain growth. Strengthening by second phase particles. Optimum distribution of particles. Lattice

PHASE DIAGRAMS **9**

Equilibrium phase diagrams. Particle strengthening by precipitation. Precipitation reactions. Kinetics of nucleation and growth. The iron-carbon system. Phase transformations. Transformation rate effects and TTT diagrams. Microstructure and property changes in iron-carbon system

FAILURE **9**

Fracture. Ductile and brittle fracture. Fracture mechanics. Impact fracture. Ductile brittle transition. Fatigue. Crack initiation and propagation. Crack propagation rate. Creep. Generalized creep behaviour. Stress and temperature effects

APPLICATIONS AND PROCESSING **9**

Types of metals and alloys. Fabrication of metals. Thermal processing of metals. Heat treatment. Precipitation hardening. Types and applications of ceramics. Fabrication and processing of ceramics, Mechanical behaviour of polymers. Mechanisms of deformation and strengthening of polymers. Crystallization, melting and glass transition. Polymer types. Polymer synthesis and processing, Particle reinforced composites. Fibre reinforced composites. Structural composites

TOTAL= 45 PERIODS

REFERENCE BOOKS

1. Dieter, G. E., “Mechanical Metallurgy”, McGraw Hill Book Company, (2013)
2. Kenneth G.Budinski and Michael K.Budinski “Engineering Materials”, Prentice Hall of India Private Limited, (2012)
3. Smallman R.E., Bishop R J “Modern Physical Metallurgy and Material Engineering, Science, Process, application”, Butterworth Heinemann, Sixth Ed., 1999.
4. Sydney H. Avner “Introduction to Physical Metallurgy” McGraw Hill Book Company, (2010)
5. William D. Callister, Jr, “Materials Science and Engineering”, John Wiley & sons, 07

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	3	2					2		3		2	
CO2	3	2					2		3		2	
CO3	3	2					2		3		2	
CO4	3	2					2		3		2	
CO5	3	2					2		3		2	
CO6	3	2					2		3		2	

192EDE03	ADVANCED MACHINE DESIGN	L-T-P	C
		3-0-0	3

Programme:	M.E ENGINERING DESIGN	Category:	PE
Aim:	To provide an overview of advances in machine design		

Course Outcomes:

The Students will be able to

CO1: Realize that creativity, manufacturability, assembly, maintainability, emotions, reliability are also important aspects of design other than finding dimensions and stresses in the highly competitive, dynamic and customer centered market.

CO2: Demonstrate the ability to identify needs of the customer and convert them in to technical specifications of a product.

CO3: Generate different ideas after identifying the need and determining the specifications and constraints of a product for a particular purpose.

CO4: Understand the principals used while designing for manufacture, assembly, emotions and maintenance.

CO5: Know various methods of rapid prototyping the products to test and modify the designs.

CO6: Design the components considering strength based reliability.

INTRODUCTION	**9**
Development processes and organizations, Product Planning,	
CONCEPT GENERATION AND TESTING	**9**
Need Identification - problem definition, product specification, concept generation&selection, evaluation, creativity methods, Concept testing	
DESIGN FOR PROCESSES	**9**
Design for manufacture, assembly, maintenance, casting, forging,	
RELIABILITY OF DESIGN	**9**
Design for Reliability, strength based reliability, parallel and series systems, robust design,	
INDUSTRIAL DESIGN	**9**
Design for Emotion and experience, Introduction to retrofit and Eco design, Human behavior in design	
TOTAL= 45 PERIODS	

REFERENCE BOOKS

1. Averill M. Law and W. David Kelton "Simulation, modelling and analysis", McGraw Hill Book Company, 1991.
2. George E Dieter, "Engineering Design", McGraw Hill Company
3. Pahl, G.and W.Beitz, Engineering Design–A Systematic Approach – Springer, 2nd Ed., 1996.
4. Prashant Kumar, "Product Design, Creativity, Concepts and Usability", Eastern Economy Edition, PHI New Delhi.
5. Woodson T.T., "Introduction to Engineering Design", McGraw Hill Book Company, 1966

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3		2				2		3		2	2
CO2	3		2				2		3		2	
CO3	3		2		2		2		3		2	
CO4	3		2		2		2		3		2	
CO5	3		2				2		3		2	
CO6	3		2	2			2		3	2	2	3

192EDE04	ADVANCED MACHINING PROCESSES	L-T-P	C
		3-0-0	3

Programme:	M.E ENGINERING DESIGN	Category:	PE
Aim:	To understand the various advanced machining processes, advantages and applications		

Course Outcomes:

The Students will be able to

CO1. Classify unconventional machining process and identify various process selection parameters
CO2. Learn various mechanical energy based process
CO3. Understand the various unconventional machining process based on electrical energy
CO4. Study the various chemical energy machining process, parameters affecting it and applications
CO5. Know the machining process that fall under electro chemical energy, its parameters and applications
CO6. Explain the various thermal energy based machining processes in detail along with their applications

INTRODUCTION **9**

Introduction to advanced machining processes – Need – classification – Brief overview - Ultrasonic machining(USM) - Ultrasonic Machining (USM) - Working Principles – equipment used – Process parameters – MRR – Variation in techniques used – Applications

MECHANICALENERGYBASEDPROCESSES **9**

Abrasive jet machining (AJM) - Water jet cutting (WJC) and Abrasive water jet machining (AWJM) - Magnetic abrasive finishing (MAF) - Abrasive flow finishing (AFF)- Magnetorheological finishing (MRF) - Magnetorheological abrasive flow finishing (MRAFF) - working Principle – equipments – Process Parameters – Surface Finish and MRR – Applications

ELECTRICALENERGYBASEDPROCESSES **9**

Electric Discharge Machining (EDM) – Electric Discharge Grinding (EDG) - Electric Discharge Diamond Grinding (EDDG) - Wire Electric Discharge Machining (W-EDM) - working Principle – equipments – Process Parameters – Surface Finish and MRR – Applications

ELECTRO-CHEMICALENERGYBASED PROCESSES **9**

Electrochemical Machining (ECM) - Electrochemical Grinding (ECG) - Electrostream Drilling (ESD) - Shaped Tube Electrolytic Machining (STEM) – working Principle – equipments –Process Parameters – Surface finish and MRR – Applications

THERMALENERGYBASEDPROCESSES **9**

Laser Beam machining and drilling (LBM), plasma Arc machining (PAM) and Electron Beam Machining (EBM) – Principles – Equipment –Types – Beam control techniques – Applications

TOTAL= 45 PERIODS

REFERENCE BOOKS

1. Benedict G.F., “Nontraditional Manufacturing Processes”, Marcel Dekker Inc., New York, (2014)
2. Mishra P.K., “Non-Conventional Machining”, The Institution of Engineers,India, (2015)
3. Pandey P.C. and Shan H.S., “Modern Machining Processes”, Tata McGraw-Hill, New Delhi (2015)
4. Paul De Garmo, Black J.T. and Ronald A. Kohser., “Material and Processes in Manufacturing”, Prentice Hall of India Pvt. Ltd., New Delhi, (2012)
5. Vijay K. Jain, “Advanced Machining Processes”, Allied Publishers Pvt. Ltd., New Delhi, (2014)

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3			2					3		2	
CO2	3		2	2					3		2	
CO3	3		2	2					3			2
CO4	3	2	2	2					3			2
CO5	3		2	2					3			2
CO6	3	2	2	2					3			2

192EDE05	ANALYSIS AND SYNTHESIS OF MECHANISMS	L-T-P	C
		3-0-0	3
Programme:	**M.E. ENGINEERING DESIGN**	**Category:**	**PE**
Aim:	To understand the analysis and synthesis of mechanisms		

Course Outcomes:

The Students will be able to

CO1. Develop analytical equations describing the relative position, velocity and acceleration of all moving links.

CO2. Select, configure, and synthesize mechanical components into complete systems.

CO3. Use kinematic geometry to formulate and solve constraint equations to design linkages for specified tasks.

CO4. Formulate and solve four position synthesis problems for planar and spherical four-bar linkages by graphical and analytical methods.

CO5. Analyze and animate the movement of planar and spherical four-bar linkages.

CO6. Apply modern computer-based techniques in the selection, analysis, and synthesis of components and their integration into complete mechanical systems.

INTRODUCTION **9**

Basic Concepts; Definitions and assumptions; planar and spatial mechanisms; kinematic pairs; degree of freedom; equivalent mechanisms; Kinematic Analysis of Planar Mechanisms. Review of graphical and analytical methods of velocity and acceleration analysis of kinematically simple mechanisms, velocity-acceleration, analysis of complex mechanisms by the normal acceleration and auxiliary-point methods.

CURVATURE THEORY **9**

Fixed and moving centrodes, inflection circle, Euler-Savary equation, Bobillier constructions, cubic of stationary curvature, Ball's point, Applications in dwell mechanisms.

SYNTHESIS OF PLANAR MECHANISMS **9**

Kinematic Synthesis of planar mechanisms, accuracy (precision) points, Chebesychev spacing, types of errors, Graphical synthesis for function generation and rigid body guidance with two, three and four accuracy points using pole method, centre and circle point curves, Analytical synthesis of four-bar and slider-crank mechanisms.

SYNTHESIS USING COMPLEX NUMBERS. **9**

Freudenstein's equation, synthesis for four and five accuracy points, compatibility condition, synthesis of four-bar for prescribed angular velocities and accelerations using complex numbers, three accuracy point synthesis using complex numbers.

KINEMATIC ANALYSIS **9**

Coupler Curves - Equation of coupler curve, Robert-Chebychev theorem, double points and symmetry. Kinematic Analysis of Spatial Mechanisms, Denavit-Hartenberg parameters, matrix method of analysis of spatial mechanisms

TOTAL= 45 PERIODS

REFERENCE BOOKS

1. Erdman A.G. and G.N. Sandor, "Mechanism Design – Analysis and Synthesis", (Vol. 1 and 2), Prentice Hall India, 1988.
2. Ghosh A. and A.K. Mallik, "Theory of Machines and Mechanisms", Affiliated East-West Press, New Delhi, 1988.
3. Hartenberg R.S. and J. Denavit, "Kinematic Synthesis of Linkages", McGraw-Hill, New York, 1980.
4. Robert L.Nortan ,"Design of Machinery',Tata McGraw Hill Edition
5. Shigley J.E. and J.J. Uicker, "Theory of Machines and Mechanisms", 2nd Edition, McGraw-Hill, 1995.

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3		2					3	2		
CO2	3	3		2					3	2		
CO3	3	3		2					3	2		
CO4	3	2		2					3	2		
CO5	3	2		2					3	2		
CO6	3	2		2					3	2		

192EDE06	CONDITION BASED MONITORING	L-T-P	C
		3-0-0	3
Programme:	**M.E. ENGINEERING DESIGN**	**Category:**	**PE**
Aim:	To understand the analysis and synthesis of mechanisms		

Course Outcomes:

The Students will be able to

CO1. Know and be able to explain the aim and the basics of CM

CO2. Aware of some methods and procedures applied for general CM;

CO3. Appreciate and understand the basic idea behind vibration-based structural health monitoring and vibration-based condition monitoring, know the general stages of CM;

CO4. Apply some basic techniques for analysis of random and periodic signals;

CO5. Know the basics of Vibration of Linear Systems: time and frequency response, resonance;

CO6. Aware of some basic instrumentation used for machinery and structural vibration-based monitoring;

INTRODUCTION	**9**
The basic idea of health monitoring and condition monitoring of structures and machines. Some basic techniques.	
BASICS OF SIGNAL PROCESSING	**9**
Study of periodic and random signals, probability distribution, statistical properties, auto and cross correlation and power spectral density functions of commonly found systems, spectral analysis.	
FOURIER TRANSFORM	**9**
Fourier transform: the basic idea of Fourier transform, interpretation and application to real signals. Response of linear systems to stationary random signals: FRFs, resonant frequencies, modes of vibration,	
VIBRATION-BASED MONITORING	**9**
Introduction to vibration-based monitoring, Machinery condition monitoring by vibration analysis: Use and selection of measurements, analysis procedures and instruments	
APPLICATIONS OF CONDITION MONITORING	**9**
Typical applications of condition monitoring using vibration analysis to rotating machines, Some other health monitoring techniques, acoustic emission, oil debris and temperature analysis, Applications	
	TOTAL= 45 PERIODS

REFERENCE BOOKS

1. Adams, M., Rotating machinery analysis - from analysis to troubleshooting, Marcel Dekker, New York, 01, ISBN 0-8247-0258-1.
2. Cornelius Scheffer Paresh Girdhar, Practical Machinery Vibration Analysis and Predictive Maintenance, Newnes, 1st Edition, 04, Paperback ISBN: 9780750662758

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2		2				3	2		
CO2	3	2	2		2				3	2		
CO3	3	3	2		3				3	2		2
CO4	3	3	2		3				3	2		2
CO5	3		2		3				3	2		
CO6	3	2	2		2				3	2		2

192EDE07	CONCEPTS OF ENGINEERING DESIGN	L-T-P	C
		3-0-0	3

Programme:	M.E ENGINERING DESIGN	Category:	PE
Prerequisites:	Nil		
Aim:	To understand the basic steps involved in concept of engineering design		

Course Outcomes:

The Students will be able to
CO1: Familiarize the various steps involved in the design process and fundamentals
CO2: Develop the skills on ethical requirements and know about customer requirements
CO3: Learn to know the design methods and optimization
CO4: Understand the material selection process and design considerations
CO5: Know the reliability in design

DESIGN FUNDAMENTALS	9

Importance of design – The design process – Considerations of Good Design – Morphology of Design – Organization for design – Computer Aided Engineering – Designing to codes and standards – Concurrent Engineering – Product and process cycles – Technological Forecasting – Market Identification – Competition Bench marking.

CUSTOMER ORIENTED DESIGN & SOCIETAL CONSIDERATIONS	9

Identification of customer needs – customer requirements – Quality Function Deployment – Product Design Specifications – Human Factors in Design – Ergonomics and Aesthetics –Societal consideration – Contracts – Product liability – Protecting intellectual property – Legal and ethical domains – Codes of ethics – Ethical conflicts – Environment responsible design – future trends in interaction of engineering with society.

DESIGN METHODS	9

Creativity and Problem Solving – Creativity methods – Theory of Inventive Problem Solving (TRIZ) – Conceptual decomposition – Generating design concepts – Axiomatic Design – Evaluation methods – Embodiment Design – Product Architecture – Configuration Design – Parametric Design – Role of models in design – Mathematical Modeling – Simulation – Geometric Modeling –Rapid prototyping – Finite Element Analysis – Optimization – Search Methods.

MATERIAL SELECTION PROCESSING AND DESIGN	9

Material Selection Process – Economics – Cost vs Performance – Weighted property Index – Value Analysis – Role of Processing in Design – Classification of Manufacturing Process – Design for Manufacture – Design for Assembly – Designing for castings, Forging, Metal Forming, Machining and Welding – Residual Stresses – Fatigue, Fracture and Failure.

PROBABILITY CONCEPTS IN DESIGN FOR RELIABILITY	9

Probability – Distributions – Test of Hypothesis – Design of Experiments – Reliability Theory – Design for Reliability – Reliability centered Maintenance – Robust Design – Failure mode Effect Analysis.

TOTAL:45 PERIODS

REFERENCE BOOKS

1. Karl T. Ulrich and Steven D. Eppinger "Product Design and Development" McGraw Hill Edition (2000)
2. Mark N. Horenstein "Design concepts for engineers", Prentice Hall, (2010)
3. Pahl, G, and Beitz, W., "Engineering Design", Springer, Verlag, NY. (1984)
4. Ray, M.S., "Elements of Engineering Design", Prentice Hall Inc. (1985)
5. Suh, N.P., "The principles of Design", Oxford University Press, NY. (1990)

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	3	3							3		2	2
CO2	3	3			3	2			3		2	2
CO3	3	3		2					3		2	2
CO4	3	2	2					2	3	2	2	2
CO5	3	2	2					2	3		2	2
CO6												

192EDE08	DESIGN FOR MANUFACTURE ASSEMBLY & ENVIRONMENT	L-T-P	C
		3-0-0	3

Programme:	M.E ENGINERING DESIGN	Category:	PE
Prerequisites:	Nil		
Aim:	To study the various factors that enhances the designing of product regarding manufacturing, assembly and environment.		

Course Outcomes:

The Students will be able to
CO1: Describe the general design principles for manufacturability.
CO2: Understand the factors that influencing form design.
CO3: Familiarize the design features to facilitate machining.
CO4: Describe the design factors that influencing the redesign of casting.
CO5: Know the techniques to reduce environmental impact of a product.

INTRODUCTION — **9**

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

FACTORS INFLUENCING FORM DESIGN — **9**

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

COMPONENT DESIGN – MACHINING CONSIDERATION — **9**

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

COMPONENT DESIGN – CASTING CONSIDERATION — **9**

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

DESIGN FOR THE ENVIRONMENT — **9**

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

TOTAL : 45 PERIODS

REFERENCE BOOKS

1. Boothroyd, G, "Design for Assembly Automation and Product Design", New York, (1980)
2. Boothroyd, G, Heartz and Nike, "Product Design for Manufacture", Marcel Dekker, (1994)
3. Dekker. Marcel Bralla, "Design for Manufacture handbook", McGraw hill, (1999)
4. Dickson, John. R, and Corroda Poly, "Engineering Design and Design for Manufacture and Structural Approach", Field Stone Publisher, USA, (1995)
5. Kevien Otto and Kristin Wood, "Product Design", Pearson Publication, (2004)

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	3	2							3	2		
CO2	3	2							3	2		
CO3	3	2	2		2				3	3		2
CO4	3	3	3		2				3	2		2
CO5	3		3		2				3	2		2
CO6												

192EDE09	FRACTURE MECHANICS	L-T-P	C
		3-0-0	3
Programme:	**M.E ENGINEERING DESIGN**	**Category:**	**PE**
Prerequisites:	Nil		
Aim:	To Understand the fundamentals of fracture mechanics and to study the fatigue crack initiation, growth and applications of fracture mechanics.		

Course Outcomes:

The Students will be able to

CO1: Define the near field equations to determine the stress-strain and load-displacement fields around a crack tip for linear elastic cases.

CO2: Identify and formulate the stress intensity factor ((K) for typical crack configurations

CO3: Identify and formulate J-integral and the stress and strain fields around a crack tip for different types of materials

CO4: Define empirical relation describing crack growth law.

CO5: Predict the fatigue life of structures using fracture mechanics approaches.

ELEMENTS OF SOLID MECHANICS	**9**

The geometry of stress and strain, elastic deformation, plastic and elasto-plastic deformation – limit analysis – Airy's function – field equation for stress intensity factor.

STATIONARY CRACK UNDER STATIC LOADING	**9**

Two dimensional elastic fields – Analytical solutions yielding near a crack front – Irwin's approximation – plastic zone size – Dugdaale model – determination of J integral and its relation to crack opening displacement.

ENERGY BALANCE AND CRACK GROWTH	**9**

Griffith analysis – stable and unstable crack growth – Dynamic energy balance – crack arrest mechanism – K1c test methods – R curves – determination of collapse load.

FATIGUE CRACK GROWTH CURVE	**9**

Empirical relation describing crack growth law – life calculations for a given load amplitude – effects of changing the load spectrum – rain flow method – external factors affecting the K1c values – leak before break analysis.

APPLICATIONS OF FRACTURE MECHANICS	**9**

Crack Initiation under large scale yielding – thickness as a design parameter – mixed mode fractures – crack instability in thermal and residual stress fields – numerical methods.

TOTAL : 45 PERIODS

REFERENCE BOOKS

1. David Broek, "Elementary Engineering Fracture Mechanics", 4th edition, Kluwer Academic Publishers, (1982)
2. John M.Barson and Stanely T.Rolfe , "Fatigue and fracture control in structures", Prentice hall Inc. Englewood cliffs, (1977)
3. Kare Hellan, "Introduction of Fracture Mechanics", McGraw-Hill Book Company, (1985)
4. Preshant Kumar, "Elements of Fracture Mechanics", Wheeler Publishing, (1999)

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	3	2							3	2		
CO2	3	2							3	2		
CO3	3	2							3	2		
CO4	3	2							3	2		
CO5	3	2							3	2		
CO6	3	2							3	2		

192EDE10	INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS	L-T-P	C
		3-0-0	3

Programme:	M.E ENGINEERING DESIGN	Category:	PE
Prerequisites:	Nil		
Aim:	To know the robot kinematics, control of various drives and programming concepts		

Course Outcomes:

The Students will be able to
CO1: Understand the kinematics and dynamics of robot control systems
CO2: Know various drives and gripper functions
CO3: Describe the principles and the functions of sensors and robot vision system
CO4: Knows the work cell layouts and safety systems followed in the industrial applications
CO5: Design the program for robot motion and the problems obtained are solved and reduced by artificial intelligence and expert systems

INTRODUCTION AND ROBOT KINEMATICS	9

Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – End effectors – Sensors – Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects.

ROBOT DRIVES AND CONTROL	9

Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers.

ROBOT SENSORS	9

Transducers and Sensors – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Representation – Image Grabbing – Image processing and analysis – Edge Enhancement – Contrast Stretching – Band Rationing – Image segmentation – Pattern recognition – Training of vision system.

ROBOT CELL DESIGN AND APPLICATION	9

Robot work cell design and control – Safety in Robotics – Robot cell layouts – Multiple Robots and machine interference – Robot cycle time analysis – Industrial application of robots.

ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS	9

Methods of Robot Programming – Characteristics of task level languages lead through programming methods – Motion interpolation – Artificial intelligence – Basics – Goals of artificial intelligence – AI techniques – problem representation in AI – Problem reduction and solution techniques – Application of AI and KBES in Robots.

TOTAL : 45 PERIODS

REFERENCE BOOKS

1. Deb, S.R., "Robotics Technology and Flexible Automation", Tata Mc Graw-Hill, (1994)
2. Fu, K.S., R.C. Gonzalez and C.S.G. Lee, "Robotics Control, Sensing, Vision and Intelligence", Mc Graw Hill, (1987)
3. Mikell, P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey, "Industrial Robotics Technology, Programming and Applications", Mc Graw-Hill, Int. (1986).
4. Richard. D, Klafter, Thomas, A, Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Prentice-Hall of India Pvt. Ltd., (1984)
5. Yoram Koren, "Robotics for Engineers", Mc Graw-Hill, (1987)

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	3		2						3			
CO2	3								3			
CO3	3	2							3	2	2	
CO4	3		3						3	2	2	2
CO5	3	2		3	2				3			2
CO6												

192EDE11	INTEGRATED MANUFACTURING SYSTEMS	L-T-P	C
		3-0-0	3

Programme:	M.E ENGINEERING DESIGN	Category:	PE
Prerequisites:	Nil		
Aim:	To study about the design concepts of various material handling equipments		

Course Outcomes:

The Students will be able to

CO1: Learn the concepts of computer integrated manufacturing and management system.

CO2:Understand the concept of group technology and computer aided process planning.

CO3: Learn the fundamentals of computer assisted numerical control programming and programming languages.

CO4: Understand the guidelines and criteria for implementing CAD/CAM Systems for inspection and testing of components.

CO5:Discuss concept of Artificial Intelligence and Expert system in CIM.

INTRODUCTION **9**

Objectives of a manufacturing system-identifying business opportunities and problems classification production systems-linking manufacturing strategy and systems analysis of manufacturing operations.

GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING **9**

Introduction – part families – parts classification and cooling – group technology machine cells – benefits of group technology – Process planning function CAPP – Computer generated time standards.

COMPUTER AIDED PLANNING AND CONTROL **9**

Production Planning and Control – cost planning and control – inventory management – Material requirements planning (MRP) – shop floor control – Factory data collection system – Automatic identification system – barcode technology – automated data collection system.

COMPUTER MONITORING **9**

Types of production monitoring systems – structure model of manufacturing process – process control & strategies – direct digital control – supervisory computer control – computer in QC – contact inspection methods non-contact inspection method – computer-aided testing – integration of CAQC with CAD/CAM.

INTEGRATED MANUFACTURING SYSTEM **9**

Definition – application – features – types of manufacturing systems – machine tools – materials handling system – computer control system – DNC systems manufacturing cell – Flexible manufacturing systems (FMS) – FMS concept – transfer systems – head changing FMS – variable mission manufacturing system – CAD/CAM system – human labour in the manufacturing system – computer integrated manufacturing system benefits – Rapid prototyping – Artificial Intelligence and Expert system in CIM.

Total : 45 periods

REFERENCES

1. David Bedworth, "Computer Integrated Design and Manufacturing", TMH, New Delhi, (1998)
2. Groover, M.P., "Automation, Production System and CIM", Prentice-Hall of India, (1998)
3. Ranky, Paul G., "Computer Integrated Manufacturing", Prentice Hall International (1986)
4. Yeomamas,R.W., A. Choudry and P.J.W. Ten Hagen, "Design rules for a CIM system", North Holland Amsterdam, (1985)
5. Yorem Koren, "Computer Integrated Manufacturing Systems", McGraw Hill, (1983)

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3								3			
CO2	3	2							3	2		
CO3	3			2					3	2		
CO4	3		2		2				3		2	2
CO5	3		2				2		3		2	2
CO6												

192EDE12	MECHANICAL BEHAVIOUR OF MATERIALS	L-T-P	C
		3-0-0	3
Programme:	**M.E ENGINERING DESIGN**	**Category**	**PE**
Prerequisites:	Engineering Materials and Metallurgy		
Aim:	To impart the knowledge about production techniques and applications of materials		

Course Outcomes:

The Students will be able to

CO1: Understand the basic concepts of material behavior.

CO2: Know the material behavior under dynamic loads.

CO3: Select the materials for various applications

CO4: Study the properties and applications of modern metallic materials.

CO5: Understand the production techniques and applications of non-metallic material.

BASIC CONCEPTS OF MATERIAL BEHAVIOR — **9**

Elasticity in metals and polymers – Strengthening mechanisms, work hardening, solid solutioning, grain boundary strengthening, poly phase mixture, precipitation, particle, fibre and dispersion strengthening –Effect of temperature, strain and strain rate on plastic behaviour – Super plasticity –. Griffith's theory – Ductile, brittle transition in steel – High temperature fracture, creep – Larson Miller parameter – Deformation and fracture mechanism maps.

BEHAVIOUR UNDER DYNAMIC LOADS AND DESIGN APPROACHES — **9**

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

SELECTION OF MATERIALS — **9**

Motivation for selection, cost basis and service requirements – Selection for mechanical properties, strength, toughness, fatigue and creep – Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing – Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications – Computer aided materials selection.

MODERN METALLIC MATERIALS — **9**

Dual phase steels, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) Steel, Maraging steel, Nitrogen steel – Intermetallics, Ni and Ti aluminides – smart materials, shape memory alloys – Metallic glass and nano crystalline materials.

NON METALLIC MATERIALS — **9**

Polymeric materials – Formation of polymer structure – Production techniques fibers, foams, adhesives and coating – structure, properties and engineering polymers – Advanced structural ceramics, WC, SiC, Si3N4, CBN and diamond – properties, processing and applications.

TOTAL : 45 PERIODS

REFERENCE BOOKS

1. Charles, J.A., Crane, F.A.A. and Fumess, J.A.G., "Selection and use of engineering materials", 3rd edition, Butterworth-Heiremann, (1997)
2. Flinn, R.A., and Trojan, P.K., "Engineering Materials and their Applications", 4th Edition, Jaico, (1999)
3. George E. Dieter, "Mechanical Metallurgy", McGraw Hill, (1988)
4. Metals Hand book, Vol.10, "Failure Analysis and Prevention", 10th Edition, Jaico, (1999)
5. Thomas H. Courtney, "Mechanical Behavior of Materials", 2nd edition, McGraw Hill, (2000)

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	3								3	2		
CO2	3	2							3	2		
CO3	3	2	2				2		3	2		
CO4	3								3	2		
CO5	3		2		2				3	2		2
CO6												

192EDE13	MECHANICAL TESTING OF MATERIALS	L-T-P	C
		3-0-0	3
Programme:	**M.E ENGINERING DESIGN**	**Category:**	**PE**
Aim:	To study the various testing of materials and its necessity		

Course Outcomes:

The Students will be able to
CO1: Conduct mechanical properties testing
CO2: Study the fatigue analysis
CO3: Understand the creep concepts
CO4: Test the polymers
CO5: Know the failure analysis

BASIC MECHANICAL TESTING	**9**

Tension - Engineering & true stress-strain curves, evaluation of tensile properties tensile instability, effect of strain-rate & temperature on flow properties - Compression - Comparison with tension, buckling & barreling. Bending - Pure bending & flexure formula. Torsion - Stresses for elastic & plastic strain, Torsion vs. Tension - Impact - Notched bar impact tests, transition Temperature & metallurgical factors affecting it.

FATIGUE	**9**

Fatigue - Stress cycles & S-N curve, effect of variables like mean stress, stress concentration, surface, size, metallurgical factors etc.

CREEP	**9**

Creep - Creep, stress rupture & stress relaxation tests, development of creep resistant alloys, prediction of long time properties.

POLYMER TESTING	**9**

Polymer testing (sample preparation, testing standards and methods, analysis of polymer and additives) - problems of polymer (thermoxidative degradation, fire hazards, toxicity, effluent disposal, feedstock scarcity).

FAILURE ANALYSIS	**9**

Modes of failures, corrosion failure, high temperature failure, Case studies in failure analysis. Prevention of failures

TOTAL:45 PERIODS

REFERENCE BOOKS

1. Dowling, Norman E (2006), Mechanical Behavior of Materials, Prentice Hall, 3rd Edition.
2. Jacek J. Skrzypek and Richard B. Hetnarski (1993), Plasticity and Creep: Theory, Examples, and Problems, CRC Press
3. Marc Andre Meyers, Krishan Kumar Chawla, Mechanical Behavior of Materials, Prentice Hall, 1998
4. Norman E. Dowling (1998), Mechanical Behavior of Materials: Engineering Methods for Deformation, Fracture, and Fatigue, Prentice Hall; 2nd edition.
5. Yung-Li Lee, Jwo Pan, Richard Hathaway, Mark Barkey (2004), Fatigue Testing and Analysis: Theory and Practice, Butterworth-Heinemann.

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3							3	2		
CO2	3			2					3	2		
CO3	3								3	2		
CO4	3	2	2	2					3	2		
CO5	3	2							3	2		
CO6												

192EDE14	MULTI-BODY DYNAMICS	L-T-P	C
		3-0-0	3
Programme:	**M.E ENGINERING DESIGN**	**Category:**	**PE**
Aim:			

Course Outcomes:

The students will be able to:

CO1. Derive equations of motion for interconnected bodies in multi-body systems with three-dimensional motion.

CO2. Implement and analyze methods of formulating equations of motion for interconnected bodies.

CO3. Write programs to solve constrained differential equations for analyzing multi-body systems.

CO4. Simulate and analyze all types of static and dynamic behaviors of the multi-body systems including the kineto-static analysis.

CO5. Lead team projects in academic research or the industry that require modeling and simulation of multi-body systems.

CO6. Demonstrate an improved technical writing and presentation skills.

INTRODUCTION	**9**

The method of constraints for planar kinematic analysis. Revolute, prismatic, gear and cam pairs are considered together with other 2 degrees-of-freedom types of constraints.

BASIC PRINCIPLES FOR ANALYSIS OF MULYI-BODY SYSTEMS	**9**

The automatic assembly of the systems of equations for position, velocity and acceleration analysis. Iterative solution of systems of non linear equations. Geometry of masses. The principle of virtual work and Lagrange's equations.

DYNAMICS OF PLANAR SYSTEMS	**9**

Dynamics of planar systems. Systematic computation and assembly of mass matrix. Computation of planar generalized forces for external forces and for actuator-spring-damper element. Simple applications of inverse and forward dynamic analysis. Numerical integration of first-order initial-value problems. The method of Baumgarte for the solution of mixed differential-algebraic equations of motion. The use of coordinates partitioning, QR and SVD decomposition for the orthogonalization of constraints.

KINEMATICS OF RIGID BODIES IN SPACE	**9**

Reference frames for the location of a body in space. Euler angles and Euler parameters. The formula of Rodrigues. Screw motion in space. Velocity, acceleration and angular velocity. Relationship between the angular velocity vector and the time derivatives of Euler parameters.

KINEMATIC ANALYSIS OF SPATIAL SYSTEMS AND COMPUTATION OF FORCES	**9**

Basic kinematic constraints. Joint definition frames. The constraints required for the description in space of common kinematic pairs (revolute, prismatic, cylindrical, spherical). Equations of motion of constrained spatial systems. Computation of spatial generalized forces for external forces and for actuator-spring-damper element. Computation of reaction forces from Lagrange's multi- pliers.

TOTAL:45 PERIODS

REFERENCE BOOKS

1. Haug, E.J., Computer-Aided Kinematics and Dynamics of Mechanical Systems-Basic Methods, Allyn and Bacon, 1989.
2. Huston, R.L., Multibody Dynamics, Butterworth-Heinemann, 1990.
3. Kane, T.R, Levinson, D.A., Dynamics: Theory and Applications, McGraw-Hill Book Co., 1985.
4. Nikravesh, P.E., Computer Aided Analysis of Mechanical Systems, Prentice-Hall Inc., Englewood Cliffs, NJ, 1988.
5. Roberson, R.E., Schwertassek, R., Dynamics of Multibody Systems, Springer-Verlag, Berlin, 1988.
6. Schielen, W. ed., Multibody Systems Handbook, Springer-Verlag, Berlin, 1990.

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2							3			
CO2	3	3		2					3	3		
CO3	3			3					3	3		
CO4	3		2	2					3	3		
CO5	3	2				3	2		3	2	2	2
CO6	3					2	3	2	3	2	3	2

192EDE15	OPTIMIZATION TECHNIQUES IN DESIGN	L-T-P	C
		3-0-0	3
Programme:	**M.E ENGINERING DESIGN**	**Category:**	**PE**
Prerequisites:	Nil		
Aim:	To describe the concept and principles of optimization techniques in design.		

Course Outcomes:

The Students will be able to

CO1: Understand the techniques and application of optimization design.

CO2: Know the constrained techniques in optimization.

CO3: Develop the knowledge of Neural network & Fuzzy logic principles in optimization.

CO4: Understand the design of shaft and structural applications.

CO5: Apply the design of simple linkage mechanisms.

UNCONSTRAINED OPTIMIZATION TECHNIQUES **9**

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

CONSTRAINED OPTIMIZATION TECHNIQUES **9**

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

ADVANCED OPTIMIZATION TECHNIQUES **9**

Multi stage optimization – dynamic programming, stochastic programming, Multi objective optimization, Genetic algorithms and Simulated Annealing techniques, Neural network & Fuzzy logic principles in optimization.

STATIC APPLICATIONS **9**

Structural applications – Design of simple truss members – Design applications – Design of simple axial, transverse loaded members for minimum cost, weight – Design of shafts and torsionally loaded members – Design of springs.

DYNAMIC APPLICATIONS **9**

Dynamic Applications – Optimum design of single, two degree of freedom systems, vibration absorbers – Application in Mechanisms – Optimum design of simple linkage mechanisms.

TOTAL : 45 PERIODS

REFERENCE BOOKS

1. Garret N. Vanderplaats, “Numerical Optimization techniques for engineering design with applications”, McGraw Hill Ryerson ltd., (1984)
2. Goldberg, D.E., “Genetic algorithms in search, optimization and machine”, Barnen, Addison-Wesley, New York, (1989)
3. Johnson Ray, C., “Optimum design of mechanical elements”, Wiley, John & Sons, (1990)
4. Kalyanamoy Deb, “Optimization for Engineering design algorithms and Examples”, Prentice Hall of India Pvt. (1995)
5. Rao, Singaresu, S., “Engineering Optimization – Theory & Practice”, New Age International (P) Limited, New Delhi, (2000)

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2							3			
CO2	3			2					3	2		
CO3	3			3	2				3	2		
CO4	3	3							3		2	2
CO5	3	3		2					3	2		
CO6												

192EDE16	PRODUCT DESIGN AND DEVELOPMENT	L-T-P	C
		3-0-0	3
Programme:	**M.E ENGINERING DESIGN**	**Category:**	**PE**
Prerequisites:	Nil		
Aim:			

Course Outcomes:

The Students will be able to

CO1. Understand the product planning and process flow
CO2. Make decisions in concept development
CO3. Know the various design processes
CO4. Realize the selection of materials and processes
CO5. Familiarize the IPR and economics

INTRODUCTION **9**

Product Development – Characteristics, Duration, Challenges, Organizations. Development Process – Processes, Process Flow. Product Planning – Identifying Opportunities, Prioritization, Resource allocation and Pre-ProjectPlanning. Customer Needs – Data gathering, Organizing Needs.

CONCEPT DEVELOPMENT **9**

Product and Target specification, various steps in concept generation, Brainstorming, Morphological analysis, Selection of Concepts – Subjective decision-making, Criteria ranking, Criteria weighting, Datum method,EVAD (Design Evaluation) method, Principles of Computer aided decision making.

DESIGN PROCESS **9**

Concept Testing – Survey, Response and Interpretation. Product Architecture, Platform planning, System leveldesign issues. Embodiment design - Introduction, Size and strength, Scheme drawing, Form design, Provisionalmaterial and process determination, Design for assembly and manufacture, Industrial design. Modeling -Introduction, Mathematical modeling, Optimization, Scale models, Simulation.

PLANNING FOR MANUFACTURE AND MANAGEMENT **9**

Detail Design - Factor of safety, Selection procedure for bought out components, Material Selection, Robust
design, Experimental Plan. Design Management - Management of design for quality, Project planning and control, Production design specification (PDS), Quality function deployment (QFD)-process, Design review,
Value analysis/engineering.

INTELLECTUAL PROPERTY RIGHTS AND PROJECT ECONOMICS **9**

Intellectual Property Rights – Introduction, Study prior inventions, Write the description of the invention, RefineClaims, Pursue application. Economics and Management – Financial Model, Project Trade – Off, AcceleratingProjects, Project Execution.

TOTAL : 45 PERIODS

REFERENCE BOOKS

1. Deborah E.and Bouchoux, Intellectual Property Rights, Cengage Learning India Pvt., 2008
2. Dieter G. E., Engineering Design, McGraw – Hill International, 2009.
3. Karl T., Ulrich and D. Steven, and Eppinger, Product Design and Development, McGraw Hill 2009.
4. Ken Hurst, Engineering Design Principles, Elsevier Science and Technology Books, 2006.

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3		2						3	2		
CO2	3		2		2				3	2	2	
CO3	3		2						3	2		
CO4	3	2	2						3	2		
CO5	3	2			2		2		3			2
CO6												

192EDE17	PRODUCTIVITY MANAGEMENT AND RE-ENGINEERING	L-T-P	C
		3-0-0	3
Programme:	**M.E ENGINEERING DESIGN**	**Category:**	**PE**
Prerequisites:	Nil		
Aim:	To study the various factors that enhances the productivity management and the applications of re-engineering concept.		

Course Outcomes:

The Students will be able to
CO1: Know the role productivity concepts
CO2: Understand the systems approach to productivity measurement
CO3: Study the organizational transformation models
CO4: Discuss the reengineering tools
CO5: Understand the re-engineering process improvement models

PRODUCTIVITY **9**

Productivity Concepts – Macro and Micro factors of productivity – Dynamics of Productivity – Productivity Cycle Productivity Measurement at International, National and Organization level – Productivity measurement models.

SYSTEMS APPROACH TO PRODUCTIVITY MEASUREMENT **9**

Conceptual frame work, Management by Objectives (MBO), Performance Objectivated Productivity (POP) – Methodology and application to manufacturing and service sector.

ORGANISATIONAL TRANSFORMATION **9**

Elements of Organisational Transformation and Reengineering – Principles of organizational transformation and re-engineering, fundamentals of process re-engineering, preparing the workforce for transformation and re-engineering, methodology, guidelines, LMI CIP Model – DSMC Q & PMP model.

RE-ENGINEERING TOOLS AND IMPLEMENTATION **9**

PMI models, PASIM Model, Moen and Nolan Strategy for process improvement, LMICIP Model, NPRDC Model.

RE-ENGINEERING PROCESS IMPROVEMENT MODELS **9**

Analytical and process tools and techniques – Information and Communication Technology – Implementation of Reengineering Projects – Success Factors and common implementation Problem – Cases.

TOTAL : 45 PERIODS

REFERENCE BOOKS

1. Donald Shandler, "Reengineering the training function: How to align training with the new corporate agenda", St.Lucie press, (1996)
2. Edosomwan, J.A., "Organisational Transformation and Process Re-engineering", Library Cataloging in Pub. Data, (1996)
3. Premvrat, Sardana, G.D. and Sahay, B.S., "Productivity Management – A Systems Approach", Narosa Publishing House. New Delhi, (1998)
4. Rastogi, P.N., "Re-engineering and Re-inventing the Enterprise", Wheeler Pub. New Delhi, (1995)
5. Sumanth, D.J., "Productivity Engineering and Management", TMH, New Delhi, (1990)

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3								3			
CO2	3	2	2						3		2	
CO3	3				2		2		3		2	
CO4	3				2	2	2		3	2		
CO5	3	2		3	2				3	2	2	
CO6												

192EDE18	QUALITY CONCEPTS IN DESIGN	L-T-P	C
		3-0-0	3
Programme:	**M.E ENGINEERING DESIGN**	**Category:**	**PE**
Prerequisites:			
Aim:	To study all the concepts coming under the quality for designing purpose		

Course Outcomes:

The Students will be able to

CO1: Study about the QFD and house of quality

CO2: Know about the advancements of FMEA

CO3: Familiarize the product testing methods in DOE

CO4: Describe the statistical consideration of quality concepts

CO5: Study the details about SIX SIGMA

DESIGN FOR QUALITY **9**

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

FAILURE MODE EFFECT ANALYSIS **9**

Basic methods: Refining geometry and layout, general process of product embodiment – Embodiment checklist – Advanced methods: systems modeling, mechanical embodiment principles – FMEA method – linking fault states to systems modeling – Case study – computer monitor stand for a docking station.

DESIGN OF EXPERIMENTS **9**

Design of experiments – Basic methods – Two factorial experiments – Extended method – reduced tests and fractional experiments, orthogonality, base design method, higher dimensional fractional factorial design – Statistical analysis of experiments: Degree of freedom, correlation coefficient, standard error of the residual t-test, ANOVA – ratio test, other indicators – residual plots, Advanced DOE method for product testing – Product applications of physical modeling and DOE, Blender panel display evaluation, coffee grinder experimental optimization – Taguchi method.

STATISTICAL CONSIDERATION AND RELIABILITY **9**

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

DESIGN FOR SIX SIGMA **9**

Basis of SIX SIGMA – Project selection for SIX SIGMA – SIX SIGMA problem solving – SIX SIGMA in service and small organizations – SIX SIGMA and lean production – Lean SIX SIGMA and services.

TOTAL : 45 PERIODS

REFERENCE BOOKS

1. Amitava Mitra, "Fundamentals of Quality control and improvement", 2nd edition, Pearson Education Asia, (2002)
2. Dhillon, B.S., "Advanced Design Concepts for Engineers", Technomic Publication company, USA, (1998)
3. James R. Evens, William M Lindsay, "The Management and control of Quality", 6th edition- Pub:son south-western, (2011)
4. Karl t. Ulrich, steven d. Eppinger, "Product Design And Development", Tata McGraw Hill, 3rd Edition, (2003)
5. Kevin Otto & Kristin Wood, "Product Design Techniques in Reverse Engineering and New Product Development", Pearson Education (LPE), (2001)

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	2		2	2			3		2	
CO2	3	2		2					3			
CO3	3	3		2			2		3	2	2	
CO4	3	2		2					3		2	2
CO5	3				2	2		2	3		2	3
CO6												

192EDE19	RAPID PROTOTYPING AND TOOLING	L-T-P	C
		3-0-0	3
Programme:	**M.E ENGINEERING DESIGN**	**Category:**	**PE**
Prerequisites:	Nil		
Aim:	To help local enterprises enhance their global competitiveness by creating values for their discerning customers		

Course Outcomes:

The Students will be able to

CO1: Familiarize the model making steps involved in product design

CO2: Understand the various prototyping systems and its working principles

CO3: Learn the applications and limitations of the prototyping systems.

CO4: Know the geometric modeling technique and its application in reverse engineering.

CO5: Study the rapid tooling technique used in various field of engineering.

INTRODUCTION **9**

Need – Development of RP systems – RP process chain – Impact of Rapid Prototyping and Tooling on Product Development – Benefits – Applications – Digital prototyping – Virtual prototyping.

LIQUID BASED AND SOLID BASED RAPID PROTOTYPING SYSTEMS **9**

Stereolithography Apparatus, Fused deposition Modeling, Laminated object manufacturing, Three dimensional printing: Working Principles, details of processes, products, materials, advantages, limitations and applications – Case studies.

POWDER BASED RAPID PROTOTYPING SYSTEMS **9**

Selective Laser Sintering, Direct Metal Laser Sintering, Three Dimensional Printing, Laser Engineered Net Shaping, Selective Laser Melting, Electron Beam Melting: Processes, materials, products, advantages, applications and limitations – Case Studies.

REVERSE ENGINEERING AND CAD MODELING **9**

Basic concept – Digitization techniques – Model Reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data Requirements – geometric modeling techniques: Wire frame, surface and solid modeling – data formats – Data interfacing, Part orientation and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation.

RAPID TOOLING **9**

Classification: Soft tooling, Production tooling, Bridge tooling; direct and indirect – Fabrication processes, Applications. Case studies – automotive, aerospace and electronic industries.

TOTAL :45 PERIODS

REFERENCE BOOKS

1. Ali K. Kamrani, Emad Abouel Nasr, “Rapid Prototyping: Theory and practice”, Springer, (2006)
2. Andreas Gebhardt, “Rapid prototyping”, Hanser Gardener Publications, (2003)
3. Chua C.K., Leong K.F., and Lim C.S., “Rapid prototyping: Principles and applications”, 2nd edition, World Scientific Publishers, (2003)
4. Liou W.Liou, Frank W.Liou, “Rapid Prototyping and Engineering applications : A tool box for prototype development”, CRC Press, (2007)
5. Peter D.Hilton, Hilton/Jacobs, Paul F.Jacobs, “Rapid Tooling: Technologies and Industrial Applications”, CRC press, (2000)

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	2	2					3		2	
CO2	3	2		2					3		2	
CO3	3		2					2	3	2		
CO4	3	2	2	3	2				3		2	3
CO5	3	2		2				2	3		2	2
CO6												

192EDE20	SUPPLY CHAIN MANAGEMENT	L-T-P	C
		3-0-0	3
Programme:	**M.E ENGINEERING DESIGN**	**Category:**	**PE**
Aim:	To provide an overview of the current scenario of Supply Chain Management		

Course Outcomes:

The Students will be able to
CO1: Understand the role of supply chain management
CO2: Know the various inventory management models in SCM
CO3: Practice the supply chain sourcing decisions
CO4: Apply various distribution network models
CO5: Discuss the SCM logistics decisions
CO6: Understand the role of IT in SCM

SUPPLY CHAIN MANAGEMENT — **9**

Supply chain network - supply chain management - building blocks of a supply chain network - business processes in supply chains - types of supply chains and examples – supply chain drivers - supply chain performance measures

SUPPLY CHAIN INVENTORY MANAGEMENT — **9**

Strategic, tactical, and operational decisions in supply chains - supply chain inventory management – EOQ – EPQ - demand forecasting – impact of uncertainty of supply in safety inventory – managing safety inventory in multi echelon supply chains - bullwhip effect.

SOURCING AND DISTRIBUTION MANAGEMENT. — **9**

Role of sourcing – in-house sourcing and outsourcing – supplier relation – procurement processes – risk management in sourcing - distribution management – types of distribution

LOGISTICS IN SUPPLY CHAIN MANAGEMENT — **9**

Logistics – concepts, definitions, approaches, factors affecting logistics – modes – design option for a transportation network

SUPPLY CHAIN AUTOMATION — **9**

Factors affecting coordination - impact of E business in supply chain performance - IT enabled supply chains – role of IT in forecasting, inventory management, procurement, transportation - customer relationship management - ERP and supply chains - supply chain automation and supply chain integration.

TOTAL : 45 PERIODS

REFERENCE BOOKS

1. Ayers, J.B., “Hand book of Supply Chain Management”, The St. Lencie press, (2000)
2. Handfield R.B. and E.L. Nochols, “Introduction to Supply Chain Management”, Prentice Hall, New Delhi (1999)
3. John T. Mentzer, “Supply Chain Management”, Sage Publications, New Delhi (2001)
4. Larsen T.S., Schary P.B., Mikkola J.H. and Kotzab H., “Managing the global supply chain”, Viva Books, New Delhi, (2007)
5. Sunil Chopra and Peter Meindl, “Supply Chain Management: Strategy, Planning, and Operation”, Pearson Education, New Delhi (2015)

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3								3			2
CO2	3								3			2
CO3	3	2	2		2				3	2	2	2
CO4	3		2	2	2	2	2		3	2		2
CO5	3		2		2		2	2	3		2	
CO6	3			3	2	2	2		3		2	3

192EDE21	TRIBOLOGY IN DESIGN	L-T-P	C
		3-0-0	3
Programme:	**M.E ENGINEERING DESIGN**	**Category:**	**PE**
Aim:	To study about the friction and various types of lubrication between different materials		

Course Outcomes:

The Students will be able to
CO1: Understand the types of friction and surface interaction
CO2: Understand Mechanism of various types of wear and surface treatments
CO3: Know the types of lubrication processes
CO4: Familiarize the various lubricant standards.
CO5: Describe the high pressure contacts and the theory of elasto hydrodynamic lubrication

SURFACE INTERACTION AND FRICTION — **9**

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

WEAR AND SURFACE TREATMENT — **9**

Types of wear – Mechanism of various types of wear – Laws of wear –Theoretical wear models – Wear of Metals and Non metals – Surface treatments – Surface modifications – surface coatings methods – Surface Topography measurements – Laser methods – instrumentation – International standards in friction and wear measurements.

LUBRICANTS AND LUBRICATION REGIMES — **9**

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

THEORY OF HYDRODYNAMIC AND HYDROSTATIC LUBRICATION — **9**

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

HIGH PRESSURE CONTACTS AND ELASTO HYDRODYNAMICLUBRICATION — **9**

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

TOTAL= 45 PERIODS

REFERENCE BOOKS

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

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3		2		2				3	2		
CO2	3		2					2	3	2		
CO3	3		2						3			
CO4	3		2		2				3	2		
CO5	3	2		2					3			2
CO6												

OPEN ELECTIVES

192OE01	BUSINESS ANALYTICS	L-T-P	C
		3-0-0	3
Programme:	M.E. Engineering Design	**Category:**	**OE**
Aim:	To demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.		

Course Outcomes:

The Students will be able to

CO1. Understand the role of business analytics within an organization.

CO2. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.

CO3. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.

CO4. To become familiar with processes needed to develop, report, and analyze business data.

CO5. Use decision-making tools/Operations research techniques.

CO6. Mange business process using analytical and management tools

BUSINESS ANALYTICS	**9**

Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

TRENDINESS AND REGRESSION ANALYSIS	**9**

Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

ORGANIZATION STRUCTURES &DESCRIPTIVE ANALYTICS	**9**

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization

FORECASTING TECHNIQUES	**9**

Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression, Forecasting with Casual Variables, Selecting Appropriate Forecasting Models, Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

DECISION ANALYSIS	**9**

Decision Analysis: Formulating Decision Problems, Decision Strategies with and without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

TOTAL : 45 PERIODS

REFERENCE BOOKS

1. James Evans "Business Analytics" persons Education
2. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey "Business analytics Principles, Concepts, and Applications", Pearson FT Press.

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3		3		2	2			3	2		
CO2	3	2			3	2			3	2		
CO3	3		2			2	2		3	2		
CO4	3			3	2				3	2	3	
CO5	3		2	3	2				3	2		2
CO6	3			3	2	2	2		3	2		2

192OE02	COMPOSITE MATERIALS	L-T-P	C
		3-0-0	3
Programme:	**M.E ENGINEERING DESIGN**	**Category:**	**OE**
Aim:	To understand the fundamentals of composite material and different types of analysis of Laminated flat plate composites.		

Course Outcomes:

The Students will be able to

CO1: Understand the fundamentals of composite material strength and its mechanical behavior.

CO2: Use the fiber reinforced Laminate design for different Combinations of plies with different orientations of the fiber.

CO3: Study the thermo-mechanical behavior and study of residual stresses in Laminates during processing.

CO4: Understand the vibration and buckling analysis of Laminated Flat Plates.

CO5: Implement the Classical Laminate Theory (CLT) to study and analysis for residual stresses in an isotropic layered structure such as electronic chips.

LAMINA CONSTITUTIVE RELATIONS **9**

Definition – Need – General Characteristics, Applications – Fibers – Glass, Carbon, Ceramic and Aramid fibers – Matrices – Polymer, Graphite, Ceramic and Metal Matrices – Characteristics of fibers and matrices. Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint – Generalized Hooke's Law – Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Q_{ij}), Typical Commercial material properties, Rule of Mixtures – Generally Orthotropic Lamina – Transformation Matrix, Transformed Stiffness – Manufacturing: Bag Moulding – Compression Moulding – Pultrusion – Filament Winding – Other Manufacturing Processes.

FLAT PLATE LAMINATE CONSTITUTIVE RELATIONS **9**

Definition of stress and Moment Resultants – Strain Displacement relations – Basic Assumptions of Laminated anisotropic plates – Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates – Laminate Structural Moduli – Evaluation of Lamina Properties from Laminate Tests – Quasi-Isotropic Laminates – Determination of Lamina stresses within Laminates.

LAMINA STRENGTH ANALYSIS **9**

Introduction – Maximum Stress and Strain Criteria – Von-Misses Yield criterion for Isotropic Materials – Generalized Hill's Criterion for Anisotropic materials – Tsai-Hill's Failure Criterion for Composites – Tensor Polynomial (Tsai-Wu) Failure criterion – Prediction of laminate Failure.

ANALYSIS OF LAMINATED FLAT PLATES **9**

Equilibrium Equations of Motion – Energy Formulations – Static Bending Analysis – Buckling Analysis – Free Vibrations – Natural Frequencies.

EFFECT OF THERMAL PROPERTIES **9**

Modification of Hooke's Law due to thermal properties – Modification of Laminate Constitutive Equations – Orthotropic Lamina – special Laminate Configurations – Unidirectional, Off-axis, Symmetric Balanced Laminates – Zero C.T.E laminates, Thermally Quasi-Isotropic Laminates.

TOTAL : 45 PERIODS

REFERENCE BOOKS

1. Gibson, R.F., "Principles of Composite Material Mechanics", McGraw-Hill, (1994)
2. Hyer, M.W., "Stress Analysis of Fiber – Reinforced Composite Materials", McGraw-Hill, (1998)
3. Issac M. Daniel and Ori Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press-2006, First Indian Edition – (2007)
4. Mallick, P.K. and Newman, S., (edition), "Composite Materials Technology: Processes and Properties", Hansen Publisher, Munish, (1990)
5. Mallick, P.K., "Fiber–Reinforced Composites: Materials, Manufacturing and Design", Maneel Dekker Inc, (1993)

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3								3	2		
CO2	3	2							3			
CO3	3		2						3			2
CO4	3	2	2						3	2		2
CO5	3	2	2						3			2
CO6												

192OE03	COST MANAGEMENT OF ENGINEERING PROJECTS	L-T-P	C
		3-0-0	3
Programme:	**M.E ENGINEERING DESIGN**	**Category:**	**OE**
Aim:	To understand the fundamentals of cost management of engineering projects		

Course Outcomes:

The Students will be able to

CO1: Understand the cost management processes.

CO2: Know the cost concepts in decision making.

CO3: Study the various types of projects.

CO4: Understand the types of costs and their behavior.

CO5: Practice the quantitative techniques used in cost management

INTRODUCTION	**9**
Introduction and Overview of the Strategic Cost Management Process	
COST CONCEPTS IN DECISION-MAKING	**9**
Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.	
PROJECT	**9**
Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and non-technical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process	
COST BEHAVIOR AND PROFIT PLANNING	**9**
Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.	
QUANTITATIVE TECHNIQUES	**9**
Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory	
	TOTAL : 45 PERIODS

REFERENCE BOOKS

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Vohra N.D, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3		2						3	2		
CO2	3				2				3	2		
CO3	3			2	2				3			2
CO4	3	2		2		2			3	2		
CO5	3	3							3			2
CO6												

192OE04	DESIGN OF EXPERIMENTS	L-T-P	C
		3-0-0	3
Programme:	M.E. Engineering Design	**Category:**	**OE**
Aim:	To design the experiments and analyze data collected from experiments		

Course Outcomes:

The Students will be able to

CO1: Familiarize the Fundamentals of design of experiments

CO 2: Practice the various tools used in DOE

CO 3: Conduct experiments based on factorial design

CO 4: Impart the concepts of Taguchi technique

CO 5: Apply for product/process optimization

FUNDAMENTALS OF DESIGN OF EXPERIMENTS — **9**

Basic principles of design of experiment – randomization – replication – interactions - simple comparative experiments - applications of experimental design - barriers in DOE - practical methodology

ANALYTICAL TOOLS OF DOE — **9**

Main effects plot - Interactions plots - Cube plots - Pareto plot of factor effects - Normal Probability Plot of factor effects - Response surface plots and regression models - Model building – Analysis of variance

FACTORIAL DESIGNS — **9**

Single factor experiments - Latin square designs and extensions –Introduction to factorial designs, two levels, 2^k factorial designs - Fractional factorial designs , two-level, three-level and mixed-level factorials

TAGUCHI APPROACH — **9**

Overview of Taguchi approach - common experiments and methods of analysis. Orthogonal array-properties - Degrees of freedom-confidence level and interval – case study exercises.

PARAMETER OPTIMIZATION — **9**

Regression models - parameter optimization – single and multi objective optimization - Response surface methodology – grey relational analysis – complex proportional assessment of alternatives (COPRAS) - case study exercises

TOTAL : 45 PERIODS

REFERENCE BOOKS

1. Douglas C. Montgomery, "Designand Analysis of Experiments", 5th edition., Wiley. 2001
2. Jiju Antony, " Design of Experiments for Engineers and Scientists", 2nd Edition, Elsevier, Londan, 2014.
3. Lennart Eriksson, " Design of Experiments: Principles and Applications", Umetrics Academy, Sweedan, 2008
4. Oehlert, GaryW. "First Course in Design and Analysis of Experiments", Freeman Publishers, New York, 2000
5. Ranjit K Roy, Design of Experiments using the Taguchi Approach, John Wiley & sons, Inc., 2001

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3							3			
CO2	3			3					3			
CO3	3	3		2					3		2	2
CO4	3	3		3					3			2
CO5	3	2		2	2				3		2	
CO6												

192OE05	INDUSTRIAL SAFETY	L-T-P	C
		3-0-0	3
Programme:	**M.E. ENGINEERING DESIGN**	**Category:**	**OE**
Aim:	To study and practice the safety concepts in industry		

Course Outcomes:

The Students will be able to

CO1: Familiarize the Fundamentals of safety procedures

CO 2: Know the fundamentals of maintenance

CO 3: Understand the wear and corrosion prevention methods

CO 4: Trace the various faults

CO 5: Apply for periodic and preventive maintenance in industries

FUNDAMENTALS OF INDUSTRIAL SAFETY — **9**

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods

FUNDAMENTALS OF MAINTENANCE ENGINEERING — **9**

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment

WEAR AND CORROSION AND THEIR PREVENTION — **9**

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

FAULT TRACING — **9**

Fault tracing-concept and importance, decision treeconcept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic,automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

PERIODIC AND PREVENTIVE MAINTENANCE — **9**

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

TOTAL : 45 PERIODS

REFERENCE BOOKS

1. Higgins & Morrow, Maintenance Engineering Handbook, Da Information Services.
2. Garg H. P. Maintenance Engineering, , S. Chand and Company.
3. Audels Pump-hydraulic Compressors, , Mcgrew Hill Publication.
4. Winterkorn, Hans, Foundation Engineering Handbook, Chapman & Hall London.

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3		2		2				3	2		2
CO2	3		2						3		2	
CO3	3		2		2				3			
CO4	3		2						3		2	2
CO5	3		3		2	2		2	3		2	3
CO6												

192EDE15	NANOMATERIALS AND NANOTECHNOLOGY	L-T-P	C
		3-0-0	3
Programme:	**M.E ENGINEERING DESIGN**	**Category:**	**PE**
Prerequisites:	Nil		
Aim:	To understand the basics of nano materials and its technology		

Course Outcomes:

The Students will be able to

CO1. Acquire the knowledge of the representatives of Nano particles and Characteristic techniques of nano materials.

CO2. Familiar with new trends in engineering, namely nanotechnology and nanofabrication and with their applications in modern industries.

CO3. Get the knowledge in the field of nanotechnology and nano materials.

CO4: Practice the nano electronics

CO5: Familiarize nano heat transfer

ZERO – DIMENSIONAL NANOSTRUCTURES	**9**

Nanoparticles through homogenous nucleation, nanoparticles through the heterogeneous nucleation, kineticallyconfined synthesis of nanoparticles, epitaxial core – shell nanoparticles. One Dimensional Nanostructure-Nanowires And Nanorods: Spontaneous growth, template based synthesis, electro spinning, and lithography.

TWO-DIMENSIONAL NANOSTRUCTURES-THIN FILMS	**9**

Fundamentals of film growth, vacuum science, physical vapor deposition (PVD), Chemical VaporDeposition(CVD), Atomic Layer Deposition (ALD), Electrochemical Deposition, Sol-Gel films.

NANOSTRUCTURES FABRICAITON	**9**

Lithography, nano manipulation and nanolithography, soft lithography, assembly of nanoparticels andnanowires, other methods of micro fabrication, Scanning Electron Microscope. Nanomechanics: A high speed review of motion: Displacement, velocity, acceleration and force, nano mechanical oscillation, feeling faint forces.

NANO ELECTRONICS: ELECTRON ENERGY BANDS, ELECTRONS IN SOLIDS	**9**

Conductors, insulation and semi conductors, fermi energy, the density of states for solids, quantumconfinement, tunneling, single electron phenomenon, molecular electronics. Nanophotonics: Photonics properties of nanomaterials, near-field light, optical tweezers, photonic crystals.

NANO SCALE HEAT TRANSFER	**9**

Nanoscale heat, conduction, convection, radiation. Nanoscale Fluid Mechanics: Fluids at the nanoscale: major concepts, flow fluids flow at the nanoscale, applications of nanofludics

TOTAL : 45 PERIODS

REFERENCE BOOKS

1. Ben Rogers, Pennathur and Adams, Nanotechnology: Understanding Small System, CRC Press, 2008.
2. Bhushan, Bharat (Ed.) Handbook of Nanotechnology, Springer 2006.
3. Guozhong Cao, Nanostructures and Nanomaterials, Imperial College Press, 2006.
4. Lundstrom, Mark, Guo, Jing, Nanoscale transistors, Device physics, modeling and simulation,Springer,2006.
5. Yury Gogotsi, Nanomaterials Handbook, Drexel University, Philadelphia, Pennsylvania, USA, 2006.

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2							3	2		
CO2	3	2	2		2				3			2
CO3	3		2						3	2		
CO4	3	2	2	2					3	2		2
CO5	3		2						3			2
CO6												

192OE07	OPERATIONS RESEARCH	L-T-P	C
		3-0-0	3
Programme:	**M.E ENGINEERING DESIGN**	**Category:**	**OE**
Aim:	To understand the various techniques of optimization in utilization of resources, operations research techniques for industrial real world problems		

Course Outcomes:

The students will be able to

CO1. Gain knowledge on Operations Research for industrial solutions
CO2. Apply L.P.P. in industrial optimization problems
CO3. Solve transportation problems using various OR methods
CO4. Solve assignment problems using various algorithms
CO5. Analyze the shortest route and critical path in a network
CO6. Apply OR methods in replacement strategy

LINEAR MODELS	**9**
Origin of Operations Research – The phases of O.R – Applications – Linear Programming: Formulation – Graphical method – Simplex method – Artificial Variable techniques: Big M Method	
TRANSPORTATION MODELS	**9**
Transportation Problems: Optimal solution by North West corner method – Vogel's Approximation method – Least cost method – MODI method	
ASSIGNMENT MODELS	**9**
Assignment Problems: Formulation – Unbalanced Assignment Problem – Hungarian algorithm – Traveling Salesman Problem	
NETWORK MODELS	**9**
Network models – Shortest route – Minimal spanning tree – Maximum flow models – Project network – CPM and PERT networks – Critical path scheduling	
REPLACEMENT MODELS	**9**
Replacement Models: Replacement of items that deteriorate with time – Value of money changing with time & not changing with time – Optimum replacement policy: Individual & Group replacement	
Total = 45 Periods:	

References

1. Hamdy A. Taha, **"Operation Research - An Introduction"**, Pearson Publications., New Delhi, (2009)
2. Frederick S. Hiller, Gerald J. Liberman**, "Operations Research–Concepts and Cases",** Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, (2010)
3. Panneerselvam R., **"Operations Research"**, Prentice Hall of India., New Delhi, (2010)
4. Prem Kumar Gupta and Hira D.S., **"Introduction to Operations Research"**, S. Chand and Co., New Delhi, (2004)
5. Ravindran A., Phillips Don T., Solberg James J., **"Operations Research: Principles and Practice",** John Wiley & Sons, New Delhi, (2011)

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3			3	2				3		2	
CO2	3	2		2	2				3	2		2
CO3	3	2		2	2				3		2	
CO4	3	3		2					3		2	
CO5	3		2	2	2				3		2	2
CO6	3		2		2				3			2

192OE08	WASTE TO ENERGY	L-T-P	C
		3-0-0	3

Programme:	M.E ENGINEERING DESIGN	Category:	OE
Aim:	To provide an overview of bio waste to energy		

Course Outcomes:

The Students will be able to
CO1: Understand the need of energy production from waste
CO2: Know the biomass pyrolysis processes
CO3: Study the gasification techniques
CO4: Apply the concepts of combustion
CO5: Generate energy from bio gas

INTRODUCTION TO ENERGY FROM WASTE — **9**

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

BIOMASS PYROLYSIS — **9**

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

BIOMASS GASIFICATION — **9**

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation

BIOMASS COMBUSTION — **9**

Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

BIOGAS — **9**

Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

TOTAL : 45 PERIODS

REFERENCE BOOKS

1. Challal, D. S., Food, Feed and Fuel from Biomass, IBH Publishing Co. Pvt. Ltd., 1991.
2. Desai, Ashok V., Non Conventional Energy, Wiley Eastern Ltd., 1990.
3. Khandelwal, K. C. and Mahdi, S. S., Biogas Technology - A Practical Hand Book - Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
4. WereKo-Brobby C. Y. and E. B. Hagan Biomass Conversion and Technology, , John Wiley & Sons, 1996.

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	2		2				3	2		2
CO2	3	2	2		2				3	2		3
CO3	3	2	2		2				3			2
CO4	3	2	2		2				3			2
CO5	3	2	2		2				3	2		3
CO6												

AUDIT COURSES

192AC01	ENGLISH FOR RESEARCH PAPER WRITING	L-T-P	C
		2-0-0	0
Programme:	**M.E ENGINEERING DESIGN**	**Category:**	**AC**

Course Outcomes:

Students will be able to:

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

UNITI	**6**
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	
UNITII	**6**
Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, 4 Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction	
UNITIII	**6**
Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check	
UNITIV	**6**
key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature	
UNITV	**6**
skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions	
TOTAL : 30 PERIODS	

REFERENCE BOOKS

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

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2			2	2		3	2	2		3	
CO2	2			2	2		3	2	2		3	
CO3	2			2	2		3	2	2		3	2
CO4	2			2	2		3	2	2		2	2
CO5												
CO6												

192AC02	DISASTER MANAGEMENT	L-T-P	C
		2-0-0	0
Programme:	**M.E ENGINEERING DESIGN**	**Category:**	**AC**

Course Outcomes:

Students will be able to:

CO1. learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO2. critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO3. develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO4. critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

UNITI	**6**

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

UNITII	**6**

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

UNITIII	**6**

Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

UNITIV	**6**

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

UNITV	**6**

Disaster Mitigation Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of DisasterMitigation In India.

TOTAL : 30 PERIODS

REFERENCE BOOKS

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

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3		2		3		2	2	3		2	2
CO2	3		2		3		2	2	3		2	2
CO3	3		2		3		2	2	3		2	2
CO4	3		2		3		2	2	3		2	2
CO5												
CO6												

192AC03	VALUE EDUCATION	L-T-P	C
		2-0-0	0
Programme:	**M.E ENGINEERING DESIGN**	**Category:**	**AC**

Course Outcomes:

Students will be able to

CO1. Understand value of education and self- development

CO2. Imbibe good values in students

CO3. Let the should know about the importance of character

UNITI	**6**

Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgements

UNITII	**6**

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism.Love for nature ,Discipline

UNITIII	**6**

Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNITIV	**6**

Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation.

UNITV	**6**

Equality, Nonviolence ,Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively

TOTAL : 30 PERIODS

REFERENCE BOOKS

1 Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3			2	3		3		3		3	
CO2	3			2	2		3		3		3	
CO3	3			2	2		3		3		3	
CO4												
CO5												
CO6												

192AC04	CONSTITUTION OF INDIA	L-T-P	C
		2-0-0	0
Programme:	**M.E ENGINEERING DESIGN**	**Category:**	**AC**

Course Outcomes:

Students will be able to:

CO1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.

CO2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.

CO3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

UNITI	**6**

History of Making of the Indian Constitution, Philosophy of the Indian Constitution, Salient Features, Contours of Constitutional Rights & Duties, Fundamental Rights , Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion , Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNITII	**6**

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

UNITIII	**6**

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

UNITIV	**6**

Pachayati raj: Introduction, Elected officials and their roles, CEO ZilaPachayat: Position and role., Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy

UNITV	**6**

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

TOTAL : 30 PERIODS

REFERENCE BOOKS

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

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3			2	3	2	3		3		2	
CO2	3			2	3	2	3		3		2	
CO3	3			2	3	2	3		3		2	
CO4												
CO5												
CO6												

192AC05	PEDAGOGY STUDIES	L-T-P	C
		2-0-0	0
Programme:	**M.E ENGINEERING DESIGN**	**Category:**	**AC**

Course Outcomes:

Students will be able to:

CO1. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.

CO2. Identify critical evidence gaps to guide the development.

UNITI	6

Terminology, Theories of learning, Curriculum, Teacher education, Conceptual framework, Research questions, Overview of methodology and Searching.

UNITII	6

Thematic overview: Pedagogical practices are being used by teachers in formal, and informal classrooms in developing countries, Curriculum, Teacher education.

UNITIII	6

Evidence on the effectiveness of pedagogical practices, Methodology for the in depth stage: quality assessment of included studies, How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change, Strength and nature of the body of evidence for effective pedagogical practices, Pedagogic theory and pedagogical approaches, Teachers' attitudes and beliefs and Pedagogic strategies.

UNITIV	6

Professional development: alignment with classroom practices and follow- up support, Peer support, Support from the head teacher and the community, Curriculum and assessment, Barriers to learning: limited resources and large class sizes

UNITV	6

Research gaps and future directions, Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

TOTAL : 30 PERIODS

REFERENCE BOOKS

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2		3	2		3		3		3	
CO2	3	2		2	2		3		3		3	
CO3	3	2		3	2		3		3		3	
CO4												
CO5												
CO6												

192AC06	STRESS MANAGEMENT BY YOGA	L-T-P	C
		2-0-0	0
Programme:	**M.E ENGINEERING DESIGN**	**Category:**	**AC**

Course Outcomes:

Students will be able to:
CO1. Achieve overall health of body and mind
CO2. Overcome stress

UNITI	6
Definitions of Eight parts of yoga. (Ashtanga)	
UNITII	**6**
Yam and Niyam, Do`s and Don't's in life.	
UNITIII	**6**
Ahinsa, satya, astheya, bramhacharya and aparigraha, Shaucha, santosh, tapa, swadhyay, ishwarpranidhan, Asan and Pranayam	
UNITIV	**6**
Various yog poses and their benefits for mind & body	
UNITV	**6**
Regularization of breathing techniques and its effects-Types of pranayam	
TOTAL : 30 PERIODS	

REFERENCE BOOKS

1. 'Yogic Asanas for Group Tarining-Part-I" :Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata

Course Outcomes	Program Outcomes (Pos)								Program Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3		2		3	2	2	2	3	2	2	
CO2	3		2		3	2	2	2	3	2		
CO3												
CO4												
CO5												
CO6												