Dr. Babasaheb Ambedkar Technological University

(Established as a University of Technology in the State of Maharashtra)
(under Maharashtra Act No. XXIX of 2014)
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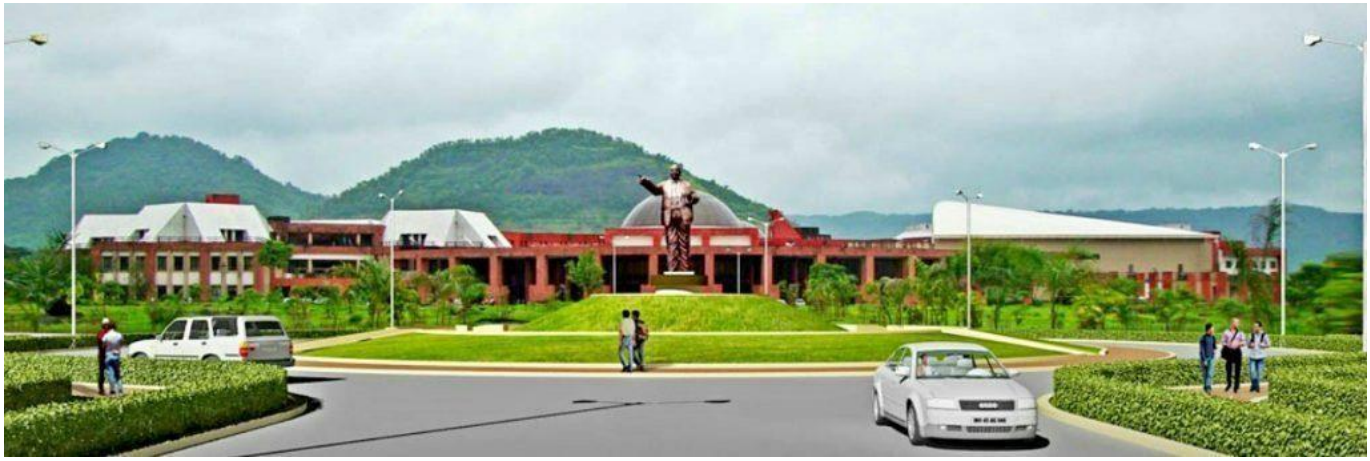
Course Structure and Contents
for

M.Tech. in Design/ Machine Design/ Design Engineering/ Mechanical Engineering Design

(For Affiliated Institutes)

Syllabus as per the guidelines of National Education Policy 2020
To be implemented from Academic Year 2024-25.



Vision

The vision of the Department is to achieve excellence in teaching, learning, research and transfer of technology and overall development of students.

Mission

Imparting quality education, looking after holistic development of students and conducting need-based research and extension activities.

Programme Educational Objectives (PEOs)

No.	PEO
PEO1	To train the students with in-depth and advanced knowledge to become professional and capable of identifying, analyzing and solving complex problems in the areas of design engineering.
PEO2	To enable post graduates to carry out innovative and independent research work, disseminate the knowledge in Academia/Industry/Research Organizations to develop systems and processes in the related field.
PEO3	To prepare the students to exhibit a high level of professionalism, integrity, effective communication skills and environmental and social responsibility.
PEO4	To provide an academic environment that gives adequate opportunity to the students to cultivate life-long independent learning abilities for their successful professional careers.

Programme Outcomes (POs)

At the end of the program, the students will be able to:

No.	PO
PO1	Acquire, demonstrate and apply advanced knowledge in the area of design engineering.
PO2	Identify problems in the field of design engineering, formulate them and solve by using advanced techniques.
PO3	Conduct independent research and generate new knowledge for the benefit of community, society Industry and country.
PO4	Apply various numerical methods, advanced software and engineering tools to model, analyze and solve design engineering problems.
PO5	Work effectively in interdisciplinary teams for solving real life problems in the related field.
PO6	Apply engineering and scientific principles for the effective management of design systems.
PO7	Effectively communicate through technical reports, presentations and scientific publications with the engineering community as well as society at large.
PO8	Demonstrate traits of management in handling engineering projects, related finance, and coordinate with workforce towards achieving goals.
PO9	Demonstrate high level of professional and intellectual integrity, ethics of research and scholarly standards.
PO10	Examine critically the outcomes of one's actions and make corrective measures subsequently.
PO11	Demonstrate the ability to work in team in the laboratory in achieving multidisciplinary tasks required for the project.
PO12	Engage in life-long reflective and independent learning with high level of enthusiasm and commitment.

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Abbreviations

PEO: Program Educational Objectives
PO: Program Outcomes
CO: Course Outcomes
L: No. of Lecture hours (per week)
T: No. of Tutorial hours (per week)
P: No. of Practical hours (per week)
C: Total number of credits
PCC: Program Core Course
OEC: Open Elective Course
PEC: Program Elective Course
AC: Audit Course
AEC: Ability Enhancement Course
VEC: Vocational Education Course
IKS: Indian Knowledge Society
MDM: Multidisciplinary Minor

M. Tech in Design/ Machine Design/ Design Engineering/ Mechanical Engineering Design
Course Structure

SEMESTER-I											
Course Code	**Type of Course**	**Course Name**	**L**	**T**	**P**	**Credit**	**ESE-Th**	**CA**	**Mid Sem**	**ESE-PR/OR**	**Total**
24AF2619PC101	PCC	Advanced Engineering Design	3	1	-	4	60	20	20		100
24AF2619PC102	PCC	Analysis and synthesis of Mechanisms	3	1	-	4	60	20	20		100
24AF2619PC103	PCC	Mechanical Vibrations and Control	3	1	-	4	60	20	20		100
24AF2619PE104 (A/B/C/D)/ 24AF2612PE104A/ 24AF2604PE104B/ 24AF2619PE104E	PEC-I	Program Elective-I	3			3	60	20	20		100
24AF2619PE105 (A/B/C)/ 24AF2604PE105A/ 24AF2604PE105B/ 24AF2604PE105C	PEC-II	Program Elective-II	3			3	60	20	20		100
24AF2619OE106A/ 24AF2604OE106A/ 24AF2604OE106C	OEC	Open elective course	3	-	-	3	60	20	20		100
24AF2619PCL107	PCC Lab	Design and Analysis Lab		-	2	1		25	25		50
24AF2604AU108A/ 24AF2956AU108B	AC	Audit Course	2					20	20		40
		Total Credit	20	3	**2**	**22**	**360**	**165**	**165**		**690**

Program Elective-I	**Program Elective-II**	**OEC**	**AC**
24AF2619PE104A Composite Materials and Mechanics	24AF2619PE105A. Tribology in Design	24AF2619OE106A Nanocomposite Material	24AF2604AU108A Universal Human Values & Professional Ethics
24AF2619PE104B Experimental Stress analysis	24AF2619PE105B Theory of Elasticity and Plasticity	24AF2604OE106A Reverse Engineering	24AF2956AU108B Plastic Waste Management
Advance Engineering Materials 24AF2619PE104C	24AF2619PE105C Process Equipment Design	24AF2604OE106C Understanding Incubation and Entrepreneurship	
24AF2619PE104D Advanced Mechanical Components Design	Failure Analysis and Design 24AF2604PE105A		
24AF2604PE104B Instrumentation and Automatic Control	Machine Tool Design 24AF2604PE105B		
Robot Kinematics 24AF2619PE104E	Engineering computing 24AF2604PE105C		

SEMESTER-II											
Course Code	**Type of Course**	**Course Name**	**L**	**T**	**P**	**Credit**	**ESE-Th**	**CA**	**Mid Sem**	**ESE-PR/OR**	**Total**
24AF2604PC201	PCC	Finite Element Method in Design	3	1	-	4	60	20	20		100
24AF2619PC202	PCC	Integrated Product Development	3	1	-	4	60	20	20		100
24AF2619PE203A 24AF2604PE203 (A/B/C/D/G)	PEC-III	Program Elective-III	3			3	60	20	20		100
24AF2604PE204(B/E/G) 24AF2956PE204B 24AF2619PE204(A/B/C)	PEC-IV	Program Elective-IV	3			3	60	20	20		100
24AF2619OE205(A/B) 24AF2630OE205C/ 24AF2604OE205(A/D)/ 24AF2956OE205C	OEC-I	Open elective course	3	-	-	3	60	20	20		100
24AF2956IK206 (A/B/C)	AEC/VEC/ IKS		2	-	-	2		20	20		40
24AF2956AU207	AC	Research Paper Writing	2			-		20	20		40
24AF2619PC208	PCC	Technical Seminar	-		2	1			50	50	100
24AF2619PC209	PCC	Mini Project	-		2	1			50	50	100
		Total Credit	**19**	**2**	**4**	**21**	**300**	**140**	**240**	**100**	**780**

Program Elective-III	**Program Elective-IV**	**OEC I**	**AEC/VEC/ IKS**
24AF2619PE203A Introduction to Machine Learning	24AF2604PE204B Mechatronics	24AF2619OE205A Computer applications in Design	24AF2956IK206A Indian Knowledge System: Concepts &Applications in Engineering
24AF2604PE203A Vehicle Dynamics	24AF2604PE204E Designing with Advanced Materials	24AF2619OE205B Mechanical Measurements and Analysis	24AF2956IK206B Indian Knowledge System: Humanities & Social Sciences
24AF2604PE203B Engineering Fracture Mechanics	24AF2604PE204G Optimization in Design	24AF2630OE205C Research Methodology	24AF2956IK206C Ancient Indian Management
24AF2604PE203C Noise Vibration and Harshness	24AF2956PE204B. Product Life cycle Management	24AF2604OE205A Design of Experiments	
24AF2604PE203D Design for Piping System	24AF2619PE204A Biomaterials	24AF2604OE205D Design for sustainability	
24AF2604PE203G Supply Chain Management	24AF2619PE204B Design for Manufacturing and Assembly	24AF2956OE205C Engineering Economic Analysis	
	24AF2619PE204C Rotor Dynamics		

SEMESTER-III											
Course Code	**Type of Course**	**Course Name**	**L**	**T**	**P**	**Credit**	**ESE-Th**	**CA**	**Mid Sem**	**ESE-PR/OR**	**Total**
24AF2604OE301A/ 24AF2956OE301(C/A)	OEC-II	Open elective course	3	-	-	3	60	20	20		100
24AF2956MD302(A/B)/ 24AF2604MD302C	MDM	Multidisciplinary Minor	3	-	-	3	60	20	20		100
24AF2956PC303	PC	Intellectual Property Rights	3	-	-	3	60	20	20		100
24AF2619PC304	PCC	Project Stage –I				10	--	--	50	50	100
		Total Credit	9			**19**	**180**	**60**	**110**	**50**	**400**

Open elective course -II	**Multidisciplinary Minor**
24AF2604OE301A Project Management for Managers	24AF2956MD302A Applications of IoT and Industry 4.0
24AF2956OE301C Industrial Safety Engineering	24AF2956MD302B e-Commerce Technologies
24AF2956OE301A Python and data science	24AF2604MD302C Entrepreneurship & Start-ups

SEMESTER-IV											
Course Code	**Type of Course**	**Course Name**	**L**	**T**	**P**	**Credit**	**ESE-Th**	**CA**	**Mid Sem**	**ESE-PR/OR**	**Total**
24AF2619PC401	PCC	Project Stage –II	-	-	-	20	-	100	-	100	200
		Total Credit	**-**	**-**	**-**	**20**	**-**	**100**	**-**	**100**	**200**

Credit Distribution				
SEM I	**SEM II**	**SEM III**	**SEM IV**	**Total**
22	**21**	**19**	**20**	**82**

Advanced Engineering Design

24AF2619PC101	Advanced Engineering Design	PCC	3-1-0	4 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: Mechanics of Materials, Machine Design

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[09 Hours]**

Design Philosophy: Design process, Problem formation, Introduction to product design, Various design models-Shigley model, Asimov model and Norton model, Need analysis, Strength considerations - standardization. Creativity, Creative techniques, Material selections, Notches and stress concentration, design for safety and Reliability.

Unit 2 **[09 Hours]**

Product Design: Product strategies, value, planning and specification, concept generation, concept selection, concept testing.

Unit 3 **[09 Hours]**

Design for Manufacturing: Forging design, casting design, Design process for non- metallic parts, Plastics, Rubber, Ceramic, Wood and Glass parts. Material selection in machine design.

Unit 4 **[09 Hours]**

Failure theories: Static failure theories, Distortion energy theory, Maximum shear stress theory, Coulomb-Mohr's theory, Modified Mohr's theory, Fracture mechanics theory, Fatigue mechanisms, Fatigue failure models, Design for fatigue strength and life, creep: Types of stress variation, design for

fluctuating stresses, design for limited cycles, multiple stress cycles, Fatigue failure theories, cumulative fatigue damage, thermal fatigue and shock, harmful and beneficial residual stresses, Yielding and transformation.

Unit 5 **[09 Hours]**

Surface failures: Surface geometry, mating surfaces, oil film and their effects, design values and procedures, adhesive wear, abrasive wear, corrosion wear, surface fatigue, different contacts, dynamic contact stresses, surface fatigue failures, surface fatigue strength.

Unit 6 **[09 Hours]**

Economic factors influencing design: Economic analysis, Break-even analysis, Human engineering considerations, Ergonomics, Design of controls, Design of displays. Value engineering, Material and process selection in value engineering, and Modern approaches in design.

Texts/References:

1. Smith Seely, "Advanced Mechanics of Materials", John Willey & Sons Publications.
2. Timoshenko, "Strength of Materials"
3. Kocanda, "Fatigue Failure of Metal", Sijthoff and Noordhoff International Publications.
4. Frost N. E., "Metals Fatigue", Oxford University Press, London.
5. Benhan& Crawford, "Mechanics of Engineering Materials", John Willey & Sons Pub.
6. Spotts M. F., "Mechanical Design Analysis", PHI Publications, New Delhi.

Analysis and Synthesis of Mechanisms

24AF2619PC102	Analysis and Synthesis of Mechanisms	PCC	3-1-0	4 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: Theory of Machines, Kinematics of Machinery

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Course Contents:

Unit 1 **[09 Hours]**

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 bythe normal acceleration and auxiliary-point methods.

Unit 2 **[09 Hours]**

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

Unit 3 **[09 Hours]**

Kinematic synthesis of planar mechanisms- Graphical: 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,

Unit 4 **[09 Hours]**

Kinematic synthesis of planar mechanisms- Analytical : Analytical

synthesis of four-bar and slider-crank mechanisms, 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.

Unit 5 **[09 Hours]**

Coupler Curves: Equation of coupler curve, Robert-Chebychev theorem, double points and symmetry.

Unit 6 **[09 Hours]**

Kinematic analysis of spatial mechanism: Denavit-Hartenberg parameters, matrix method of analysis of spatial mechanisms

Texts/Reference:

1. R.S. Hartenberg and J. Denavit, “Kinematic Synthesis of Linkages”, McGraw-Hill, New York, 1980.
2. Robert L. Nortan ,"Design of Machinery', Tata McGraw Hill Edition
3. Hamilton H. Mabie, "Mechanisms and Dynamics of Machinery", John Wiley and sons New York
4. S. B. Tuttle, "Mechanisms for Engineering Design" John Wiley and sons New York
5. Ghosh and A.K. Mallik, “Theory of Machines and Mechanisms”, Affiliated East- West Press, New Delhi, 1988.
6. A.G. Erdman and G.N. Sandor, “Mechanism Design – Analysis and Synthesis”, (Vol. 1 and 2), Prentice Hall India, 1988.
7. A.S. Hall, “Kinematics and Linkage Design”, Prentice Hall of India.
8. J.E. Shigley and J.J. Uicker, “Theory of Machines and Mechanisms”, 2nd Edition, McGraw-Hill, 1995.

Mechanical Vibrations and Control

24AF2619PC103	Mechanical Vibrations and Control	PCC	3-1-0	4 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[09 Hours]**

Multi-degree of freedom system: Free Vibration Equation of motion, Influence Coefficients (Stiffness and Flexibility), Generalized Coordinates, and Coordinate Coupling. Lagrangian and Hamilton Equations, Matrix Method, Eigen value and Eigen Vector Method

Unit 2 **[09 Hours]**

Vibration measurement: Basic signal attributes, Vibration measuring sensors (Displacement, Velocity, and Acceleration), Piezoelectric Accelerometers, Method for Calibrating Accelerometer, Basic Process of Digital Frequency Analyzer, Digital Analyzeroperating principles, Measurement of phase, Phase fundamentals, Comparing two waveforms using reference, Cross Channel phase analysis, Electronic Filters, Time and orbital domain, Time and frequency domains, Evaluation of vibration severity, ISO standards: ISO 10816 and ISO 7919

Unit 3 **[09 Hours]**

Modal analysis: Introduction, Free vibration response using modal analysis, Forced vibration response using modal analysis, Experimental modal analysis: Necessary equipment, signal processing, Measurement of mode shapes, Introduction to damage detection in structures using changes in modal frequency and mode shapes

Unit 4 **[09 Hours]**

Vibration control: Conventional Methods: By Mass/Inertia, Stiffness, Damping (Vibration Isolation Principles). Dynamic vibration absorbers. Introduction to Semi-Active and Active Vibration Control

Unit 5 **[09 Hours]**

Non-linear vibrations: Basics of non-linear vibration, Systems with non-linear elastic properties, free vibrations of system with non-linear elasticity and damping, phase- plane techniques, Duffing's equation, Jump phenomenon, Limit cycle, Perturbation method.

Unit 6 **[09 Hours]**

Vibration analysis for machinery malfunction: Analysis of machinery vibration problems, Methodology of vibration analysis, Condition/vibration monitoring data collection, Trending of data, Time wave form analysis, Signature analysis, Absolute Phase analysis and cross channel phase analysis, Orbit analysis. Root Cause Analysis. Methodology of diagnosis of unbalance, misalignment and antifriction bearing defects. Frequency calculation and their significance in signature analysis of antifriction bearing, Mechanical Looseness, diagnosis of foundation problem.

Texts/References:

1. Leonard Meirovitch – Elements of Vibration Analysis, McGraw Hill
2. Thomson W.T , Theory of Vibration with Applications., Prentice Hall India.
3. Rao V and J Srinivas, Mechanical Vibrations, PHI Learning Pvt. Ltd.
4. S.S Rao, Mechanical Vibrations, Pearson Education India

Composite Materials and Mechanics

24AF2619PE104A	Composite Materials and Mechanics	PEC-I	3-0-0	3 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[07 Hours]**

Introduction, basic concepts and characteristics: Definition and characteristics, Overview of advantage and limitations of composite materials, Significance and objectives of composite materials, Science and technology, current status and future prospectus, Structural performance of conventional material, Geometric and physical definition, Material response, Classification of composite materials, Scale of analysis; Micromechanics, Basic lamina properties, Constituent materials and properties, Properties oftypical composite materials.

Unit 2 **[07 Hours]**

Elastic behavior of unidirectional lamina: Stress-strain relations, Relation between mathematical and engineering constants, transformation of stress, strain and elastic parameters.

Unit 3 **[07 Hours]**

Strength of unidirectional lamina: Micromechanics of failure; failure mechanisms, Macro-mechanical strength parameters, Macro-mechanical failure theories, Applicability of various failure theories.

Unit 4 **[07 Hours]**

Elastic behavior of laminate: Basic assumptions, Strain-displacement relations, Stress-strain relation of layer within a laminate, Force and moment resultant, general load–deformation relations, Analysis of different types of laminates.

Unit 5 **[07 Hours]**

Hygro-thermal effects: Hygro-thermal effects on mechanical behaviour, Hygro- thermal stress-strain relations, Hygro-thermoelastic stress analysis of laminates, Residual stresses, Warpage.

Unit 6 **[07 Hours]**

Stress and failure analysis of laminates: Types of failures, Stress analysis and safety factors for first ply failure of symmetric laminates, Micromechanics of progressive failure; Progressive and ultimate laminate failure, Design methodology for structural composite materials

Texts/References:

1. Isaac M. Daniels, OriIshai, "Engineering Mechaincs of Composite Materials", Oxford University Press, 1994.
2. Bhagwan D. Agarwal, Lawrence J. Broutman, "Analysis and Performance of fiber composites", John Wiley and Sons, Inc. 1990.
3. Mathews, F. L. and Rawlings, R. D., "Composite Materials: Engineering andScience", CRC Press, Boca Raton, 2003.
4. MadhujitMukhopadhyay, "Mechanics of Composite Materials and Structures", University Press, 2004.
5. Mazumdar S. K., "Composaite Manufacturing – Materials, Product and Processing Engineering", CRC Press, Boca Raton, 2002.

Experimental Stress Analysis

24AF2619PE104B	Experimental Stress Analysis	PEC - I	3-0-0	3 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[07 Hours]**

Introduction: Need of stress analysis; Why experimental methods? Merits and demerits of experimental methods.

Unit 2 **[07 Hours]**

Basics of Elasticity: Stress at a point; stress equations of equilibrium; 2-D state of stress; Strains and displacements; Stress strain relationship for 2-D state of stress; Plane stress and plane strain approach.

Unit 3 **[07 Hours]**

Measurement of Strain: Strain gauges: Mechanical, optical, electrical, acoustical and semiconductor; Grid method of strain analysis.

Unit 4 **[07 Hours]**

Electrical strain gauges: Gauge construction; Strain gauge adhesives and mounting techniques; Gauge sensitivity and gauge factor; Strain gauge linearity, hysteresis and zero shift; Temperature compensation; Environmental effects: moisture, humidity and hydrostatic pressure, high and cryogenic temperatures; The Wheatstone bridge; Calibration of strain gauge circuit; Strain analysis method: 3-element rectangular rosette, torque gauge.

Unit 5 **[07 Hours]**

Basics of Optics: Nature of light; Wave theory of light; Optical instruments; Plane and circular polariscopes.

Unit 6 **[07 Hours]**

Theory of Photoelasticity**:** Stress optics law; Effects of a stressed model in a plane polariscope; Effects of principal stress directions; Effects of principal stress difference; Effects of a stressed model in circular polariscope in dark and light field arrangements; 2-D Photoelasticity; Isochromatic and isoclinic fringe patterns; Materials for 2-D Photoelasticity; Introduction to moiré fringe technique and coating methods.

Texts/References:

1. Doyle, J.F.: Modern Experimental Stress Analysis. J. Wiley, 2004.
2. Dove Adams, Experimental Stress Analysis, McGraw Hill, 1992.
3. CC Perry and HR Lissner, "The Strain Gage Primer", McGraw-Hill, 2000.
4. Abdul Mubeen, "Experimental Stress Analysis", DhanpatRai and Sons, 2001.
5. PS Theocaris, "Moire Fringes in Strain Analysis", Pergammon Press, 2002.

Advance Engineering Materials

24AF2619PE104C	Advance Engineering Materials	PEC - I	3-0-0	3 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[07 Hours]**

Special Steels: Metallurgical aspects, Composition, Properties and applications of: different types of Stainless steels, Dual phase steels, TRIP steels, Maraging steels, High speed steels, Hadfield steels, Free cutting steels, Ausformed steels, Tool Steels, manganese steels, chrome steels, electrical steels, bearing steels, spring steels, heat resistant steels, creepsteels, HSLA steels etc.

Unit 2 **[07 Hours]**

Alloy cast iron: Need of alloying. Silal, Nicrosilal, High silicon cast iron, Ni-hard, Heat resistant cast iron: Composition, Properties and their applications.

Unit 3 **[07 Hours]**

Light metals and their alloys: Aluminum, magnesium and titanium alloys: Metallurgical aspects, Properties and applications

Unit 4 **[07 Hours]**

Super alloys: Iron base, nickel base and cobalt base super alloys: Strengthening mechanism, Composition, Properties and their applications.

Unit 5 **[07 Hours]**

Nano materials: Definition, Types, Properties and applications, Carbon nano tubes, Methods of production.

Smart materials: Shape memory alloys, Piezoelectric materials, Electro-rheological fluid, Magneto-rheological fluids.

Unit 6 **[07 Hours]**

Biomaterials: Property requirement, biocompatibility, bio-functionality, Important bio metallic alloys like: Ni-Ti alloy and Co-Cr-Mo alloys. Applications

Texts/References:

1. The Science and Engineering of Materials by D. R. Askeland and P. P. Phule, Thomson Publication
2. Advances in Material Science by R. K. Dogra and A. K. Sharma
3. Material science by Van Black.
4. Engineering Materials and Applications by R. A. Flinn and P. K. Trojan
5. Materials, their Nature, Properties and Fabrication by R. A. Lindberg and S. D. Sehgal, S Chand & Co.
6. Light Alloys: Metallurgy of Light Metals by I. J. Polmear
7. Engineering Materials: Properties and applications of Metals and alloys by CP Sharma, PHI
8. Engineering Materials: Polymers, ceramics and composites by AK Bhargava, PHI Nano Technology by AK Bandyopadhyay, New age international publishers

Advanced Mechanical Components Design

24AF2619PE104D	**Advanced Mechanical Components Design**	**PEC-I**	**3-0-0**	**3 Credits**

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: Machine Design I and II

Course Outcomes: At the end of the course, the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[07 Hours]**

Introduction: Statistical Considerations in Design for factor of safety, relationship between actual load and load capability, selection of factor of safety based on percentage estimates for tolerances on actual load and load capability and where the occurrence of the failure phenomenon would be disastrous

Unit 2 **[07 Hours]**

Optimum Design: Optimum design for mechanical elements by considering adequate design, optimum design, P.D.E., S.D.E., limit equations, principles of optimum design with normal specifications, redundant specifications, incompatible specifications, optimum design of tensile bar, torsion shaft, beams, step shafts and with combined loading.

Unit 3 **[07 Hours]**

Mechanical Springs: Design of square or rectangular bar helical springs, Belleville springs, ring springs, torsion bar springs, theory of square or rectangular bar helical springs under axial loading, cone or flat disc spring theory.

Unit 4 **[07 Hours]**

Cams: Basic curves, cam size determination, calculating cam profiles, advance curves, polydyne cams, dynamics of high speed cam systems, surface materials, stresses and accuracy, ramps.

Unit 5 **[07 Hours]**

Flat plate: Stress resultants in a flat plate, kinematics strain- displacement, relations for plates, equilibrium equation for small displacement, theory of plates, stress-strain temperature relations for isotropic elastic plates, strain energy of a plate, boundary conditions for plates, Circular plates with hole and without hole with different types of support and loading.

Unit 6 **[07 Hours]**

Advances in machine design: Defining design, creativity, invention and innovation, design methodology, patterns of evaluation, design patents, functional approach, performance specifications, Quality Function Deployment, improvement of ideality, design strategy, problem definition, objective, top down and bottom up approaches, system, problem formulation, substance field analysis, morphological analysis, creative problem solving, inventive principle, evaluation of ideas or concepts, product design specifications, selectionof best design,

Texts/References:

1. Robert L. Norton, Machine Design: An Integrated Approach, Prentice-Hall New Jersey,USA.
2. George E Dieter, Engineering Design, McGraw Hill, 2008.
3. J.E. Shigley and L.D. Mitchell, Mechanical Engineering Design, McGraw Hill International Book Company, New Delhi.
4. Hamrock, Schmid and Jacobian, Fundamentals of machine elements, 2nd edition, McGraw-Hill International edition.
5. Karl T. Ulrich and Steven D. Eppinger, Product design and development, 3rd edition, Tata McGraw Hill.
6. A.K. Chitale and R.C. Gupta, Product Design and Manufacturing, Prentice Hall
7. T.K. Varadan and K. Bhaskar, "Analysis of Plates - Theory and Problems", Narosa Publishing House
8. Stephen P. Timoshenko and S. Woinowsky-Krieger, "Theory of Plates and Shells", Tata McGraw Hill
9. Spring Design and Manufacture, Tubal Cain
10. Mechanical Springs, A D Brown
11. Fundamentals of Machine Design, R C Juvinall and K M Marshek, Wiley India
12. Mechanical Design of Machine Elements and Machines: A failure prevention perspective, Wiley India
13. Dislocations and Mechanical Behaviour of Materials, M N Setty, PHI.
14. Mechanical Behaviour of Materials, T C Courney, Overseas Press India
15. Metal Fatigue in Engineering, R I Stephens, A Fatemi, R R Stephens, H O Fuchs,John Wiley
16. Introduction to Optimum Design, Jasbir Arora, Academic Press

Instrumentation and Automatic Control

24AF2604PE104B	**Instrumentation and Automatic Control**	**PEC - I**	**3-0-0**	**3 Credits**

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[07 Hours]**

Introduction to measurements for scientific and engineering application needs and goals. Broad category of methods for measuring field and derived quantities

Unit 2 **[07 Hours]**

Principles of measurement, parameter estimation, regression analysis, correlations, error estimation and data presentation, analysis of data

Unit 3 **[07 Hours]**

Measurement of field quantities, thermometry, heat flux measurement, measurement of force, pressure, flow rate, velocity, humidity, noise, vibration, measurement of the above by probe and non-instructive techniques

Unit 4 **[07 Hours]**

Measurement of derived quantities, torque, power, thermo physical properties, radiation and surface properties

Unit 5 **[07 Hours]**

Analytical methods and pollution monitoring, mass spectrometry, chromatography, spectroscopy.

Unit 6 **[07 Hours]**

Basics of P, PI, PID controllers, pneumatic and hydraulic controllers, electronic controllers, applications to machine tools, furnaces, material handling etc

Texts/References

1. Doebelin E.O: Measurement Systems-Application and Design, McGraw Hill Publication Co.
2. Beckwith TG. N. Lewis Buck and Marangoni R.D: Mechanical Measurements, Narosa Publishing House, New Delhi
3. Liptak B.G. Instrument Engineers' Handbook
4. Bolton W, Mechatronics-Electronics Control Systems in Mechanical and Electrical Engg.
5. Modern Electronic Instrumentation and Measurement Technique by A.D. Helfrick and W.D. Cooper Johnson C.D., Process Control Instrumentation
6. J. P. Holman: Experimental Methods for Engineers, McGraw Hill International Edition, Seventh Edition

Robot Kinematics

24AF2619PE104E	Robot Kinematics	PEC - I	3-0-0	3 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[07 Hours]**

Introduction: Review, forward and inverse kinematics, dynamics, Robots with Flexible Elements: Robots with Flexible Joints, Robots with Flexible Links

Unit 2 **[07 Hours]**

Parallel mechanisms and robots: Definitions, Type of Synthesis of Parallel Mechanisms, Kinematics, Velocity and Accuracy Analysis, Singularity Analysis, Workspace Analysis, Static Analysis and Static Balancing, Dynamic Analysis, Design

Unit 3 **[07 Hours]**

Mobile robots: Wheeled mobile robots: mobile robot kinematics, Mobility of Wheeled Robots, State-Space Models of Wheeled Mobile Robots, Wheeled Robot Structures, sensors for mobile robots, planning and navigation Legged robots: Analysis of Cyclic Walking, Control of Biped Robots Using Forward Dynamics, Biped Robots in the ZMP Scheme, Multilegged Robots, Performance Indices

Unit 4 **[07 Hours]**

Cooperative manipulators: Kinematics and Statics, Cooperative Task Space, Dynamics and Load Distribution, Task-Space Analysis,

Unit 5 **[07 Hours]**

Control of manipulators: Manipulator control problem; Linear and nonlinear control schemes; PID control scheme; Force control.

Unit 6 **[07 Hours]**

Image processing and analysis with vision systems: Acquisition of images, digital images, image processing techniques, noise reduction, edge detection, image analysis, object recognition by features, application of vision systems

Texts / References:

1. K. S. Fu, R. C. Gonzalez, C. S. G. Lee, Robotics, McGraw Hill New york, 1987.
2. Y. Koren, Robotics for Engineers, McGraw Hill, 1985.
3. J. J. Craig, Robotics, Addison-Wesley, 1986.

Tribology in Design

24AF2619PE105A	Tribology in Design	PEC - II	3-0-0	3 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[07 Hours]**

Surfaces, friction and wear: Topography of Surfaces, Surface features, Surface interaction, Theory of Friction, Sliding and Rolling Friction, Friction properties of metallic and non -metallic materials, Friction in extreme conditions, Wear, types of wear, Mechanism of wear, wear resistance materials, Surface treatment, Surface modifications, Surface coatings.

Unit 2 **[07 Hours]**

Lubrication theory: Lubricants and their physical properties lubricants standards, Lubrication Regimes in Hydrodynamic lubrication, Reynolds Equation, Thermal, inertia and turbulent effects.

Unit 3 **[07 Hours]**

Other types of lubrication: Electro-hydrodynamic (EHD), Magnetohydrodynamic lubrication, Hydro static lubrication, Gas lubrication, Solid lubrication.

Unit 4 **[07 Hours]**

Design of fluid film bearings: Design and performance analysis of thrust and journal bearings, Full, Partial, Fixed and pivoted journal bearings design, Lubricant flow and delivery, Power loss, Heat and temperature of steady and dynamically loaded journal bearings, Special bearings, Hydrostatic Bearing design.

Unit 5 **[07 Hours]**

Rolling element bearings: Geometry and kinematics, Materials and manufacturing processes, contact stresses, Hertzian stress equation, Load divisions, Stresses and deflection, Axial loads and rotational effects, bearing life capacity and variable loads, ISO standards, Oil films and their effects, Rolling Bearings Failures.

Unit 6 **[07 Hours]**

Tribo measurement and Instrumentation: Surface Topography measurements, Electron microscope and friction and wear measurements, Laser method, Instrumentation, International standards, Bearings performance measurements, bearing vibration measurement

Texts/References:

1. Cameron A., "Basic Lubrication Theory", Ellis Horwood Ltd., UK, 1981
2. Halling J. (Editor) – "Principles of Tribology ", Macmillian, 1984.
3. Williams J.A., "Engineering Tribology", Oxford Univ. Press, 1994.
4. Neale, M.J., "Tribology Hand Book", Butterworth Heinemann, 1995.
5. StolarskiT.a., "Tribology in Machine Design", Industrial Press Inc., 1990.

Theory of Elasticity and Plasticity

24AF2619PE105B	Theory of Elasticity and Plasticity	PEC - II	3-0-0	3 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Course Contents:

Unit 1 **[07 Hours]**

Introduction: Stress transformation and Strain transformation at a point in an elastic body, 3D Problems, Rigid body translation and rotation of an element in space. Generalized, Hook law, Separation of Elastic Strains and rigid body displacement for a general displacement field u, v, w. Principal Stress and Strains.

Unit 2 **[07 Hours]**

Two dimensional problems in elasticity: Plane Stress and Plane Strain Problems. Differential equations of equilibrium and compatibility equations. Boundary Conditions & Stress Functions. Problems in Rectangular coordinates, Polynomial solutions, Cantilever loaded at the end, simply supported load beam under uniformly distributed load, linear loading, Two dimensional problems in polar coordinated, stress distribution symmetrical about an axis, pure bending of curved bar, Displacement for symmetric loaded cases, Bending of curved bar by forces at end. Effect of circular hole in plate under in plane loading. Concentrated load at point of Straight boundary. Stresses in circular disk. Forces acting on end of wedge.

Unit 3 **[07 Hours]**

Three dimensional problems in elasticity: Differential equation of equilibrium in 3D, Condition of Compatibility, Determination of Displacement, Principal of superposition, Uniqueness theorem, Problems of Rods under axial stress, Bar under its own weight, Pure bending of Prismatic roads, Torsion of Prismatic bars of Elliptical, rectangular, triangular and other sections, Membrane Analogy-Torsion of narrow rectangular bars. Torsion of hollow shaft and thin tubes.

Unit 4 **[07 Hours]**

Bending of prismatic bars as a problem of elasticity in 3D: Bending of a cantilever, Stress function, Circular and rectangular sections, Non-symmetrical cross section. Shear Centre for different cross sections of bars, Calculation of deflections.

Unit 5 **[07 Hours]**

Energy theorems: Applications of complimentary energy theorems to the problems of elasticity.

Unit 6 **[07 Hours]**

Introduction to Plasticity: Criteria of yielding, strain hardening, rules of plastic flow, different stress strains relations. Total Strain theory, theorems of limit analysis. Elastoplastic bending and torsion of bars.

Texts/References:

1. Wang, “Applied Elasticity”, McGraw hill book Co.
2. Timoshenko, “Theory of Elasticity”, McGraw hill book Co.
3. J. Chakrabarti, “Theory of Plasticity”, McGraw hill book Co.

Process Equipment Design

24AF2619PE105C	Process Equipment Design	PEC-II	3-0-0	3 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Course Contents:

Unit 1 **[07 Hours]**

Design considerations for pressure vessel: Introduction; Selection of type of vessel, Methods of fabrication, Effect of fabrication methods, Various criteria in vessel design, Economic considerations, Types of process equipment, Constructional requirement and applications., Fabrication and testing, Inspection and non-destructive testing of equipment.

Unit 2 **[07 Hours]**

Storage vessel: Design methods of atmospheric storage vessel: storage of fluids, storage of non-volatile liquids, storage of volatile liquids, storage of gases, Optimum tank proportion, Bottom design, Shell design, Wind girder for open top tank, Rub curb angle, Self supported roof, Design of rectangular tank.

Unit 3 **[07 Hours]**

Pressure vessel: Unfired process vessel with internal and external pressure, Operating condition, Selection of material, Design condition, Stresses, Design criteria, Design of shell subjected to internal and external pressure, Cylindrical vessel under combined loading, Design of heads and closures: flat head and formed heads for vessel. Design consideration for rectors and chemical process vessels. Flange facings, Gaskets, Design of flanged joint, Flange thickness, and Blind flanges.

Unit 4 **[07 Hours]**

High pressure vessel: Design of thick walled high-pressure vessel, Constructional features, Materials for high-pressure vessels, Multilayer vessel with shrink fit construction, Thermal expansion for shrink fitting, stress in multishell or shrink fit construction, autofrettage, Pre-stressing. Tall vessels and their design, Stress in shell, Determinations of longitudinal stresses, Longitudinal bending stresses due to eccentric loads, Determination of resultant longitudinal stresses.

Unit 5 **[07 Hours]**

Agitated vessel: Type of agitators, Baffling, Power requirement for agitation, Design based on torque and bending moment, Design based on critical speed, Blade design, Hub and key design, Stuffing box and gland design, Turbine agitator design,

Unit 6 **[07 Hours]**

Support for pressure vessel: Bracket or lug support: Thickness of the base plate, Thickness of web (gusset) plate, Column support for bracket base plate for column or leg support. Skirt Support: Skirt design, Skirt bearing plate, and Anchor bolt design, Design of bolting chair. Saddle Support: Longitudinal bending moment, Stresses in shell at saddle.

Texts/References:

1. Process Equipment Design by V.V .Mahajani and S. B. Umarji. Macmillan PublisherIndia Ltd.
2. Process equipment design by L.E.Brownell and E.H.Young, John Wiley and Sons.
3. Introduction to process Equipment Design by B.C. Bhattacharya
4. Pressure Vessel Design Manual by Dennis Moss, Elsevier
5. Theory and Design of Pressure Vessels by John F. Harvey, P. E., CBS Publication

Failure Analysis and Design

24AF2604PE105A	Failure Analysis and Design	PEC -II	3-0-0	3 Credits

Continuous Assessment 20 Marks	Mid Sem Exam 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[07 Hours]**

Theories of failure: Maximum shear stress theory, Maximum normal stress theory, Maximum distortion energy theory, Maximum strain theory, Applicability of theories of failure.

Unit 2 **[07 Hours]**

Fracture: Type of fracture, Theoretical cohesive strength of metals, Griffith theory of brittle fracture, fracture single crystals, Metallographic aspects of fracture, Dislocation theories of brittle fracture, Ductile fracture, Notch effects, Fracture under combined stresses.

Unit 3 **[07 Hours]**

Elements of fracture mechanics: Strain- energy release rate, Stress intensity factor, Fracture toughness, Plane - strain toughness testing, Crack-opening displacement, J-Integral to solve energy of crack formation, R-curves, Toughness of material.

FATIGUE FAILURE: Stress cycle, S-N curve, Description of fatigue fractured parts, Phases of fatigue fracture, Fatigue crack propagation, Effects of metallurgical variables, Temperature, Stress concentration, Size and surface factors, Fatigue under combined stresses.

Unit 4 **[07 Hours]**

Creep failure: Creep curve, Structural changes and mechanisms during creep, Activation energy for steady-state creep, Fracture at elevated temperature.

Brittle fracture: Transition temperature curves, Fracture analysis diagrams, Various types of embitterment, Fracture under very rapid loading.

Unit 5 **[07 Hours]**

Ductile fracture: Condition for necking, Dislocation and void formation activities, Types of fractured parts.

Assessment of types of fractures by observation: Comparison between different fractured parts undergoing various type of fracture.

Unit 6 **[07 Hours]**

Design application of the knowledge of failure: Design considering fatigue-Geber's parabola, Soderberg equation, lubricating optimally to combat bearing failures. Selection of materials to prevent seizure, galling, etc. Wear reduction techniques, Fracture toughness consideration in design.

Texts/ References:

1. Madoyag, F., Metal Fatigue Design and Theory.
2. Sors, L., Fatigue Design of Machine Components, Pergamon Press.
3. Rolfe, S.T. and Barson, J.M., Fracture and Fatigue Control Structures, Prentice Hall.
4. Broek, D., Elementary Engineering Fracture Mechanics, Noordnoff.
5. Dieter, G.E., Mechanical Metallurgy, McGraw Hill Book Co., New Delhi.

Machine Tool Design

24AF2604PE105B	Machine Tool Design	PEC-II	3-0-0	3 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: Machine Design

Course Outcomes: At the end of the course, the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[07 Hours]**

Introduction to metal cutting machine tools- criteria for the selection of operating capacity and design parameters, kinematics of machine tools.

Unit 2 **[07 Hours]**

Basic principles of machine tool design, estimation of drive power, machine tool drives, electrical, mechanical and fluid drives, stepped and step less speed arrangements and systems.

Unit 3 **[07 Hours]**

Design of machine tool spindles and bearings, design of power screws, design of slide ways, selective and pre-selective mechanisms.

Unit 4 **[07 Hours]**

Machine tool structures-beds, columns, tables and supports, stock feed mechanism, Measurement and control of machine tools, protective and safety devices, design of precision machine tools.

Unit 5 **[07 Hours]**

Micro-feeding mechanisms, concept of modular design and integration of SPM`s, and Concepts of

aesthetic and ergonomics applied to machine tools.

Unit 6 **[07 Hours]**

Acceptance tests standardization of machine tools, machine tool conditioning, latest trends in machine tool design, Introduction to CAD techniques.

Texts/References:

1. N. K.Mehta , Machine tool design, Tata Mcgraw-hill, New Delhi, 1989.
2. N.Acherkan, Machine tool design, Vol. 3 and 4, Mir publisher, Moscow, 1968.
3. A.Koenigsburger, Design principles of metal cutting machine tools, Pergamon press,1964.
4. C.M.T.I. Machine tool design course notes, C.M.T.I. Bangalore.
5. G.Sen andA.Bhattacharya , Principles of machine tools, Vol. 2, NCB, Calcutta, 1973.

Engineering Computing

24AF2604PE105C	Engineering Computing	PEC-II	3-0-0	3 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[07 Hours]**

Data Analysis and Curve Fitting: Errors in numerical calculations, Interpolation by central differences, sterling Bessel & Everett Formulae, Interpolation Formula for unequal Intervals, Spline Interpolation, Cubic Splines. Least square method for linear & non-linear functions, weighted least square methods.

Unit 2 **[07 Hours]**

Solution of Linear System of Equations: Gauss Elimination with Pivoting, LU Decomposition method, Iterative methods, Eigen vectors-Jacobi method, Jacob's method, Gauss Siedel method.

Unit 3 **[07 Hours]**

Solution of Ordinary Differential Equation, Numerical Differentiation & Integration: Differentiation by Finite Differences, Numerical Integration by Newton-Cotes formula & Gauss Quadrature. Picard's Method, Euler's & Modified Euler's Method, Runge-KuttaMethod (up to fourth order), Predictor-Corrector Methods, Milne Sompson, AdamsBashforth Moulten Methods.

Unit 4 **[07 Hours]**

Boundary value and Eigen value problems: Shooting method, finite difference method to solve boundary value problems, Polynomial method, power method to solve Eigen value problems.

Unit 5 **[07 Hours]**

Solution of Partial differential equations: Finite difference method, solution of Laplace & Parabolic equations.

Unit 6 **[07 Hours]**

Mathematical Modeling of Physical Problems, modeling Concept, Modeling of Linear Differential Equations of Second order.

Texts / References:

1. Dr. B.S. Grewal, Numerical methods for science &Engg., Khanna publications.
2. M.K. Jain, Numerical methods for Scientific &Engg. Computation, New age international publication.
3. E. Balagurusamy, Numerical methods, Tata McGraw Hill Publications.
4. K. Atkinson and W. Han, Elementary Numerical Analysis, 3rd Edition, Wiley-India,2004.
5. J. D. Hoffman and Steven Frankel, Numerical Methods for Engineers and Scientists, 2nd Edition, McGraw-Hill, 2001
6. S. D. Conte and Carl de Boor, Elementary Numerical Analysis - An Algorithmic Approach, 3rd Edition, McGraw-Hill, 1980.
7. S. S. Shastry, Introductory methods of numerical analysis, Third edition, Prentice hall of India publications pvt. Ltd.
8. Swami, Saran Singh, Computer programming and numerical methods.

Nanocomposite Material

24AF2619OE106A	Nanocomposite Material	OEC	3-0-0	3 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course contents:

Unit 1 Basics of Nanocomposites [07 Hour]

Nomenclature, Properties, features and processing of nanocomposites. Sample Preparation and Characterization of Structure and Physical properties. Designing, stability and mechanical properties and applications of super hard nanocomposites.

Unit 2 Metal Based Nanocomposites [07 Hours]

Metal-metal nanocomposites, some simple preparation techniques and their properties. Metal- Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Core-Shell structured nanocomposites

Unit 3 Polymer Based Nanocomposites [07 Hours]

Preparation and characterization of diblock Copolymer based nanocomposites; Polymer Carbon nanotubes based composites, their mechanical properties, and industrial possibilities.

Unit 4 Nanocomposite from Biomaterials [07 Hour]

Natural nanocomposite systems - spider silk, bones, shells; organic-inorganic nanocomposite formation through self-assembly. Biomimetic synthesis of nanocomposites material; Use of synthetic nanocomposites for bone, teeth replacement.

Unit 5 Nanocomposite Technology [07 Hours]

Nanocomposite membrane structures- Preparation and applications. Nanotechnology in Textiles and Cosmetics-Nano-fillers embedded polypropylene fibers – Soil repellence, Lotus effect - Nano finishing in textiles (UV resistant, anti-bacterial, hydrophilic, self-cleaning, flame retardant finishes), Sun-screen dispersions for UV protection using titanium oxide — Colour cosmetics. Nanotechnology in Food Technology - Nanopackaging for enhanced shelf life - Smart/Intelligent packaging.

References:

1. Introduction to Nanocomposite Materials. Properties, Processing, Characterization- Thomas E. Twardowski. 2007. DEStech Publications. USA.
2. Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V.Braun 2006.
3. Physical Properties of Carbon Nanotubes- R. Saito 1998.
4. Carbon Nanotubes (Carbon , Vol 33) - M. Endo, S. Iijima, M.S. Dresselhaus 1997.
5. The search for novel, superhard materials- Stan Vepr¡ek (Review Article) JVST A, 1999
6. Nanometer versus micrometer-sized particles-Christian Brosseau, Jamal BeN Youssef, Philippe Talbot, Anne-Marie Konn, (Review Article) J. Appl. Phys, Vol 93, 2003
7. Diblock Copolymer, - Aviram (Review Article), Nature, 2002
8. Bikramjit Basu, Kantesh Balani Advanced Structural Ceramics, A John Wiley & Sons, Inc.,
9. P. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead publication, London, 2006

Reverse Engineering

24AF2604OE106A	Reverse Engineering	OEC	3-0-0	3 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None
Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[07 Hours]**

Introduction to Reverse Engineering & Geometric Form: Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering - Surface and Solid Model Reconstruction – Dimensional Measurement – Prototyping.

Unit 2 **[07 Hours]**

Material Characteristics, Part Durability and Life Limitation: Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength – Hardness –Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure

Unit 3 **[07 Hours]**

Material Identification and Process Verification: Material Specification - Composition Determination - Microstructure Analysis - Manufacturing Process Verification.

Unit 4 **[07 Hours]**

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

Unit 5 **[07 Hours]**

Acceptance, Legality and Industrial Applications of RE: Legality of Reverse Engineering – Patent – Copyrights –Trade Secret – Third-Party Material. Reverse Engineering in the Automotive Industry; Aerospace Industry; Medical DeviceIndustry.

References

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

Understanding Incubation and Entrepreneurship

24AF2604OE106C	Understanding Incubation and Entrepreneurship	OEC	3-0-0	3 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[07 Hours]**

Introduction to Entrepreneurship, Hand holding for Entrepreneurship GDC start-up stories, What is Entrepreneurship GDC Program

Unit 2 **[07 Hours]**

Entrepreneurship Types, Team Building, Methodology for innovation, Innovation and Entrepreneurship, Solar Oven case-study Paradigm shift from Design to Entrepreneurship, team building, problem statement presentation, IDEAS program, From users to customers- solar oven case study, student projects- customers discovery

Unit 3 **[07 Hours]**

Health care and innovation, Bio-Med Innovation and Entrepreneurship, Mad Tech success story, The innovation process, Human centered innovation, creating human experience design, New-age Entrepreneurship, Humanizing technology, Business model canvas, Technology led Entrepreneurship, Introduction to SINE incubator, Lean model Canvas SINE, start up success story

Unit 4 **[07 Hours]**

Entrepreneurship as Academic Program - IITH case study, ITIC Incubator, Success stories of CHfE, Entrepreneurship – Plan to action, Creativity and Generating Product Ideas, From Idea to Proof of Concept, Network Entrepreneurship, From corporate to Entrepreneurship, Creative Ideation, Building

proof of concept

Unit 5 **[07 Hours]**

Learning from examples Start-up PITCHES - Using Lean Canvas Model Part 1, Start up project presentation by students

References:

1. Disciplined Entrepreneurship: 24 Steps to a Successful Startup by Bill Aulet
2. The Essence of Medical Device Innovation by B Ravi
3. The Fortune At Bottom of Pyramid: Eradicating Poverty Through Profits by C.K.Prahalad
4. Stay Hungry Stay Foolish by Rashmi Bansal
5. The Entrepreneurial Connection: East Meets West in the Silicon Valley by Gurmeet Naroola
6. Innovation By Design: Lessons from Post Box Design & Development by B. K. Chakravarthy, Janaki Krishnamoorthi

Design and Analysis Laboratory

24AF2619PCL107	Design and Analysis Laboratory	PCC Lab	0-0-2	1 Credit
Continuous Assessment 25 Marks	PR/OR 25 Marks	Total 50 Marks		

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	
CO2	
CO3	
CO4	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												

Course Contents:

1. Experiment on damped vibration
2. Torsional vibration analysis
3. Experiment based on failure analysis of mechanical component.
4. Design of mechatronic system for mechanical application
5. Demonstration of process control such as temp, level, flow, etc control using PIDcontroller
6. (Experiments No 6 to 15 to be performed using commercially available software)
7. 2D element problem linear static analysis
8. 3D element problem linear static analysis
9. Static analysis of any mechanical component
10. Dynamic anlysis of any mechanical component
11. Modal analysis of cantilever beam
12. Thermal analysis of mechanical component
13. Design and modeling of mechanical component using commercial software
14. Stress Analysis of composite shaft
15. Modal analysis of composite shaft
16. Optimization techniques using MATLAB

Note: Minimum 3 experiments to be performed from 1 to 5 and 7 experiments fromremaining.

Universal Human Values and Professional Ethics

24AF2604AU108A	Universal Human Values and Professional Ethics	AU	2-0-0	Audit Course

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	--	Total 40 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Course Contents:

Unit 1: Need, basic guidelines, contents and process for value education [04 Hours]

- Understanding the need
- basic guidelines
- content and process for Value Education
- Self-Exploration-what is it? – its content and process; 'Natural Acceptance' and Experiential Validation- as the mechanism for self- exploration
- Continuous Happiness and Prosperity- A look at basic Human Aspirations
- Right understanding
- Relationship and Physical Facilities- the basic requirements for fulfilment of aspirations of every human being with their correct priority
- Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
- Method to fulfil the above human aspirations: understanding & living in harmony at various levels.

Unit 2: Understanding harmony in human being- harmony in myself YSELF [04 Hours]

- The understanding human being as a co-existence of the sentient 'T' and the material 'Body
- Understanding the needs of Self ('T') and 'Body' – Sukh and Suvidha

- Understanding the Body as an instrument of 'T' (I being the doer, seer, and enjoyer)
- Understanding the characteristics and activities of 'T' and harmony in T
- Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs
- meaning of Prosperity in detail
- Programs to ensure Sanyam & Swasthya.

Unit 3: Understanding harmony in family and society - harmony in human relationship. [04 Hours]

- Understanding harmony in the Family- the basic unit of human interaction.
- Understanding values in human-human relationship; meaning of Nyaya and program for its fulfillment to ensure Ubhay tripti; Trust (Vishwas) and Respect (Samman) as the foundational vales of relationship.
- Understanding the meaning of Vishwas; Difference between intention and competence.
- Understanding the meaning of Samman.
- Difference between respect and differentiation; the other salient values in relationship.
- Understanding the harmony in the society (society being an extension of family): Samadhan, Samridhi, Abhay, Sah-astitva as comprehensive Human Goals.
- Visualizing a universal harmonious order in society.
- Undivided Society (Akhand Samaj).
- Universal Order (Sarvabhaum Vyawastha) – from family to world family.

Unit 4: Understanding harmony in the nature and in existence DERSTAINY [04 Hours]

- Understanding the harmony in the Nature.
- Interconnectedness and mutual fulfilment among the four orders of nature – recyclability and self-regulation in nature.
- Understanding Existence as Co-existence (Sah-astitva) of mutually interacting units in all-pervasive space.
- Holistic perception of harmony at all levels of existence.

Unit 5: Implications of the above holistic understanding harmony on professional ethics [04 Hours]

- Natural acceptance of human values
- The definitiveness of Ethical Human Conduct,
- The basis for Humanistic Education,
- Humanistic Constitution and Humanistic Universal Order,
- Competence in Professional Ethics: a) Ability to utilize the professional competence for augmenting universal human order, b) Ability to identify the scope and characteristics of people-friendly and eco-friendly production systems,
- Technologies and management models,
- Case studies of typical holistic technologies,
- Management models and production systems,

- Strategy for the transition from the present state to Universal Human Order: a) At the level of the individual: as socially and ecologically responsible engineers,
- Technologists and Managers, b) At the level of society: as mutually enriching institutions and organizations.

Textbooks/Reference Books:

1. A Foundation Course in Human Values and Professional Ethics, R. R. Gaur, R. Asthana, G. P. Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019, ISBN 978-93-87034-47-1
2. Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, R. R. Gaur, R. Asthana, G. P. Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019, ISBN 97893-87034- 53-2

Plastic Waste Management

24AF2956AU108B	**Plastic Waste Management**	**AC**	**2-0-0**	**Audit Course**

Continuous Assessment 20 Marks	Mid Sem Exam - 20 Marks	--	Total 40 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[04 Hours]**

Plastic and plastic types, uses of plastics, global statistics, plastic waste sources. Plastic waste sources production, Global sources of plastic waste and national sources of plastic waste

Unit 2 **[04 Hours]**

Plastic waste management rules 2016, Global rules and regulations, plastic bans including china sword policy implication on plastic global waste management, Plastic bans- global examples, plastic bans- china sword policy imparts, impact on global plastic waste management

Unit 3 **[04 Hours]**

Impact of plastic pollution on marine life, plastic pollution impact on marine and wildlife, health and environmental impact of plastic pollution

Unit 4 **[04 Hours]**

Plastic waste management practices- recycling and waste plastic, Mechanical and feedstock recycling, pyrolysis and waste to energy, landfilling, other applications, use of waste plastic in road construction.

Unit 5 **[04 Hours]**

Possible alternate materials to plastics – Greener alternatives, Biodegradable plastics, Greener plastic products, Biobased plastic products, How to quantify something is green, plastic resource recovery and circular economy, plastics and circular economy – case studies.

TEXTS/REFERENCES:

1. Plastic Waste Management by Murali Srinivasan and Natamai Subramaniam
2. The Circular Economy A User's Guide by Walter R Stahel. CRC Press 2019.
3. Waste to Wealth: The Circular Economy Advantage Peter Lacy, Jakob Rutqvist, 2015
4. Sustainable Practices for Landfill Design and Operation,Townsend, T.G., Powell, J., Jain, P., Xu, Q., Tolaymat, T., and Reinhart, D. (2015), Springer, USA
5. Recycling and recovery of plastics, Hanser Publishers, New York, 1996-R. Johanner Brandrup
6. Plastics Waste Management, Disposal Recycling and reuse, Marcel Dekker, Inc.New York,1993-Nabil Mustafa
7. Plastics and the Environment, Wiley Inter Science, New York (2003) – Anthony L.Andrady (Ed)
8. Plastics Recycling, Products and Processes, Hanser Publishers, New York,1992 –R.J. Ehrig.

Semester II

Finite Element Methods in Design

24AF2604PC201	**Finite Element Methods in Design**	**PCC**	**3-1-0**	**4 Credits**

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[09 Hours]**

1-D PROBLEMS: Principles of linear elastic mechanics, principles of virtual displacements and minimum potential energy, Rayleigh Ritz method, exact v/s approximate solution, beam elements.

Unit 2 **[09 Hours]**

2-D PROBLEMS: Plane stress and plane strain conditions, triangular elements, constant strain triangle, linear strain triangle, Boundary conditions, body forces and stress recovery, quadrilateral elements.

Unit 3 **[09 Hours]**

2-D PROBLEMS: Lagrange and Serendipity shape functions, isoparametric formulation, numerical integration, modeling with isoparametric elements, requirements for convergence, patch test,

nonconforming elements, reduced integration.

Unit 4 **[09 Hours]**

3-D PROBLEMS: Axisymmetric solids, governing equations, axisymmetric elements and their applications, mixed formulations, bending of flat plates (Kirchhoff Theory), continuity requirements and boundary conditions.

Unit 5 **[09 Hours]**

3-D PROBLEMS: Discrete Kirchhoff's elements, thick plate elements, plate bending applications, shells as assemblage of flat plates, finite element formulation for dynamic problems, mass properties, introduction to elastic stability for frames and plates.

Texts / References:

1. R. D. Cook, Concepts and Applications of Finite Element Analysis, John Wiley andSons, second edition, 1981.
2. C.S. Krishnamurti, Finite element method, Tata Mc-Graw Hill Publication.
3. K.J. Bathe, Finite Element Method and Procedures, Prentice hall, 1996.
4. Tirupathi, R., and Chandrupatla,Finite Elements in Engineering, PHI Publication, NewDelhi.
5. Bruce Irons and SoharabAhmed,Techniques of Finite Elements, John Wiley and Sons,New York.
6. K.J. Bathe, Finite Element Method, Prentice Hall, 1987.
7. O.P., Gupta, Finite and Boundary Element Methods in Engineering, Oxford and IBH.

Integrated Product Development

24AF2619PC202	Integrated Product Development	PCC	3-1-0	4 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None
Course Outcomes: At the end of the course, the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 Introduction to Product Design [09 Hours]

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

Unit 2 Product Specifications, Concept Generation, Selection and Testing [09 Hours]

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

Unit 3 Product Architecture and Industrial Design [09 Hours]

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

Unit 4 Design For Manfacture, Prototyping and Robust Design [09 Hours]

DFM Definition - Estimation of Manufacturing cost- Reducing the component costs, costs of supporting function and assembly costs – Impact of DFM decision on other factors - Prototype basics - Principles of

prototyping – Prototyping technologies - Planning for prototypes - Robust design –Robust Design Process

Unit 5 Product Development Economics and Managing Projects [09 Hours]

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

REFERENCES:

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

Introduction to Machine Learning

24AF2619PE203A	Introduction to Machine Learning	PEC – III	3-0-0	3 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 Statistical basics for Machine Learning **[07 Hours]**

Introduction, Statistical Decision Theory, Regression, Classification, Bias Variance, Linear Regression, Multivariate Regression, Subset Selection, Shrinkage Methods, Principal Component Regression, Partial Least squares

Unit 2 Neural Network Learning **[07 Hours]**

Linear Classification, Logistic Regression, Linear Discriminant Analysis, Week 4: Perceptron, Support Vector Machines, Neural Networks - Introduction, Early Models, Perceptron Learning, Backpropagation, Initialization, Training & Validation, Parameter Estimation - MLE, MAP, Bayesian Estimation

Unit 3: **[07 Hours]**

Decision Trees, Regression Trees, Stopping Criterion & Pruning loss functions, Categorical Attributes, Multiway Splits, Missing Values, Decision Trees - Instability Evaluation Measures, Bootstrapping & Cross Validation, Class Evaluation Measures, ROC curve, MDL, Ensemble Methods - Bagging, Committee Machines and Stacking, Boosting

Unit 4: **[07 Hours]**

Gradient Boosting, Random Forests, Multi-class Classification, Naive Bayes, Bayesian Networks, Undirected Graphical Models, HMM, Variable Elimination, Belief Propagation, Partitional Clustering, Hierarchical Clustering, Birch Algorithm, CURE Algorithm, Density- based Clustering

Unit 5: **[07 Hours]**

Gaussian Mixture Models, Expectation Maximization, Learning Theory, Introduction to Reinforcement Learning, Optional videos (RL framework, TD learning, Solution Methods, Applications)

TEXTS/REFERENCES:

1. Y. S. Abu-Mostafa, M. Magdon-Ismail, and H.-T. Lin, "Learning from Data", AMLBook Publishers, 2012.
2. P. Flach, "Machine Learning: The art and science of algorithms that make sense of data", Cambridge University Press, 2012.
3. K. P. Murphy, "Machine Learning: A probabilistic perspective", MIT Press, 2012.
4. C. M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2007.
5. D. Barber, "Bayesian Reasoning and Machine Learning", Cambridge University Press, 2012.
6. M. Mohri, A. Rostamizadeh, and A. Talwalkar, "Foundations of Machine Learning", MIT Press, 2012.
7. T. M. Mitchell, "Machine Learning", McGraw Hill, 1997. 8. S. Russel and P. Norvig, "Artificial Intelligence: A Modern Approach", Third Edition, Prentice Hall, 2009.
8. The Elements of Statistical Learning, by Trevor Hastie, Robert Tibshirani, Jerome H. Friedman
9. NPTEL Resource: Introduction to Machine Learning, By Prof. Balaraman Ravindran from IIT Madras

Vehicle Dynamics

24AF2604PE203A	Vehicle Dynamics	PEC-III	3-0-0	3 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[07 Hours]**

INTRODUCTION TO VEHICLE DYNAMICS

Unit 2 **[07 Hours]**

LONGITUDINAL DYNAMICS: Vehicle Load Distribution – Acceleration and Braking - Brake Force Distribution, Braking Efficiency and Braking Distance - Longitudinal dynamics of a Tractor-Semi Trailer

Unit3 **[07 Hours]**

TIRE MECHANICS – AN INTRODUCTION**:** Mechanical Properties of Rubber - Slip, Grip and Rolling Resistance – Tire Construction and Force Development- Contact Patch and Contact Pressure Distribution

Unit 4 **[07 Hours]**

A SIMPLE TIRE MODEL: Lateral Force Generation - Ply Steer and Conicity - Tire Models – Magic Formula Classification of Tire Models and Combined Slip

Unit 5 **[07 Hours]**

LATERAL DYNAMICS: Bicycle Model - Stability and Steering Conditions - Understeer Gradient and State Space Approach – Handling Response of a Vehicle - Mimuro Plot for Lateral Transient

Response - Parameters affecting vehicle handling characteristics

Unit 6 **[07 Hours]**

VERTICAL DYNAMICS**:** Rollover Prevention - Half Car Model - Quarter Car Model

Texts/References:

1. Pacejka, Hans. Tire and vehicle dynamics. Elsevier, 2005.
2. Wong, Jo Yung. Theory of ground vehicles. John Wiley & Sons, 2001.
3. Moore, Desmond F. "The friction of pneumatic tyres." (1975).
4. Jazar, Reza N. Vehicle dynamics: theory and application. Springer, 2008
5. Gillespie, Thomas D. Fundamentals of vehicle dynamics, 1992

Engineering Fracture Mechanics

24AF2604PE203B	Engineering Fracture Mechanics	PEC-III	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam - 60 Marks	Total- 100 Marks

Pre-Requisites: Basic Additive Manufacturing

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[07 Hours]**

INTRODUCTION: - Macroscopic failure mode, ideal fracture strength, energy release rate, Fracture Modes

Unit 2 **[07 Hours]**

FRACTURE CRITERIA: Griffith criterion, Irwin's Fracture Criterion, Stress Intensity Approach, Stress intensity factor, crack tip plasticity, crack opening displacement, plastic constraint

Unit 3 **[07 Hours]**

METHODS FOR EVALUATING FRACTURE TOUGHNESS:

Numerical Methods: - Finite Elements (FE), Finite Differences (FD), Boundary Integral Equations (BIE)

Experimental Methods: - Compliance Method, Photoelasticity. Interferometry and Holography

Unit 4 **[07 Hours]**

EXPERIMENTAL EVALUATION OF FRACTURE TOUGHNESS**:** Plane strain fracture toughness, J– Integral

Unit 5 **[07 Hours]**

FATIGUE MECHANICS**:** S-N diagram, fatigue limit, fatigue crack growth rate, Paris law.

Unit 6 **[07 Hours]**

CREEP MECHANICS**:** Creep deformation, creep strength, creep-fatigue interaction

Texts/References:

1. Fundamentals of Fracture Mechanics, T. Kundu, Pub. CRC Press (Taylor and Francis), 2008, ISBN 0-8493-8432-5
2. T. Anderson, Fracture Mechanics, CRC Pub.
3. D. Broek, Elementary Engineering Fracture Mechanics, 4th Revised Edition, Kluwer Academic Pub., 1991, ISBN 90-247-2656-5.
4. K. Hellan, Introduction to Fracture Mechanics, McGraw-Hill, 1984.
5. G. Sih, Handbook of Stress Intensity Factors.
6. 6 Timoshenko, S.P. and J.N. Goodier, "Theory of Elasticity", McGraw Hill (1970).
7. 7.Broek, D., "Elementary Engineering Fracture Mechanics", 4th edition, MartinusNijhoff(1987).
8. Rolfe, S.T. and J.M. Barsom, "Fracture and Fatigue Control in Structures, Applications of Fracture Mechanics", Prentice Hall (1977).
9. Hellan, K., "Introduction to Fracture Mechanics" McGraw-Hill (1985).
10. Maiti S. K., Fracture Mechanics: Fundamentals and Applications, Cambridge University Press, 2015.

Handbooks:

1. Tada, H., Paris, P. and Irwin, G., "The stress Analysis of Cracks Handbook" 3rdedition, ASME Pren (2000).
2. Rooke, D.P. and Cartwright, D.J., "Compedium of Stress Intensity Factors", Her Majestys Stationery Office, London (1976).
3. Murakami, Y. Editor in Chief, "Stress Intensity Factors Handbook", Pergamon Press (1988) (3 Volumes).

Noise, Vibration and Harshness

24AF2604PE203C	**Noise, Vibration and Harshness**	**PEC-III**	**3-0-0**	**3 Credits**

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[07 Hours]**

NVH IN THE AUTOMOTIVE INDUSTRY: Sources of noise and vibration. Design features. Common problems. Marque values. Noise quality. Pass-by noise requirements. Target vehicles and objective targets. Development stages in a new vehicle programme and the altering role of NVH engineers.

Unit 2 **[07 Hours]**

SOUND AND VIBRATION THEORY: Sound measurement. Human sensitivity and weighting factors. Combining sound sources. Acoustical resonances. Properties of acoustic materials. Transient and steady state response of one degree of freedom system applied to vehicle systems. Transmissibility. Modes of vibration.

Unit 3 **[07 Hours]**

TEST FACILITIES AND INSTRUMENTATION: Laboratory simulation: rolling roads (dynamometers), road simulators, semi-anechoic rooms, wind tunnels, etc. Transducers, signal conditioning and recording systems. Binaural head recordings., Sound Intensity technique, Acoustic Holography, Statistical Energy Analysis

Unit 4 **[07 Hours]**

SIGNAL PROCESSING: Sampling, aliasing and resolution. Statistical analysis. Frequency analysis. Campbell's plots, cascade diagrams, coherence and correlation functions.

Unit 5 **[07 Hours]**

NVH CONTROL STRATEGIES & COMFORT: Source ranking. Noise path analysis. Modal analysis. Design of Experiments, Optimisation of dynamic characteristics. Vibration absorbers and Helmholtz resonators. Active control techniques.

Unit 6 **[07 Hours]**

NVH LEGISLATIONS: Psycho-acoustics and effect of noise on human beings, Ambient airquality standards, Noise specifications for automotive vehicles – pass-by & stationary and Noise specifications for generator sets, fire crackers and household articles.

Texts/References:

1. Baxa, Noise Control of Internal Combustion Engine, John Wiley, 1984.
2. Ewins D. J., Model Testing: Theory and Practice, John Wiley,1995.
3. Boris and Kornev, Dynamic Vibration Absorbers, John Wiley, 1993.
4. McConnell K, "Vibration Testing Theory and Practice", John Wiley, 1995.
5. Legislation standard
6. Norton M P, Fundamental of Noise and Vibration, Cambridge University Press,1989
7. Munjal M.L., Acoustic Ducts and Mufflers, John Wiley, 1987

Design for Piping System

24AF2604PE203D	Design for Piping System	PEC-III	3-0-0	3 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: Basic Electronics
Course Outcomes: At the end of the course, the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Course Contents:

Unit 1 **[07 Hours]**

PROCESS PIPING: Scope of Piping; Code and Standards; Mechanical Design Fundamentals; Mechanical design of piping system; Wall thickness; Piping size selection; Steel and cast iron pipe; Steel and wrought iron pipe; Light wall pipe; Tubing; Pipe connection and fittings; Rail fittings; Piping elements and specialties; Pipe representation; Welded and flanged fittings; Valves.

Unit 2 **[07 Hours]**

PIPING SYSTEM LAYOUT AND DESIGN: Piping layout; Equipment Layout; Process Piping Layout; Utility Piping Layout; Pipe flow sheets; Tube fastening and attachment; Non- ferrous tube fittings; Ducts and elbows; Pipe and tube design data; Design of steam piping; Design of oil piping; Design of cast iron pipe; Miscellaneous design and applications: Pipeline; Flexibility expansive forces in pipelines; Expansion stresses and reaction pipelines.

Unit 3 **[07 Hours]**

PIPE INSTALLATION: Selection of materials; Piping design; Basic principle; Piping sketches; Steam reducing and regulating valves; Selection of pipe size; Pipe hydraulics and sizing; Flow of

water in pipes; Economical pipe selection; Selection of steam pipe size; Determination of steam pipe size; Development of plot plan; Flexibility analysis.

Unit 4 **[07 Hours]**

PROCESS AUXILIARIES: Piping; Explanation of code; Methods of fabrication; Nominal pipesize; Non-metallic piping and tubing; Pipe sizing by internal diameter; Choosing the final pipe size; Process steam piping; Pressure relief system; Pressure relief devices; Design of pressure relief system; Layout by scale model method.

Unit 5 **[07 Hours]**

MECHANICAL PIPING DESIGN**:** Piping drawings; Piping stress design; Internal or externalfluid pressure stresses; Design of overhead piping; Design of underground piping; Erection of piping and support; Insulation; Drainage piping design; Design of natural gas pipeline.

Unit 6 **[07 Hours]**

DESIGN OF PIPING SYSTEM FOR THE FOLLOWING APPLICATIONS: Refrigeration piping system, Cryogenic piping system, Transmission piping system, Steam power plant piping system, Underground steam-piping system, Underground petroleum piping, Submerged piping for petroleum products, Piping system sprinklers, Non-metallic piping; Selection and joining techniques; Cross Country Pipe Technology.

Texts/ References:

1. J. M. Coulson, R. K. Sinnott and J. F. Richerdson,'Chemical Engineering' vol.6, Maxwell McMillan International Edition.
2. Sabin Crocker, 'Piping Handbook' Fifth Edition, McGraw Hill Publication.
3. Sahu G. K. handbook of Piping Design, New Age International**,** 1998

Supply Chain Management

24AF2604PE203G	Supply Chain Management	PEC – III	3-0-0	3 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit1: Introduction **[07 Hours]**

Introduction, Generic Types of supply chain, Various Definitions and Implications, Major Drivers of Supply chain. Strategic Decisions- in Supply Chain Management Introduction, Business Strategy, Core Competencies in Supply Chain, Strategic SC Decisions, Customer Reletationship Management Strategy, Supplier Relationship Management Strategy Source of Management in Supply Chain Introduction, Elements of Strategic Sourcing, A Collaborative Perspective, Development of Partnership.

Unit 2: Inventory Management in Supply Chain **[07 Hours]**

Introduction, Types of Inventory, Supply/ Demand Uncertainties, Inventory costs, Selective Inventory Control, Vendor Manage Inventory system, Inventory Performance Measure Logistics In Supply Chain Management Introduction, Strategy, Transportation Selection, Trade-off, Models for Transportation and Distribution, Third Party Logistics,, Overview of Indian Infrastructure for Transportation.

Unit 3: Information Technology in Supply Chain [07 Hours]

Introduction, Types of IT Solutions like Electronic Data Inter change (EDI), Intranet/ Extranet, Data Mining/ Data Warehousing and Data Marts, E-Commerce, E- Procurement, Bar Coding Technology. Information System in Supply Chain Introduction, Computer Based Information Systems, Computer Models and Perceptions about ERP, ERP & SCM. Application of Mathematical Modeling in Supply Chain Introduction, Modeling, Consideration in Modeling SCM System, Structuring the Logistic chain, Concept of Modeling.

Unit 4: Reverse Supply Chain [07 Hours]

Introduction, Reverse Supply Chain v/s Forward Supply Chain, Types of Reverse Flows, Issues in Management of Reverse Supply Chain, Reverse Supply Chain for Food items, Reverse Logistic and Environment Impact. Integration & Collaborative Supply Chain Introduction, Evolution of collaborative SCM, Efficient Customer response, Collaboration at various levels, Imperatives for Successful Integrative Supply Chains.

Unit 5: Agile Supply Chain [07 Hours]

Introduction, Source of Variability, Characteristics of Agile Supply Chain, Achieving Agility in Supply Chain. Cases of Supply Chain Cases of Supply Chain like, News Paper Supply Chain, Book Publishing, Mumbai Dabbawala, Disaster management, Organic Food, Fast Food.

TEXTS / REFERENCES:

1. Supply Chain Management Theories & Practices, R. P. Mohanty, S. G. Deshmukh, Dreamtech Press, 19-A, Anari Road, Daryaganj, New Delhi
2. Supply Chain Management Strategy, Planning & Operation by Sunil Chopra, Peter Meindl
3. Total Supply Chain Management by Ron Basu, J. Nevan Wright
4. Supply Chain Management, Chopra, Pearson
5. Logistics Engineering and Management, Blanchard, pearson

Mechatronics

24AF2604PE204B	Mechatronics	PEC-IV	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: Machining science

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Course Contents:

Unit 1 **[07 Hours]**

Introduction to Mechatronic systems, elements, advantages and practical examples of Mechatronic systems.

Sensors and Transducers:

Various types of sensors and transducers used in Mechatronic system such as pressure sensors, temperature sensors, velocity sensors, Acceleration sensors, proximity sensors, position sensors, force sensors, Optical encoders, Capacitive level sensor, tactile sensors, Selection of sensors.

Unit 2 **[07 Hours]**

Signal Conditioning and Data Representation: Types of electronic signals, need for signal processing, Operational amplifiers: Types, classification and applications, Opto-isolators, Protection devices, Analogue to Digital and Digital to Analog Converters, Interfacing devices, Electro-magnetic Relays, Data representation systems, Displays, seven segment displays, LCD

displays, Printers, Data loggers, Data Acquisition Cards/Systems

Unit 3 **[07 Hours]**

Electrical Drives: Types of Electrical Motors, AC and DC motors, DC servomotors, Stepper motors, linear motors, etc.

Pneumatics and Hydraulics

Components of Pneumatic systems, actuators, direction control valves, pneumatic air preparation, FRL unit, methods of actuation of valves, Sequencing of Pneumatic cylinders using Cascade and shift register methods. Electro-pneumatic valves, Electro- pneumatic circuits using single and double solenoid methods. Hydraulic cylinders, design of cylinder, Design of Piston and piston rod, Valves, poppet valve, house pipes and design of tubing, Meter-in and Meter-out circuits.

Unit 4 **[07 Hours]**

Microprocessor and Microcontroller

8085 microprocessor, architecture, various types of registers and their functions in 8085µP, Instruction sets, interfacing, applications.8081 microcontroller, architecture, Instruction sets, various pins and their functions interfacing, applications.

Programmable Logic Controller

Introduction, Architecture, Types of inputs/outputs, Specifications, guidelines for Selection ofPLCs, Programming: Ladder logic and FBD

Unit 5 **[07 Hours]**

Control Systems

Open and closed loop system; block diagram manipulation/reduction, Transfer function, modeling of Mechanical Systems using spring, Dashpot and Masse quivalence.

Unit 6 **[07 Hours]**

Stabilty of Systems

On/Off controller, Proportional Control, Integral control, Derivative Control; PI, PD and PID Controllers, Introduction to control using state variable system models, Bode Plots and stability criteria.

Texts / References:

1. HMT Limited, Mechatronics, Tata McGraw-Hill, 1998.
2. Bolton, W., Mechatronics; Electronic Control Systemin Mechanical Engineering, PearsonEducationAsia,1999.
3. Raven, Automatic Control Engineering, McGraw Hill, NewYork,1986

Designing with Advanced Materials

24AF2604PE204E	**Designing with Advanced Materials**	**PEC IV**	**3-0-0**	**3 Credits**

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: Engineering mathematics, Manufacturing Processes

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1: Introduction To Reverse Engineering & Geometric form [07 Hours]
Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering - Surface and Solid Model Reconstruction – Dimensional Measurement – Prototyping.

Unit 2: Material Characteristics, Part Durability and Life Limitation [07 Hours]
Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength – Hardness –Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure

Unit 3: Material Identification and Process Verification [07 Hours]
Material Specification - Composition Determination - Microstructure Analysis - Manufacturing Process Verification.

Unit 4: Data Processing, Part Performance and System Compatibility [07 Hours]
Statistical Analysis – Data Analysis – Reliability and the Theory of Interference – Weibull Analysis — Data Conformity and Acceptance — Data Report — Performance Criteria — Methodology of Performance Evaluation – System Compatibility.

Unit 5: Acceptance, Legality and Industrial Applications Of RE [07 Hours]

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

References:

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

Optimization in Design

24AF2604PE204G	Optimization in Design	PEC IV	3-0-0	3 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[07 Hours]**

INTRODUCTION: Optimal problem formulation, engineering optimization problems, optimization algorithms. Single Variable Optimization Algorithms: Optimality criteria, bracketing methods, region elimination methods, point estimation methods, gradient based methods, root finding using optimization techniques.

Unit 2 **[07 Hours]**

MULTIVARIABLE OPTIMIZATION ALGORITHMS: Optimality criteria, unidirectional search, direct search methods, gradient based methods, Computer programs on above methods.

Unit 3 **[07 Hours]**

CONSTRAINED OPTIMIZATION ALGORITHMS: Kuhn-Tucker conditions, transformation methods, sensitivity analysis, direct search for constrained minimization, linearized search techniques, feasible direction method, generalized reduced gradient method, gradient projection method, Computer programs on above methods.

Unit 4 **[07 Hours]**

SPECIAL OPTIMIZATION ALGORITHMS: Integer programming, Geometric programming, Genetic Algorithms, Simulated annealing, global optimization, Computer programs on above methods.

Unit 5 **[07 Hours]**

OPTIMIZATION IN OPERATIONS RESEARCH: Linear programming problem, simplex method, artificial variable techniques, dual phase method, sensitivity analysis

Unit 6 **[07 Hours]**

STOCHASTIC PROGRAMMING: Basic concepts of probability theory, random variables Distributions – mean, variance, Correlation, co variance, joint probability distribution stochastic linear, dynamic programming.

Texts/References:

1. Deb Kalyanmoy, "Optimization in Engineering Design", PHI, New Delhi
2. Rao S. S. "Engineering Optimization", John Wiley, New Delhi.
3. Deb Kalyanmoy, "Multi-objective Algorithms using Evolutionary Algorithms", John Wiley, New Delhi.
4. Paplambros P. Y. and Wilde D. J., "Principles of Optimum Design: Modeling and Computation", Cambridge University Press, UK
5. Chandrupatla, "Optimization in Design", PHI, New Delhi.

Product Life cycle Management

24AF2956PE204B	**Product Life cycle Management**	**PEC IV**	**3-0-0**	**3 Credits**

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents

Unit 1: History, Concepts and Terminology of PLM **[07 Hours]**

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

Unit 2: PLM/PDM Functions and Features **[07 Hours]**

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

Unit 3: PLM Software and Tools **[07 Hours]**

Technology Forecasting and PLM Software and Tools : Future mapping, invocating rates of technological change, methods of technology forecasting such as relevance trees, morphological methods and mission flow diagram, combining forecast of different technologies, uses in manufacture alternative. Product data security. Product structure, workflow, Terminologies in workflow, The Link between Product Data and Product Workflow, PLM applications, PDM applications.

Unit 4: Role of PLM In industries **[07 Hours]**

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

Unit 5: BASICS ON CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE **[07 Hours]**

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

References:

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

Advanced CAD

24AF2956PE204B	**Advanced CAD**	**PEC IV**	**3-0-0**	**3 Credits**

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand conceptual design process and geometric transformation techniques in CAD.
CO2	Develop mathematical models to represent curves.
CO3	Design surface and solid models for engineering applications.
CO4	Apply CAD techniques for engineering analysis and geometry processing

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		2		2							
CO2	2		2	2	2							
CO3	3		3	3	2							
CO4	3		2	2	2							

Course Contents

Unit 1

Introduction: Introduction to CAE, CAD. Role of CAD in Mechanical Engineering, Design process, software tools for CAD, Geometric modelling

Unit 2

Transformations in Geometric Modelling: Introduction, Translation, Scaling, Reflection, 85 Rotation in 2D and 3D. Homogeneous representation of transformation, Concatenation of transformations. Implementation of the transformations using computer codes

Unit 3

Design of Curves: Analytic Curves, PC curve, Ferguson, Composite Ferguson, curve Trimming and Blending, Bezier segments, de Casteljau's algorithm, Bernstein polynomials, Bezier subdivision, Degree elevation, Composite Bezier, Splines, Polynomial Splines, B-spline basis functions, Properties of basic functions, Knot Vector generation, NURBS, Developing algorithms/computer codes for Design of Curves

Unit 4

Design of Surfaces: Differential geometry, Parametric representation, Curves on surface, Classification of points, Curvatures, Developable surfaces, Surfaces of revolution, Intersection of

surfaces, Surface modelling, 16-point form, Coons patch, B-spline surfaces, Developing algorithms/computer codes for Design of Surfaces.

Unit 5

Design of Solids: Solid entities, Boolean operations, B-rep of Solid Modelling, CSG approach of solid modelling, advanced modelling methods, Applications of CAD Applications: Data exchange formats, Finite element analysis, mesh generation for finite element analysis, reverse engineering, modelling with point cloud data, working with .STL files, Additive Manufacturing.

TEXTS/REFERENCES:

1. Mathematical Elements for Computer Graphics, David F. Rogers, J. A. Adams, TMH, 2008.
2. Geometric Modeling", Michael E. Mortenson, Wiley, NY, 1997.
3. Product Design", Kevin N. Otto, Kristin L. Wood, Pearson Education, 2004.
4. CAD/CAM Theory and Practice, Ibrahim Zeid and Sivasubramanian, R., TataMcGraw Hill Publications, New Delhi, 2009.
5. Computer Aided Engineering Design", Anupam Saxena, BirendraSahay, Springer, 2005.

Biomaterials

24AF2619PE204A	Biomaterials	PEC-IV	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[07 Hours]**

Introduction to Bio-Materials: Definition and classification of bio-materials, mechanical properties, surface and physical properties, visco elasticity, biomaterial performance, body response to implants, wound healing, blood compatibility, Nano scale phenomena. Effects of physiological fluid on the properties of biomaterials.

Unit 2 **[07 Hours]**

Metallic implant materials: Stainless steel, Co-based alloys, Ti and Ti-based alloys. Importance of stress-corrosion cracking. Host tissue reaction with bio metal, corrosion behavior and the importance of passive films for tissue adhesion. Hard tissue replacement implant: Orthopedic implants, Dental implants. Soft tissue replacement implants: Percutaneous and skin implants, Vascular implants, Heart valve implants-Tailor made composite in medium.

Unit 3 **[07 Hours]**

Ceramic implant materials: Definition of bio ceramics. Common types of bioceramics: Aluminum

oxides, Glass ceramics, Carbons. Bio resorbable and bioactive ceramics. Importance of wear resistance and low fracture toughness. Host tissue reactions: importance of interfacial tissue reaction (e.g. ceramic/bone tissue reaction).

Composite implant materials: Mechanics of improvement of properties by incorporating different elements. Composite theory of fiber reinforcement (short and long fibers, fibers pull out). Polymers filled with osteogenic fillers (e.g. hydroxyapatite). Host tissue reactions.

Unit 4 **[07 Hours]**

Polymeric Implant Materials: Polymerization, factors influencing the properties of polymers, polymers as biomaterials, biodegradable polymers, Bio polymers: Collagen, Elastin and chitin. Medical Textiles, Materials for ophthalmology: contact lens, intraocular lens. Membranes for plasma separation and Blood oxygenation, electro spinning: a new approach, Physiochemical characteristics of biopolymers. Biodegradable polymers for medical purposes, Biopolymers in controlled release systems. Synthetic polymeric membranes and their biological applications.

Unit 5 **[07 Hours]**

Testing of Biomaterials: Biocompatibility, blood compatibility and tissue compatibility tests, Toxicity tests, sensitization, carcinogenicity, mutagenicity and special tests, Invitro and Invivo testing; Sterilisation of implants and devices: ETO, gamma radiation, autoclaving. Effects of sterilization, Tissue Replacement Implants: Small intestinal sub mucosa and other decullarized matrix biomaterials for tissue repair: Extra cellular Matrix. Soft tissue replacements, sutures, surgical tapes, adhesive, Percutaneous and skin implants, maxillofacial augmentation, Vascular grafts, hard tissue replacement Implants, joint replacements, tissue scaffolding and engineering using Nano biomaterials.

TEXTS/REFERENCES:

1. Sujata V. Bhatt, Biomaterials, Second Edition, Narosa Publishing House, 2005.
2. Sreeram Ramakrishna, Murugan Ramalingam, T. S. Sampath Kumar, and Winston O. Soboyejo, Biomaterials: A Nano Approach, CRC Press, 2010.
3. Park J.B., “Biomaterials Science and Engineering”, Plenum Press, 2015.
4. D F Williams, “Materials Science and Technology: Volume 14, Medical and Dental Materials: A comprehensive Treatment Volume”, VCH Publishers 1992.
5. Monika Saini, Yashpal Singh, PoojaArora, VipinArora, and KratiJain. “Implant biomaterials: A comprehensive review”, World Journal of Clinical Cases, 2015.
6. John Enderle, Joseph D. Bronzino, Susan M.Blanchard, “Introduction to Biomedical Engineering”, Elsevier, 2018.

Design for Manufacture & Assembly

24AF2619PE204B	**Design for Manufacture & Assembly**	**PEC-IV**	**3-0-0**	**3 Credits**

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[07 Hours]**

DESIGN FOR MANUFACTURING: reduce the cost of manufacturing process, understanding the process and constraints, standard components and process, consider the impact of DFM decisions and other factors.

Unit 2 **[07 Hours]**

DESIGN CONSIDERATION IN METAL CASTING: Mold and Gating System Design, Directional Solidification, and Troubleshooting.

Unit 3 **[07 Hours]**

DESIGN FOR WELDING: selection of materials for joining, welding defects, minimize theresidual stresses etc. Design for forging and sheet metal and powder metal process.

Unit 4 **[07 Hours]**

SELECTION OF MATERIALS: choice of materials, organizing material and processes.

Unit 5 **[07 Hours]**

Application of Design for manufacture and assembly with selection of materials and ranking of processes like casting, injection moulding, sheet metal working, die casting, powder metal process, investment casting and hot forging,

Unit6[07 Hours]

Design for assembly and automation

Texts/References:

1. Geoffrey Boothroyd, Peter Dewhurst and Winston Knight, Product Design for Manufacturing and Assembly, 2nd Edition
2. Harry Peck, "Design for Manufacture", Pittman Publication 1983.
3. 3.Robert Matousek, "Engineering Design – A systematic approach", Blackie & sonsLtd., 1963.
4. 4.James G. Bralla, "Hand Book of Product Design for Manufacturing", McGraw HillCo., 1986
5. 5.Swift K. G. "Knowledge based design for manufacture", Kogan Page Ltd., 1987.

Rotor Dynamics

24AF2619PE204C	**Rotor Dynamics**	**PEC IV**	**3-0-0**	**3 Credits**

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: Engineering mathematics, Manufacturing Processes

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[07 Hours]**

Introduction to Vibration and the Laval-Jeffcott Rotor Model: Co-ordinate systems, Steady state rotor motion, Elliptical motion, Single degree of freedom systems, Free and forced vibrations.

Unit 2 **[07 Hours]**

The two degrees of freedom rotor system, Geared systems, Translational motion, Natural frequencies and Natural modes, Steady state response to unbalance, The effect of flexible support.

Unit 3 **[07 Hours]**

Torsional Vibrations of Rotating Machinery: Modeling of rotating machinery shafting, Multi degree of freedom systems, Determination of natural frequencies and mode shapes, Branched systems, Numerical methods for fundamental frequency.

Unit 4 **[07 Hours]**

Rigid Rotor Dynamics and Critical Speed: Rigid disk equation - Rigid rotor dynamics, Rigid rotor and flexible rotor, the gyroscopic effect on rotor dynamics, whirling of an unbalanced simple elastic rotor, Unbalance response, Orbital Analysis and Cascade Plots, Simple shafts with several disks, Effect of axial stiffness, Determination of bending critical speeds, Campbell diagram.

Unit 5 **[07 Hours]**

Influence of Bearings on Rotor Vibrations: Support stiffness on critical speeds- Stiffness and damping coefficients of journal bearings, Computation and measurements of journal bearing coefficients, Mechanics of Hydro Dynamic Instability, Half frequency whirl and Resonance whip, Design configurations of stable journal bearings.

Unit 6 **[07 Hours]**

Balancing of Rotors: Single plane balancing, Multi-plane balancing, balancing of rigid rotors, Balancing of flexible rotors, Influence coefficient and modal balancing techniques for flexiblerotors.

Texts/References:

1. J. S. Rao, "Rotor Dynamics", New Age International Publishers, New Delhi.
2. S. Timoshenko, D H. Young and W. Weaver, "Vibration Problems in Engineering", John Wiley.
3. W J Chen and J E Gunter, "Introduction to Dynamics of Rotor – Bearing Systems",Trafford Publishing Ltd.
4. T. Yamamoto and Y. Ishida, "Linear and Nonlinear Rotor Dynamics: A ModernTreatment with Applications", John Wiley.
5. V J. S. Rao, "Vibratory Condition Monitoring of Machines", Narosa PublishingHouse.

Computer Applications in Design

24AF2619OE205A	Computer Applications in Design	OEC-I	3-0-0	3 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: Mechanics of Materials, Machine Design
Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

UNIT 1 INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS [07 Hours]

Overview of Graphics systems: Video Display Devices, Raster-Scan System, Random-Scan Systems, Graphics Monitors and Workstations, Input Devices, Hard-Copy Devices, Graphics Software.

Output primitives: Line Drawing Algorithm - DDA, Bresenham's and Parallel Line Algorithm. Circle generating algorithm – Midpoint Circle Algorithm.

Geometric Transformations: Coordinate Transformations, Windowing and Clipping, 2D Geometric transformations-Translation, Scaling, Shearing, Rotation and Reflection, Composite transformation, 3D transformations.

UNIT 2 CURVES AND SURFACES MODELLING [07 Hours]

Introduction to curves - Analytical curves: line, circle and conics – synthetic curves: Hermite cubic spline- Bezier curve and B-Spline curve – curve manipulations.

Introduction to surfaces - Analytical surfaces: Plane surface, ruled surface, surface of revolution and tabulated cylinder – synthetic surfaces: Hermitebicubic surface- Bezier surface and B-Spline surface-surface manipulations.

UNIT 3 NURBS AND SOLID MODELING [07 Hours]

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

UNIT 4 VISUAL REALISM [07 Hours]

Hidden Line removal, Hidden Surface removal, – Hidden Solid Removal algorithms - Shading – Coloring. Animation - Conventional, Computer animation, Engineering animation - types and techniques.

UNIT 5 ASSEMBLY OF PARTS AND PRODUCT LIFE CYCLE MANAGEMENT [07 Hours]

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

References:

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

Mechanical Measurements and Analysis

24AF2619OE205B	Mechanical Measurements and Analysis	OEC-I	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 Forces And Strain Measurement **[07 Hours]**

Strain gauge, principle, types, performance and uses. Photo elasticity–Principle and applications

- Moire Fringe-Hydraulic jacks and pressure gauges–Electronic load cells–Proving Rings–Calibration of Testing Machines**.**

Unit 2 Vibration Measurements **[07 Hours]**

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

Unit 3 Acoustics And Wind Flow Measurements **[07 Hours]**

Principles of Pressure and flow measurements–pressure transducers–sound level meter–

venturimeter and flow meters–wind tunnel and its use in structural analysis–structural modeling – direct and indirect model analysis

Unit 4 Distress Measurements [07 Hours]

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

Unit 5 Non Destructive Testing Methods [07 Hours]

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

References:

1. Bray DonE and Stanley, R.K., "Non-destructive Evaluation", McGraw Hill Publishing Company, N.Y.1989
2. Garas,F.K.,Clarke,J. Land Armer GST, "Structural assessment", Butterworths,London,1987
3. James W. Dally and William Franklin Riley, "Experimental Stress Analysis", McGraw Hill ,3rdEdition,1991
4. Sadhu Singh, Experimental Stress Analysis, Khanna Publishers, New Delhi,2009.
5. SrinathLS, Raghavan Mr, Lingaiah K, Gargesha G, Pant Band Ramachandra, K,"Experimental Stress Analysis",TataMcGrawHillCompany,NewDelhi,1984
6. Sirohi,R.S.andRadhakrishna,H.C,"MechanicalMeasurements",New Age International (P) Ltd,3rd Edition 1997

Research Methodology

24AF2630OE205C	Research Methodology	OEC-I	3-0-0	3 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None
Course Outcomes: At the end of the course, the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[07 Hours]**

Research Concepts – concepts – meaning – objectives – motivation. Types of research – descriptive research – conceptual research – theoretical research – applied research – experimental research.

Unit 2 **[07 Hours]**

Research process – Criteria for good research – Problems encountered by Indian researchers. Formulation of Research Task – Literature Review – Importance & Methods – Sources – Quantification of Cause Effect Relations – Discussions– Field Study – Critical Analysis of Facts Generated

Unit 3 **[07 Hours]**

Hypothetical proposals for future development and testing, selection of Research task.

Unit 4 **[07 Hours]**

Mathematical modelling and simulation – Concepts of modelling – Classification of mathematical models – Modelling with – Ordinary differential equations – Difference equations – Partial differential equations – Graphs – Simulation – Process of formulation of model based on simulation.

Unit 5 **[07 Hours]**

Interpretation and report writing – Techniques of interpretation – Precautions in interpretation – Significance of report writing – Different steps in report writing – Layout of research report – Mechanics of writing research report – Layout and format – Style of writing – Typing – References – Tables – Figures – Conclusion – Appendices.

Texts/References

1. J.W Bames, Statistical Analysis for Engineers and Scientists, McGraw Hill, N.York
2. Schank Fr., Theories of Engineering Experiments, Tata McGraw Hill Publication.
3. C. R. Kothari, Research Methodology, New Age Publishers.
4. Willktnsion K. L, Bhandarkar P. L, Formulation of Hypothesis, Himalaya Publication.

Design of Experiments

24AF2604OE205A	Design of Experiments	OEC-I	3-0-0	3 Credits

Continuous Assessment 20 Marks	Mid Sem Exam 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: Engineering mathematics-I
Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[07 Hours]**

Introduction: Modern quality control, quality in engineering design, history of qualityengineering.

The Taguchi Approach to quality: Definition of quality, loss function, off-line and on-linequality control, Taguchi`s quality philosophy.

Unit 2 **[07 Hours]**

Full Factorial Designs: Experimentation as learning process, traditional scientific experiments, three factor design, replicating experiments, factor interactions, normal plots of estimated effects, mechanical plating experiments, two factor design, four factor design, Taguchi design and western design.

Unit 3 **[07 Hours]**

Fractional Factorial Design: Fractional factorial design based on eight run experiments, folding over an eight run experimental design, Fractional factorial design in sixteen run, folding over an

sixteen run experimental design, blocking two level designs, other two leveldesigns.

Unit 4 **[07 Hours]**

Evaluating Variability: Necessity to analyze variability, measures of variability, the normal distribution, using two level designs to minimize variability, signal-to-noise ratio, minimizing variability and optimizing averages.

Taguchi Inner and Arrays: Noise factors, experimental designs for control and noise factors, examples.

Unit 5 **[07 Hours]**

Experimental Design for Factors at Three and Four level: Necessity to use more than two level, factors at four levels, factors at three levels. Analysis of Variance in Engineering Design: Hypothesis testing concepts, using estimated effects as test statistics, analysis of variance for two level designs, when to use analysis of variance.

Unit 6 **[07 Hours]**

Computer Software for Experimental Design: Role of computer software in experimental design, summery of statistical packages, example of use of software packages. UsingExperiments to improve Processes: Engineering design and quality improvement, steps to implementing use of engineering design.

Texts/References:

1. D.C. Montgomery, Design and Analysis of Experiments, 5th Edition, John Wiley and Sons, NewYork, 2004.
2. R.H. Lochner and J.E. Matar, Designing for Quality: An Introduction to the Best of Taguchi and Western Methods of Statistical Experimental Design, Chapman and Hall, London, 1983.

DESIGN FOR SUSTAINABILITY

24AF2604OE205D	DESIGN FOR SUSTAINABILITY	OEC-I	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents

UNIT I INTRODUCTION [07 Hours]

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

UNIT II CAST & WELDED COMPONENTS DESIGN [07 Hours]

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

UNIT III FORMED & MACHINED COMPONENTS DESIGN [07 Hours]

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

UNIT- IV DESIGN FOR ASSEMBLY [07 Hours]

Design for assembly – General assembly recommendations – Minimizing the no. of parts – Design

considerations for: Rivets – Screw fasteners – Gasket & Seals – Press fits – Snap fits – Automatic assembly– Computer Application for DFMA.

UNIT V DESIGN FOR ENVIRONMENT [07 Hours]

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

References:

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

Engineering Economic Analysis

24AF2956OE205C	Engineering Economic Analysis	OEC-I	3-0-0	3 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites:
Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents

Unit-1: Introduction **[07 Hours]**

Project Life Cycle Stages, What is a Feasibility Study?, Feasibility Study Process, What is Engineering Economic Analysis?, Engineering Economic Analysis Steps, Cost Terminologies.

Unit-2: Time Value of Money **[07 Hours]**

Time Value of Money Concept, Cash Flow Diagrams, Interest and Interest Rate, Types of Interest Rates

Unit-3: Economic Equivalence **[07 Hours]**

Economic Equivalence Concept, Uniform (Equal) Series Cash Flow, Uneven (Irregular) Series Cash Flow, Arithmetic (Linear) Gradient Series Cash Flow, Geometric Gradient Series Cash Flow, Composite Cash Flow

Unit-4: Money Management **[07 Hours]**

Money Management Aspects, Multiple Compounding Periods Concept, Nominal and Effective Interest Rates, Changing Interest Rates, Amortized Loans, Add-On Loans, Inflation, Customized Loans

Unit-5: Measuring Worth Investments **[07 Hours]**

Project Cash Flow, Measuring Worth of Investments Methods, Payback Period Method, Net Present Worth Method, Net Future Worth Method, Net Annual Worth Method, Internal Rate of Return (IRR) Method, IRR Direct Solution Method, IRR Trial and Error Method, External Rate of Return Method.
Types of Projects/Investments, Independent and Mutually Exclusive Projects, Ranking Approach, Time Span Equalizing.

Texts/References:

1. Engineering Economic Analysis, Donald G. Newman, Jerome P. Lavalle and Ted G. Eschenbach, Oxford University Press, 12th Edition.

Indian Knowledge System: Concepts and Applications in Engineering

24AF2956IK206A	Indian Knowledge System-Concepts and Applications in Engineering	IKS	2-0-0	2 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	--	Total 40 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents

Unit-1 **[04 Hours]**

Indian Knowledge System – An Introduction: 1. What is IKS? 2. Why do we need IKS? 3. Organization of IKS 4. Historicity of IKS 5. Some salient aspects of IKS

The Vedic Corpus: 1. Introduction to Vedas 2. A synopsis of the four Vedas 3. Sub- classification of Vedas 4. Messages in Vedas 5. Introduction to Vedāṅgas 6. Prologue on Śikṣā and Vyākaraṇa 7. Basics of Nirukta and Chandas 8. Introduction to Kalpa and Jyotiṣa 9. Vedic Life: A Distinctive Features

Unit-2 **[04 Hours]**

Number Systems and Units of Measurement: 1. Number systems in India - Historical evidence 2. Salient aspects of Indian Mathematics 3. Bhūta-Saṃkhyā system 4. Kaṭapayādi system 5. Measurements for time, distance, and weight 6. Piṅgala and the Binary system

Mathematics: 1. Introduction to Indian Mathematics 2. Unique aspects of Indian

Mathematics 3. Indian Mathematicians and their Contributions 4. Algebra 5. Geometry 6. Trigonometry 7. Binary mathematics and combinatorial problems in Chandaḥ Śāstra 8. Magic squares in India

Astronomy: 1. Introduction to Indian astronomy 2. Indian contributions in astronomy 3. The celestial coordinate system 4. Elements of the Indian calendar 5. Notion of years and months 6. Pañcāṅga – The Indian calendar system 7. Astronomical Instruments (Yantras) 8. Jantar Mantar of Rājā Jai Singh Sawai.

Unit-3 **[04 Hours]**

Engineering and Technology: Metals and Metalworking: 1. Wootz Steel: The rise and fall of a great Indian technology 2. The Indian S & T heritage 3. Mining and ore extraction 4. Metals and metalworking technology 5. Iron and steel in India 6. Lost wax casting of idols and artefacts 7. Apparatuses used for extraction of metallic components

Engineering and Technology: Other applications: 1. Irrigation systems and practices in South India 2. Literary sources for science and technology 3. Physical structures in India 4. Irrigation and water management 5. Dyes and painting technology 6. The art of making perfumes 7. Surgical techniques 8. Shipbuilding 9. Sixty-four art forms (64 Kalās) 10. Status of Indigenous S & T.

Unit-4 **[04 Hours]**

Town Planning and Architecture: 1. Perspective of Arthaśāstra on town planning 2. Vāstu- śāstra – The science of architecture 3. Eight limbs of Vāstu 4. Town planning 5. Temples in India: marvelous stone architecture for eternity 6. Temple architecture in India 7. Iconography**.**

Knowledge Framework and classifications: 1. Indian scheme of knowledge 2. The knowledge triangle 3. Prameya – A vaiśeṣikan approach to physical reality 4. Dravyas – the constituents of the physical reality 5. Attributes – the properties of substances and Action – the driver of conjunction and disjunction 6. Sāmānya, viśēṣa, samavāya 7. Pramāṇa – the means of valid knowledge 8. Saṃśaya – ambiguities in existing knowledge 9. Framework for establishing valid knowledge 10. Deductive or inductive logic framework 11. Potential fallacies in the reasoning process 12. Siddhānta: established tenets in a field of study

Unit-5 **[04 Hours]**

Linguistics 1. Introduction to Linguistics 2. Aṣṭādhyāyī 3. Phonetics 4. Word generation 5. Computational aspects 6. Mnemonics 7. Recursive operations 8. Rule based operations 9. Sentence formation 10. Verbs and prefixes 11. Role of Sanskrit in natural language processing.

TEXTBOOKS /REFERENCES:

1. Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavana R.N. (2022), "Introduction to Indian Knowledge System: Concepts and Applications", PHI Learning Private Ltd. Delhi.

For additional reading:

1. Pride of India: A Glimpse into India's Scientific Heritage, Samskrita Bharati, New Delhi.
2. Sampad and Vijay (2011). "The Wonder that is Sanskrit", Sri Aurobindo Society, Puducherry.
3. Bag, A.K. (1979). Mathematics in Ancient and Medieval India, Chaukhamba Orientalia, New Delhi.
4. Datta, B. and Singh, A.N. (1962). History of Hindu Mathematics: Parts I and II, Asia Publishing House, Mumbai.
5. Kak, S.C. (1987). "On Astronomy in Ancient India", Indian Journal of History of Science, 22(3), pp. 205–221.
6. Subbarayappa, B.V. and Sarma, K.V. (1985). Indian Astronomy: A Source Book, Nehru Centre, Mumbai.

7. Bag, A.K. (1997). History of Technology in India, Vol. I, Indian National Science Academy, New Delhi.
8. Acarya, P.K. (1996). Indian Architecture, Munshiram Manoharlal Publishers, New Delhi.
9. Banerjea, P. (1916). Public Administration in Ancient India, Macmillan, London.
10. Kapoor Kapil, Singh Avadhesh (2021). "Indian Knowledge Systems Vol – I & II", Indian Institute of Advanced Study, Shimla, H.P.

Indian Knowledge System: Humanities and Social Sciences

24AF2956IK206B	**Indian Knowledge System-Humanities and Social Sciences**	**IKS**	**2-0-0**	**2 Credits**

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	--	Total 40 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit-1 **[04 Hours]**

Indian Knowledge System – An Introduction: 1. What is IKS? 2. Why do we need IKS? 3. Organization of IKS 4. Historicity of IKS 5. Some salient aspects of IKS

The Vedic Corpus: 1. Introduction to Vedas 2. A synopsis of the four Vedas 3. Sub- classification of Vedas 4. Messages in Vedas 5. Introduction to Vedāṅgas 6. Prologue on Śikṣā and Vyākaraṇa 7. Basics of Nirukta and Chandas 8. Introduction to Kalpa and Jyotiṣa 9. Vedic Life: A Distinctive Features

Unit-2 **[04 Hours]**

Philosophical Systems: 1. An introduction to philosophical systems 2. Development of philosophy 3. Unique features of philosophy 4. Sāṅkhya approach of philosophy 5. Introduction to Yoga 6. Tenet of Nyāya philosophy 7. Principles of Vaiśeṣika 8.

Doctrine of Pūrva-Mīmāṃsā Darśana 9. Thesis of Vedānta and synopsis of Advaita 10. Philosophy of Viśiṣṭādvaita 11. Ideology of Dvaita 12. Tenets of Jaina 13. Doctrine of Buddhism 14. Notions of Cārvāka

Wisdom through the Ages: 1. Gateways of ancestral wisdoms 2. Introduction to Purāṇa 3. The Purāṇic repository 4. Issues of interest in Purāṇas 5. Introduction to Itihāsas 6. Key messages in Itihāsas 7. Wisdom through Nīti-śāstras 8. Wisdom through Subhāṣita

Unit-3 **[04 Hours]**

Knowledge Framework and classifications: 1. Indian scheme of knowledge 2. The knowledge triangle 3. Prameya – A vaiśeṣikan approach to physical reality 4. Dravyas – the constituents of the physical reality 5. Attributes – the properties of substances and Action – the driver of conjunction and disjunction 6. Sāmānya, viśēṣa, samavāya 7. Pramāṇa – the means of valid knowledge 8. Saṃśaya – ambiguities in existing knowledge 9. Framework for establishing valid knowledge 10. Deductive or inductive logic framework 11. Potential fallacies in the reasoning process 12. Siddhānta: established tenets in a field of study

Linguistics: 1. Introduction to Linguistics 2. Aṣṭādhyāyī 3. Phonetics 4. Word generation 5. Computational aspects 6. Mnemonics 7. Recursive operations 8. Rule based operations 9. Sentence formation 10. Verbs and prefixes 11. Role of Sanskrit in natural language processing

Unit-4 **[04 Hours]**

Number Systems and Units of Measurement: 1. Number systems in India – Historical evidence 2. Salient aspects of Indian Mathematics 3. Bhūta-Saṃkhyā system 4. Kaṭapayādi system 5. Measurements for time, distance, and weight 6. Piṅgala and the Binary system

Health Wellness and Psychology: 1. Introduction to health 2. Āyurveda: approach to health 3. Sapta-dhātavaḥ: seven-tissues 4. Role of agni in health 5. Tri-doṣas 6. Āyurveda: definition of health 7. Psychological aspects of health 8. Disease management elements 9. Dinacaryā: daily regimen for health & wellness 10. Importance of sleep 11. Food intake methods and drugs 12. Approach to lead a healthy life 13. Indian approach to psychology 14. The tri guṇa system & holistic picture of the individual 15. The Nature of Consciousness 16. Consciousness studies and issues

Unit-5 **[04 Hours]**

Town Planning and Architecture: 1. Perspective of Arthaśāstra on town planning 2. Vāstu-śāstra – The science of architecture 3. Eight limbs of Vāstu 4. Town planning 5. Temples in India: marvelous stone architecture for eternity 6. Temple architecture in India 7. Iconography

Governance and Public Administration: 1. Introduction to raja dharma 2. Arthaśāstra: a historical perspective 3. Elements of a kauṭilyan state 4. The king & the amātya 5. Janapada & durga 6. Treasury and the State Economy (Kośa) 7. Danda 8. Mitra 9. The Administrative Setup 10. Relevance of Arthaśāstra 11. Public Administration in Epics

TEXTBOOKS /REFERENCES:

1. Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavana R.N. (2022), "Introduction to Indian Knowledge System: Concepts and Applications", PHI Learning Private Ltd. Delhi.

Additional Readings:

1. Pride of India: A Glimpse into India's Scientific Heritage, Samskrita Bharati, New Delhi.
2. Sampad and Vijay (2011). "The Wonder that is Sanskrit", Sri Aurobindo Society, Puducherry.
3. Acarya, P.K. (1996). Indian Architecture, Munshiram Manoharlal Publishers, New Delhi.
4. Kapoor Kapil, Singh Avadhesh (2021). "Indian Knowledge Systems Vol – I & II", Indian Institute of Advanced Study, Shimla, H.P.
5. Dasgupta,S. (1975). A History of Indian Philosophy- Volume 1, Motilal Banarsidass, New Delhi.
6. PLofker, K. (1963). Mathematics in India, Princeton University Press, New Jeresy, USA"

Ancient Indian Management

24AF2956IK206C	Ancient Indian Management	IKS	2-0-0	2 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	--	Total 40 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents

Unit-1 **[04 Hours]**

Introduction

Understanding management: Defining management, Nature of management, Management: Science or art?

Ancient Indian Management

Unit-2 **[04 Hours]**

Management Perspective of Ancient Indian Literature: What is Jain Literature?, What is Vedantic Literature?, code of conduct in vedantic literature, code of conduct in Jain Literature, Four pillars of human labor in ancient Vedantic and Jain Literature **Management lessons from Mahabharata**

Unit-3 **[04 Hours]**

Management in Bhagavad Gita:

Introduction to Gita**,** Management Lessons from Bhagavad Gita

Unit-4 **[04 Hours]**

Management lessons from Ramayana:

Introduction to Ramayana**,** Management Lessons from Ramayana

Unit-5 **[04 Hours]**

Ancient Indian Economics:

Kautilya's economics, Mahavira's economics

TEXTBOOKS / REFERENCES:

1. Indian Management by Subhash Sharma. New Age International (P) Limited Publishers< New Delhi ISBN: 978-93-89802-41-2
2. Management Concepts - In Ancient Indian Psycho-Philosophic Thought &Thier Significance for Present Day Organisations by Ipshita Bansal, Popular Book Depo
3. In Indian Logic: Modern Management Philosophies as derived from Ancient Indian Philosophies, by Aparna Singh.

Research Paper Writing

24AF2956AU207	Research Paper Writing	AC	2-0-0	Audit Course

Continuous Assessment - 20 Marks	Mid Sem Exam 20 Marks	--	Total 40 Marks

Pre-Requisites: Communication Skills

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[04 Hours]**

Types of Research

Role & purposes of Research Designs, Defining and differentiating research: Descriptive Research, Analytical Research, Applied Research, Fundamental Research, Quantitative Research, Qualitative Research, Conceptual Research, and Empirical Research

Unit 2 **[04 Hours]**

Sources of Information

Finding/Gathering information for research, using information, Using research tools, Using Library and electronic databases

Unit 3 **[04 Hours]**

Writing research literature review

Need for a literature review, Strategies for writing literature review, Reviewing skills, Literature search and evaluation, Method of conducting a literature review, Organizing the literature review

Unit 4 **[04 Hours]**

Citing sources/references and maintaining Academic honesty Referencing and in-text citations, Styles of referencing, Paraphrasing and summarizing, Citing sources, Developing academic honesty

Unit 5 **[04 Hours]**

Writing, refining and editing a research paper

Writing a Research Proposal, Developing objectives of the research topic, Developing logical research statements and hypotheses, Editing the research paper, Proofreading techniques, Revision of the research paper

Unit 6 **[04 Hours]**

Ethical issues in collecting data

Ethics, stakeholders in research, ethical issues concerning participants, seeking consent, providing incentives, confidentiality, bias, incorrect reporting, issues with sponsoring organizations, Study of research papers in the respective areas of specialization.

TEXTS/REFERENCES:

1. Kothari, C. R. (2004). Research Methodology: Methods and Techniques. New Delhi: New Age International.
2. Kumar, R. (2005). Research Methodology-A Step-by-Step Guide for. Singapore: Pearson Education.
3. Saravanavel, P. (2012). Research Methodology. Allahabad: Kitab Mahal Publishers. Page 3 of 3

Technical Seminar

24AF2619PC208	**Seminar**	**PCC**	**0-0-2**	**1 Credit**

Continuous Assessment 50 Marks	PR/OR 50 Marks	Total 100 Marks

Pre-Requisites: Previously studied courses.
Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												

Objective:
To assess the debating capability of the student to present a technical topic. Also, to impart training to a student to face audience and present ideas and thus creating self-esteem, self- confidence and courage that are essential for an engineer.

Individual students are required to choose a topic of their interest from Manufacturing Systems Management related topics preferably from outside the M.Tech syllabus or an extension of syllabus and give a seminar on that topic for about 30 minutes. The Seminar can also be a case study from a manufacturing organization. A committee consisting of at least three faculty members shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his / her seminar topic. One copy shall be returned to the student after duly certifying it by the Chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

Mini Project

24AF2619PC209	**Mini Project**	**PCC**	**0-0-2**	**1 Credit**

Continuous Assessment 50 Marks	PR/OR 50 Marks	Total 100 Marks

Pre-Requisites: Previously studied courses.

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Objectives:

To train students in identification, analysis, finding solutions and execution of live engineering and managerial problems. It is also aimed to enhance the capabilities of the students for group activities.

Individual students are required to choose a topic of their interest. The course content of the mini project shall be from emerging / thrust areas, topics of current relevance having research aspects or shall be based on industrial visits. Students can also choose live problems from manufacturing organisations as their mini project. At the end of the semester, the students should submit a report duly authenticated by the respective guide, to the head of the department.

Mini Project will have internal marks 50 and Semester-end examination marks 50. Internal marks will be awarded by respective guides as per the stipulations given below. Attendance, regularity of student (20 marks)

Individual evaluation through viva voce / test (30 marks) Total (50 marks)

Semester end examination will be conducted by a committee consisting of three faculty members. The students are required to bring the report completed in all respects duly authenticated by the respective guide and head of the department, beforethe committee. Students individually will present their work before the committee. The committee will evaluate the students individually and marks shall be awarded as follows.

Report = 25 marks

Concept/knowledge in the topic = 15 marks, Presentation = 10 marks, Total marks = 50 marks

Semester III

Project management for managers

24AF2604OE301A	Project management for managers	OEC-II	3-0-0	3 Credits

Continuous Assessment - 20 Marks	Mid Sem Exam - 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: Engineering mathematics-I

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[07 Hours]**

Introduction to project management, project success, types of structure organizations, project management office, stake holders management, types of projects and project life cycle, project life cycle phases and project appraisal, methods of project selection –I, methods of project selection – II, MCDM-I, Methods of project selection MCDM- II, MCDM –III

Unit 2 **[07 Hours]**

Market and demand analysis – I, market and demand analysis – II, Financial analysis, capital budgeting techniques – I, capital budgeting techniques –II, Financing of projects, Risk management I and Risk management II, Risk management (Control and documentation), stand alone risk analysis I, stand alone risk analysis II, Hilier model.

Unit 3 **[07 Hours]**

Simulation analysis, decision tree analysis –I, decision tree analysis –II, Abandonment analysis,

Technical analysis, product mix and plant capacity analysis, Project team building, conflict and negotiation, HRM Issues and time management.

Unit 4 **[07 Hours]**

Introduction to project time management, project scheduling, node numbering, PERT Networks, CPM, Laddering in PERT/CPM, probability models in networks-I, probability models in network –II,

Unit 5 **[07 Hours]**

Probability models in network –III and IV, simulations of networks I and II, Slacks and floats, time and cost relationship, crashing of networks, Free float method, Introduction to project crash management, cost control tools and techniques, cost estimation, introduction to quality management

TEXTS/REFERENCES:

1. "Project Management- A Managerial Approach", Jack Meredith, Samuel J. Mantel Jr., John Wiley and Sons
2. Project Management For Engineering, Business And Technology, John M. Nicholas (Author), Herman Steyn (Author), Routledge; 6th edition (August 3, 2020)
3. Engineering Project Management by Neil G. Siegel, Wiley 1st edition (February 18, 2020).
4. Project Management: The Managerial Process, 8th Edition, By Erik Larson and Clifford Gray, McGraw Hill
5. Mitra, Amitava. Fundamentals of Quality Control and Improvement, Wiley India Pvt Ltd.
6. Evans, J R and W M Lindsay, An Introduction to Six Sigma and Process Improvement, CENGAGE Learning.

Industrial Safety Engineering

24AF2956OE301C	Industrial Safety Engineering	OEC-II	3-0-0	3 Credits

Mid SemTest 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: Engineering mathematics-I

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution 2- Means medium contribution 3- Maximum contribution

Course Contents

Unit-1 **[07 Hours]**

Introduction, key concepts, terminologies, safety domain ontology, and safety quantification, safety by design, Application of hazard identification techniques (e.g., HAZOP, FMEA, etc.) - preliminary hazard list, preliminary hazard analysis, Risk assessment and Control, Safety engineering and accident causing mechanism

Unit-2 **[07 Hours]**

Fault tree Analysis- construction, gate by gate method, cut set method, importance measures, and event tree analysis (qualitative & quantitative), Bow-tie tool, common cause cut sets, cut sets for accident scenarios, identification of safety barriers,

Unit-3 **[07 Hours]**

Risk assessment, Consequence assessment, Energy control model and hazard control hierarchy, Safety function deployment, Ranking of design solution using AHP, Safety vs reliability –

quantification of basic events (for non repairable components, hazard rate, exponential distribution, Weibull distribution)

Unit-4 **[07 Hours]**

Quantification of basic events -repair to failure, repair-failure-repair, and combined processes, Computation of combined process parameters – Laplace transform and Markov analysis, Safety vs reliability – quantification of basic events, Systems safety quantification (e.g., truth tables, structure functions, minimal cut sets)

Unit-5 **[07 Hours]**

Human error -classification and causes, Human error identification, Human reliability assessment, analysis and safety, Accident investigation and analysis, control chart analysis, regression and classification tree, OSHAS 18001 and OSHMS- part I, II, III and safety performance indicators, Energy isolations, Application of virtual reality.

Books and references:

1. Probabilistic Risk Assessment for Engineering and Scientists, Komamoto and Henley, IEEE Press, 1995.
2. Industrial Accident Prevention, Heinrich et al., McGraw Hill, 1980.
3. Techniques for safety management - A systems approach, Petersen D, ASSE 1998.

Python for Data Science

24AF2956OE301A	Python for Data Science	OEC-II	3-0-0	3 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites:

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 **[07 Hours]**

Basics of Data Science and Python Spyder

Basics of data analysis and data modeling methodologies; and techniques for approaching data science, Spyder introduction, Setting working Directory, Creating and saving a script file, File execution, clearing console, removing variables from environment, clearing environment, Commenting script files, Variable creation, Arithmetic and logical operators, Data types and associated operations

Unit 2 **[07 Hours]**

Python notebook using Google Colab; instructions using built-in Python data and control structures; random numbers within the random module; and basic plotting and data rendering instructions using the matplotlib module, Sequence data types and associated operations: Strings, Lists, Arrays, Tuples, Dictionary, Sets, Range, instructions to create numpy arrays; instructions to index arrays using slicing; demonstrate computation and visualization using array operations; and instructions to load and save data using numpy file formats, random numbers within the numpy module; statistical methods within the scipy.stats module; and scipy.stats module for solving data science problems.

Unit 3 **[07 Hours]**

Pandas dataframe and dataframe related operations on Toyota Corolla dataset- Reading files, Exploratory data analysis, Data preparation and preprocessing, Data visualization on Toyoto Corolla

dataset using matplotlib and seaborn libraries- Scatter plot, Line plot, Bar plot, Histogram, Box plot, Pair plot, Control structures using Toyota Corolla dataset- if-else family, for loop, for loop with if break, while loop, Functions, similarities and differences between dataframes and arrays; instructions for cleaning data sets; implement operations on dataframes; Python instructions for interacting with spreadsheet files; and built-in pandas visualization methods to visualize pandas dataframe data.

Unit 4 **[07 Hours]**

Seaborn commands to visualize pandas dataframe data; advanced data visualization techniques; and seaborn module to solve data science problems, supervised learning techniques; scikit-learn module to supervised learning; Python scripts that extract features and reduce feature dimension; and models using data mining techniques.

Unit 5 **[07 Hours]**

Unsupervised learning concepts; scikit-learn module to perform unsupervised learning; similarities and differences between hierarchical clustering and K-means clustering; and validate models using clustering techniques, linear regression concepts; scikit-learn module to build linear regression models; scikit-learn module to validate linear regression models; and data overfitting, statsmodels module; autoregressive and moving average models; and AR, MA, and ARIMA models

Books and references

1. Introduction to linear algebra - Gilbert Strang
2. Applied statistics and probability for engineers –Douglas Montgomery
3. Mastering python for data science, Samir Madhavan
4. Python Data Analytics, With Pandas, NumPy, and Matplotlib, Fabio Nell, Apress publisher, 2018.

Application of IoT and Industry 4.0

24AF2956MD302A	Application of IoT and Industry 4.0	MDM	3-0-0	3 Credits

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites:

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1: **[07 Hours]**

Introduction: Sensing & actuation, Communication-Part I, Part II, Networking-Part I, Part II, Industry 4.0: Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories

Unit 2: **[07 Hours]**

Industry 4.0: Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artifical Intelligence, Big Data and Advanced Analysis, Cybersecurity in Industry 4.0, Basics of Industrial IoT: Industrial Processes-Part I, Part II, Industrial Sensing & Actuation, Industrial Internet Systems.

Unit 3: **[07 Hours]**

IIoT-Introduction, Industrial IoT: Business Model and Referece Architerture: IIoT-Business Models-Part I, Part II, IIoT Reference Architecture-Part I, Part II, Industrial IoT- Layers: IIoT Sensing-Part I, Part II, IIoT Processing-Part I, Part II, IIoT Communication-Part I, Industrial IoT- Layers: IIoT Communication-Part II, Part III, IIoT Networking-Part I, Part II, Part III.

Unit 4: **[07 Hours]**

Industrial IoT: Big Data Analytics and Software Defined Networks: IIoT Analytics - Introduction, Machine Learning and Data Science - Part I, Part II, R and Julia Programming, Data Management with Hadoop, Industrial IoT: Big Data Analytics and Software Defined Networks: SDN in IIoT-Part I, Part

II, Data Center Networks, Industrial IoT: Security and Fog Computing: Cloud Computing in IIoT-Part I, Part II, Industrial IoT: Security and Fog Computing
- Fog Computing in IIoT, Security in IIoT-Part I, Part II, Industrial IoT- Application Domains: Factories and Assembly Line, Food Industry.

Unit 5: **[07 Hours]**

Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management, Industrial IoT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies, Case studies in Milk Processing and Packaging Industries, Manufacturing Industries, Student Projects,

Books and references:

1. Industry 4.0: The Industrial Internet of Things Alasdair Gilchrist Publications: Apress
2. The Concept Industry 4.0 An Empirical Analysis of Technologies and Applications in Production Logistics Authors: Bartodziej, Christoph Jan Springer: Publication in the field of economic science.
3. Embedded System: Architecture, Programming and Design by Rajkamal, TMH3.
4. Dr. OvidiuVermesan, Dr. Peter Friess, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers

e-Commerce Technologies

24AF2956MD302B	e-Commerce Technologies	MDM	3-0-0	3 Credits

Mid SemTest 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: Engineering mathematics-I

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit-1 **[07 Hours]**

Introduction to e-commerce, Technical components and functions of e-commerce, Advantages and disadvantages of e-commerce, Scope and applications of e-commerce, E-commerce and e- business

Unit-2 **[07 Hours]**

Evolution of internet, Domain names and internet organization, Types of network, Role of internet in B2B application and Building own website, Web promotion, Target email, Banner exchange and Shopping Bots, Secure transaction over internet

Unit-3 **[07 Hours]**

Privacy issues, Computer crime, Threats and attacks on computer system, Software packages for privacy, Hacking and computer virus, Security algorithms, Authorization and authentication, digital signature, Firewall, Basic concepts of EDI

Unit-4 **[07 Hours]**

Applications of EDI, EDI model and Disadvantages of EDI model, Introduction to electronic payment systems, Payment types, Planning e-commerce initiates, Linking objectives to business strategies, Managing costs, Strategies for developing e-commerce websites

Unit-5 **[07 Hours]**

Pros and cons of online shopping, Case study- cons of online shopping, E-cycle of internet marketing, Internet marketing techniques, Personalization of e-commerce.

TEXTS/REFERENCES:

1. C.S.V.Murthy, E-Commerce Concepts, Models, Strategies- :- Himalaya Publishing House, 2011.
2. Kamlesh K Bajaj and Debjani Nag , E- Commerce , 2005.
3. Gary P. Schneider , Electronic commerce, International Student Edition, 2011.
4. Electronic Commerce: The Strategic Perspective, Richard T.Watson, Pierre Berthon, Leyland F. Pitt, George M. Zinkhan.
5. Rana tassabehji, Applying E-commerce in business, 2003.
6. Kalakota, Ravi and Whinston, Andrew B., Electronic Commerce – A Manager‘s Guide, Pearson Education, Inc.
7. William Stallings, Cryptography and Network security Principles and practice, Fifth edition.
8. Bharat Bhasker, Electronic commerce-framework, technologies and applications, 3rd edition.

Entrepreneurship & Start-ups

24AF2604MD302C	Entrepreneurship & Start-ups	MDM	3-0-0	3 Credits

Mid SemTest 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Unit 1 Understanding the meaning of StartUp **[07 Hours]**

Why StartUps are growing immensely these days, Characteristics of Successful Entrepreneur, Theories & Types of Entrepreneurs, Understanding the StartUp Ecosystem

Unit 2 Idea Generation **[07 Hours]**

Introduction to Design Thinking, Idea Identification, Genuity of Idea, Understanding what customers really want?, Market Research: Validation of idea, Testing your idea with real time user into the market, Selection a demographic area for implementing your idea, Building of Minimum Viable Product

Unit 3 Soft Skills required to handle StartUp **[07 Hours]**

Leadership, Negotiation skills, Time management, Problem solving, Communication

Unit 4 StartUp Plan **[07 Hours]**

Making Business Plan of your startup, Understanding the legal compliances of your startup, Building marketing strategies to get your product into the market (Traditional & Digital Marketing), Understanding Cash Flow Management, Raising funds for your business

Unit 5 MANAGEMENT OF SMALL BUSINESS [07 Hours]

Monitoring and Evaluation of Business - Preventing Sickness and Rehabilitation of Business Units- Effective Management of small Business.

Intellectual Property Rights

24AF2956PC303	**Intellectual Property Rights**	**PCC**	**3-0-0**	**3 Credits**

Mid SemTest 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	State the fundamental terms i.e. trademark, copyright, patents, trade secret etc.
CO2	Interpret laws of trademark, copyright, patents, trade secret and its registration processes.
CO3	Understand the roles and responsibilities of various international organizations, agencies, and treaties.
CO4	Manage and safeguard the intellectual property and protect it against unauthorized use.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1			1			1			1
CO2	1	1	1						1			1
CO3			1			1			1			1
CO4	2	1	1			1			1			1

Course Contents

UNIT I: Understanding and Overview of the IPR Regime (08 Hours)

Introduction, types of intellectual property- Copyright, Trademarks, Patents, Trade secrets. Need for Intellectual property rights, Rationale for protection of IPR. Impact of IPR on development, health, agriculture, and genetic resources. IPR in India- Genesis and Development. IPR abroad. International Organizations, agencies, and treaties.

UNIT II: Trademarks and Trade secret (08 Hours)

Rights of trademark-Kind of signs used as trademark types, Purpose and Function of a trademark, Trademark Protection, trademark registration, acquisition of trademark rights, protectable matters, selecting and evaluating trademark, trademark registration processes. Infringement of Trademark.

Geographical Indication of Goods: Geographical Indications (GI) laws, Indian Geographical Indications (GI) act, Types of Geographical Indications (GI), Need for protection, legal aspects.

Trade Secret: Trade Secret laws, determination of trade secret status, liabilities for misappropriation of trade secrets, protection for submission, trade secret litigation.

UNIT III: Copyrights (08 Hours)

Rights and Protection covered by copyrights- Laws of copyrights: Fundamental of copyright law,

originality of material, rights of reproduction, rights to perform the work publicly, copyright ownership issues, obtaining copyright registration and process, international copyright law, Infringement of copyright under copyright act, the role, and liabilities of IPRs in India.

UNIT IV: Patents (08 Hours)

Kinds of inventions protected by patent, Patentable and Non patentable inventions, process and product patent, Legal requirements for patents-Granting of patent-Rights of a patent-exclusive right, Patent application process: Searching a patent- Drafting of a patent- Filing of a patent- Types of a patent application. Patent document: specifications and claims, Management of IP asses and IP portfolio, Commercial exploitation of IP- Assignment, licensing, infringement. Different laws of the international patent system: national, regional and international options. Industrial Design protection.

UNIT V: New Development of Intellectual Property (08 Hours)

New development in trademark law, copyright law, patent law, trade secret law, Intellectual property audits. International overview on intellectual property, international trademark law, copyright law, international patent law and international trade secret law.

Textbooks:

1. Deborah, E. Bouchoux, “Intellectual Property Rights”, Cengage learning.
2. Prabuddha Ganguli, “Intellectual Property right: Unleashing the knowledge economy”, Tata McGraw Hill Publishing Company Ltd.

Project Stage -1

24AF2619PC304	**Project Stage – I**	**PCC**	**0-0-0**	**10 Credits**

Continuous Assessment 50 Marks	End Sem Evaluation 50 Marks	Total 100 Marks

Pre-Requisites: Previously studied courses.

Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Objective:

To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

The project work can be a design project, experimental project, computer simulation project or an empirical study involving data collection and analysis from manufacturing organisations. The topic should be on Manufacturing Systems Management orany of the topics related with Manufacturing stream. The project work is allotted individually on different topics.The students shall be encouraged to do their project work in the parent institute. If found essential they may be permitted to continue their project outside the parent institute subject to the conditions of M.Tech regulations. Department will constitute an Evaluation Committee to review the project work. The Evaluation committee consists of at least three faculty members of which internal guide and another expert in the specified area of the project shall be two essential members. The student is required to undertake the masters research project phase-I during the third semester and the same is continued in the 4^{th} semester (Phase-II). Phase-I consists of preliminary thesis work, two

reviews of the work and the submission of preliminary report. First review would highlight the topic, objectives, methodology and expected results. Second review evaluates the progress of the work, preliminary report and scope of the work which is to be completed in the 4th semester.

Semester IV

Project Stage – II

24AF2619PC401	Project Stage – II	PCC	0-0-0	20 Credits

Continuous Assessment 100 Marks	PR/OR 100 Marks	Total 200 Marks

Pre-Requisites: Previously studied courses.
Course Outcomes: At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Objectives:
To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

Masters Research project phase-II is a continuation of project phase-I started in the third semester. Before the end of the fourth semester, there will be two reviews, one at middle of the fourth semester and other towards the end. In the first review, progress of the project work done is to be assessed. In the second review, the complete assessment (quality, quantum and authenticity) of the thesis is to be evaluated. Both the reviews should be conducted by guide and Evaluation committee. This would be a pre-qualifying exercise for the students for getting approval for the submission of the thesis. At least one technical paper is to be prepared for possible publication in journal or conferences. The technical paper is to be submitted along with the thesis. The final evaluation of the project will be external evaluation.