SMTB5102	ADVANCED MATHEMATICS (Common to all M.E Branches and M.Tech. Bio-Medical)	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVES

- The ability to identify, reflect upon, evaluate and apply different types of information and knowledge to form independent judgments.

UNIT 1 MATRIX THEORY 9 Hrs.

QR decomposition – Eigen values using shifted QR algorithm – Singular Value Decomposition – Pseudo inverse – Least square approximations.

UNIT 2 CALCULUS OF VARIATIONS 9 Hrs.

Concept of Functionals – Euler's equation – functional dependent on first and higher order derivatives – Functionals on several dependent variables – Iso-perimetric problems – Variational problems with moving boundaries.

UNIT 3 TRANSFORM METHODS 9 Hrs.

Laplace transform methods for one dimensional wave equation – Displacements in a string – Longitudinal vibration of a elastic bar – Fourier transform methods for one dimensional heat conduction problems in infinite and semi infinite rod.

UNIT 4 ELLIPTIC EQUATIONS 9 Hrs.

Laplace equation – Properties of harmonic functions – Fourier transform methods for Laplace equations – Solution for Poisson equation by Fourier transforms method.

UNIT 5 LINEAR AND NON-LINEAR PROGRAMMING 9 Hrs.

Simplex Algorithm – Two Phase and Big M techniques – Duality theory – Dual Simplex method – Non Linear Programming – Constrained external problems – Lagranges multiplier method – Kuhn – Tucker conditions and solutions.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Defining the concepts of Matrix theory.
CO2 - Learning the concepts of calculus of variations and its applications.
CO3 - Understanding the concept of transform methods and elliptic equations.
CO4 - Evaluation of one dimensional heat conduction problems using transform methods
CO5 - Applying various techniques for solving linear programming problems.
CO6 - Produce the solution for non linear programming problems.

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TEXT / REFERENCE BOOKS

1. Richard Bronson, Schaum's Outline Matrix Operations, McGraw-Hill, 2011
2. Venkataraman M K, Higher Engineering Mathematics, National Pub. Co, 2003
3. Elsgolts, L., Differential Equations and Calculus of Variations University Press of the Pacific,2003.
4. I.N., Elements of Partial differential equations, Dover Publications, 2006.
5. Sankara Rao, K., Introduction to partial differential equations. Prentice Hall of India,2011.
6. Taha H A, "Operations research - An introduction, McMilan Publishing co, 2010.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

S32BLH11	ADVANCED STRENGTH OF MATERIALS	L	T	P	EL	Credits	Total Marks
		3	0	2	2	4	100

COURSE OBJECTIVES

- To gain a thorough overview of the advanced strength of materials skills required for today's mechanical engineers.
- Gain knowledge of stresses, strains and deformations in three dimensions.
- Provide the concepts of shear center, unsymmetrical bending and the shear flow.
- Gain the knowledge on stresses and deformations in the plates and curved beams.
- Provide the concept of torsion stresses of non-circular sections.
- Gain the knowledge on the stresses induced in the solid discs and ring due to rotation and contact stresses.

UNIT 1 ELASTICITY 6 Hrs.

Stress - Strain relations and general equations of elasticity in Cartesian coordinates - Differential equations of equilibrium – compatibility - boundary conditions - representation of 3-dimensional stress of a tensor- Generalized Hooke's law - St. Venant's principle - plane strain – plain stress- Analysis of stress and strain, Elasticity problems in two and three dimensions, Airy's stress function in rectangular and polar coordinates- Strain energy.

UNIT 2 SHEAR CENTRE AND UNSYMMETRICAL BENDING 6 Hrs.

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

UNIT 3 STRESSES IN FLAT PLATES AND CURVED FLEXURAL MEMBERS 6 Hrs.

Stresses in circular and rectangular plates due to various types of loading and end conditions - buckling of plates and stress concentrations. Winkler Bach formula - Equivalent area method - Circumferential - Radial stresses and Deflections in curved beams – Limitations – Correction factors - Curved beam with restrained ends- closed ring subjected to concentrated load and uniform load – chain links and crane hooks.

UNIT 4 TORSION OF NON-CIRCULAR SECTIONS 6 Hrs.

Torsion of rectangular cross sections - St. Venant's theory – Elastic membrane Analogy – Prandtl's stress function (Soap- Film) Analogy – Torsional stresses in hollow thin walled tubes- Multiply connected cross section.

UNIT 5 STRESSES DUE TO ROTATION AND CONTACT STRESSES 6 Hrs.

Radial and tangential stresses due to rotation in solid ring and hollow disc of uniform thickness and varying thickness – rotating long cylinders - allowable speeds. Theory of contact stresses - Assumptions - Methods of computing contact stresses - Deflection of bodies in point and line contact applications- Normal and Tangent to contact area - Stresses for two bodies in contact over narrow rectangular area (Line contact) - Loads normal to area - Stresses for two bodies in line contact.

Max. 30 Hrs.

LIST OF EXPERIMENTS

1. Determine the modulus of rigidity of the given material of circular shaft.
2. Determine the central deflection of a simply supported beam.
3. investigate the relationship between shear stress and shear strain for rubber and to determine the modulus of rigidity of the material
4. Determine the central deflection of a fixed ended beam loaded at mid-span
5. Determine the central deflection of a fixed ended beam loaded at mid-span.
6. Measure the stiffness of a compression spring and compare it with theoretical values.
7. Measure the stiffness of an Extension spring and compare it with theoretical values.
8. verify the relationship among load on spiral spring, number of turns and degree of rotation of a coil spring.

Max. 60 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Apply the concepts of stress, strain and strain energy.
CO2 - Understand about shear center and unsymmetrical bending.
CO3 - Analyze about stresses in plates and curved members.
CO4 - Use the principles of torsion for analysis.
CO5 - Asses the radial and tangential stresses in the rotating solid discs and rings.
CO6 - Understand the theory of contact stresses.

TEXT / REFERENCE BOOKS

1. William B Bickford,"Advanced Mechanics of Materials",1ST Edition, Pearson, 2016
2. Robert Mott, "Applied Strength of Materials", 6th Edition, Taylor & Francis, 2016
3. Den Hartong, "Advanced Strength of Materials", McGraw Hill Book Co., New York, 2016.
4. Kumar, B. Raghu, "Strength of Materials", 1st Edition, Taylor and Francis Ltd, 2022
5. G H Ryder, "Strength of Materials", Macmillan, India Ltd, 2007.
6. Allan F. Bower, "Applied Mechanics of Solids", CRC press – Special Indian Edition, 2012.

SMEB5101	PRODUCT DESIGN AND PLM	L	T	P	EL	Credits	Total Marks
		3	0	0	3	4	100

COURSE OBJECTIVES

- To understand the integration of customer requirements in product.
- To learn about the principles of design for manufacture and environment
- To understand history, concepts and terminology of PLM

UNIT 1 INTRODUCTION 9 Hrs.

Introduction: Characteristics of successful product development, Design and development of products, duration and cost of product development, the challenges of product development. Development Processes and Organizations, Product Planning, Identifying Customer Needs - organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process. Product Specifications: establishing target specifications, setting the final specifications

UNIT 2 BASIC CONCEPTS 9 Hrs.

Concept Generation: The activity of concept generation clarify the problem, search externally, search internally, explore systematically, and reflect on the results and the process. Concept Selection: Overview of methodology, concept screening, and concept scoring. Concept Testing: Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process.

UNIT 3 DESIGN FOR MANUFACTURING AND ECONOMICS 9 Hrs.

Design for Manufacturing: Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors. Prototyping: Prototyping basics, principles of prototyping, technologies, planning for prototypes. Product Development Economics: Elements of economic analysis, base case financial mode, Sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis

UNIT 4 HISTORY, CONCEPTS AND TERMINOLOGY OF PLM 9Hrs.

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 5 ROLE OF PLM IN INDUSTRIES 9 Hrs.

User Functions – Data Vault and Document Management, Workflow and Process Management, 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**.**

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Describe the new product based on mechanical design engineering.
CO2 - Define the mechanical aspects of product design by incorporating concept, creativity, structural, manufacturing, aesthetics and ergonomics.
CO3 - Solve open ended problem belongs to design engineering that meet the requirements.
CO4 - Summarize the history, concepts and terminology of PLM.
CO5 - Implement PLM approaches for industrial applications.
CO6 - Use the functions and features of PLM

TEXT / REFERENCE BOOKS

1. Karl T Ulrich, Steven D Eppinger, “Product Design & Development.” Tata McGrawhill New Delhi 2003.
2. Kevin Otto & Kristin Wood Product Design: “Techniques in Reverse Engineering and new Product Development.” 1 st Edition, Pearson Education New Delhi, 2004.
3. David G Ullman, “The Mechanical Design Process.” McGrawhill Inc Singapore 1992
4. John Stark, “Product Lifecycle Management: 21st Century Paradigm for Product Realisation”, Springer Publisher, 2011 (2nd Edition).
5. Michael Grieves, “Product Life Cycle Management”, Tata McGraw Hill, 2006..
6. Antti Saaksvuori and AnselmiImmonen, “Product Lifecycle Management”, Springer Publisher, 2008 (3rd Edition).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SMEB5102	RESEARCH METHODOLOGY AND IPR	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To impart knowledge on formulation of research problem, research methodology, ethics involved in doing research
- To explain the functions of the literature review in research.
- To explain various forms of the intellectual property, its relevance and business impact in the changing global business environment.

UNIT 1 INTRODUCTION TO RESEARCH METHODOLOGY 9 Hrs.

Meaning of research problem, Sources of research problem, Criteria Characteristics of a goodresearch problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, plagiarism, research ethics.

UNIT 2 DATA COLLECTION AND SOURCES 9 Hrs.

Importance and scientific methodology in recording results, importance of negative results, different ways of recording, industrial requirement, artifacts versus true results, types of analysis (analytical, objective, subjective),outcome as new idea, hypothesis, concept, theory, model etc.

UNIT 3 INTERPRETATION AND REPORT WRITING 9 Hrs.

Effective technical writing, how to write a manuscript/ responses to reviewers comments, preparation of research article/ research report, Writing a Research Proposal - presentation and assessment by a review committee.

UNIT 4 INTELLECTUAL PROPERTY RIGHTS 9 Hrs.

Intellectual Property – Concept of IPR, Evolution and development of concept of IPR, Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, patenting under PCT.

UNIT 5 PATENT RIGHTS AND NEW DEVELOPMENTS IN IPR 9 Hrs.

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process of E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licenses, Licensing of related patents, patent agents, Registration of patent agents. Scope of Patent Rights. Licensing and transfer of technology, Patent information and databases, Geographical Indications. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, the student will be able to

CO1 - Understand the important basics of research and Intellectual Property Rights
CO2 - Write research problem formulations through various methods of literature survey
CO3 - Analyze research related information and Follow research ethics
CO4 - Correlate the results of any research article with other published results. Write a review article in the field of engineering.
CO5 - Differentiate patents, copyrights, trademark and designs.
CO6 - Apply the process for IPR protection

TEXT / REFERENCE BOOKS

1. Kothari C.R,Gaurav Garg, "Research Methodology: Methods and Techniques", 4thEdition, New Age International, 2018.
2. Ranjit Kumar, "Research Methodology – A Step by Step for Beginners", 2ndEdition, Pearson Education, 2016.
3. Robert P. Merges, Peter S. Menell and Mark A. Lemley, "Intellectual Property in New Technological Age", Aspen Publishers, 2016.
4. Ratan Khasnabis and Suvasis Saha, "Research Methodology", Universities Press, Hyderabad, 2015
5. Ganesan.R, "Research Methodology for Engineers", MJP Publishers, Chennai, 2011.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**

PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SMEB6101	CAD LAB 1 - MODELLING	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVES

- To familiarize the students with the working of CAD modelling.
- To make the students aware of design automation and documentation.

PREREQUISITE

Exposure to at least one popular 3D Modelling Software, such as AutoCAD, Pro/E, Solidworks etc, is essential.

- CAD INTRODUCTION
  Orthographic Views, Isometric Views, Sectional Views, Symbols - Welding, Surface Finish, Threads. Text, Bill of Materials, Generating Orthographic view from Isometric View - Part Drawing, Assembly Drawing, Broken views, Detailed Drawing - Dimensioning, Annotations, Title Block.
- SOLID MODELING
  Extrude, Revolve, Sweep, etc and Variational sweep, Loft, etc.
- SURFACE MODELING
  Extrude, Sweep, Mesh of curves, Free form etc.
- FEATURE MANIPULATION
  Copy, Edit, fillet, chamfer, mirror, rib, sweep, draft, Pattern, Shell, History operations etc.
- ASSEMBLY
  Constraints, Exploded Views, Interference check.
- DRAFTING
  Layouts, Standard & Sectional Views, Detailing & Plotting.
- VIEW COMMANDS
  Rendering - wire frame – Shade - View ports.
- FILE MANAGEMENT
  DXF – IGES – SAT – DWG –PRT – Para solid, VRML.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Create Surface and solid models.
CO2 - Create Technical drawings with solid, orthographic.
CO3 - Produce project design documentation.
CO4 - Create Project based assignment.
CO5 - Create design using various design software like Pro-E, CATIA, solid works.
CO6 - Create Industrial Oriented design product and development.

S32BLH21	FINITE ELEMENTS IN MECHANICAL DESIGN	L	T	P	EL	Credits	Total Marks
		3	0	2	2	4	100

COURS OBJECTIVES

- To understand the basic principles of the finite element analysis techniques.
- To effectively use the tools of the analysis for solving practical problems arising in engineering design.
- An ability to effectively use the tools of the analysis for solving practical problems.

UNIT 1 INTRODUCTION 6 Hrs.

General finite element solution procedure-Approximate solutions of boundary value problems, Basic concepts – examples variational formulation and approximation- Rayleigh Ritz method- the method of weighted residuals- time dependent problems.

UNIT 2 FEA OF ONE DIMENSIONAL PROBLEM 6 Hrs.

Discretization of the domain into elements – derivation of element equations – assembly of element equations imposition of boundary conditions- solution of equations- post processing of the solution. One dimensional heat transfer element – application to one-dimensional heat transfer problems.

UNIT 3 FEA OF TWO DIMENSIONAL PROBLEMS 6 Hrs.

Description of the model equation- variation formulation – finite element formulation- interpolation functions- 3 noded triangular elements-four noded rectangular, higher order elements-computation of element matrices-assembly of the element matrices- Applications to heat transfer in 2- Dimension – Application to problems in fluid mechanics in 2-D, Formulation of plate and shell elements.

UNIT 4 MESH GENERATION AND ISOPERIMETRIC ELEMENTS 6 Hrs.

Discretization of a domain- triangular elements – rectangular elements- the serendipity elements- isoperimetric elements and numerical integration- interpolation functions. Approximation errors in the finite element method- various measures of errors- accuracy of the solution. Lagrangian and serendipity elements – Shape function.

UNIT 5 SPECIAL TOPICS 6 Hrs.

Eigen value problems- plain stress strain problems- three dimensional elements- equations of motion based on weak form – longitudinal vibration of bars – transverse vibration of beams -Transient vibration Analysis- P and H methods of mesh refinement-Applications of FEM concept to solve simple problems using ANSYS, Basic of Non-linear Techniques.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Discuss the different classical methods in FEA.
CO2 - Solve the 1D bar and Heat Transfer problems.
CO3 - Arrive at the solutions for fluid mechanics and heat transfer problems.
CO4 - Understanding the Mesh generation and error types in FEA.
CO5 - Solve problems under dynamic conditions by applying various techniques.
CO6 - Find the solution for the real world engineering problems using FEA packages.

30 Hrs.

LIST OF EXERCISES - USING FEA PACKAGE

- Convective Heat Transfer Analysis of 2D Component.
- Analysis of Connecting Rod.
- Analysis of Piston
- Analysis of Door panel
- Analysis of Pressure vessel
- Analysis of Truss problems.
- Analysis of Bicycle frame using Different loads
- Analysis of crank shaft

Max. 60 Hrs.

TEXT / REFERENCE BOOKS

1. Krishnamoorthy,C.S., "Finite Element Analysis- Theory and programming", Tata McGraw –Hill publishing Co., 1987.
2. Desai, C.S.," Elementary Finite Element Method", Prentice-Hall, Engle wood cliffs, N.J., 2002.
3. Zienkiewicz, O.C.,"The Finite Element method in Reddy, J.N.,"An introduction to the Finite Element method ",
   McGraw – Hill Book Companylj, Newyork, 2004.Engg. Science", McGraw-Hill, London,1977.
4. Forray, M.J."Variational calculus in Science Engg., McGraw Hill,NewYork,2004.
5. Cheung, Y.K. and Yeo, M.F."A practical introduction to Finite Element Analysis", Ptiman, London, 1979.
6. Huebner, K.H., Dewhirst, D.L., Smith, D.E & Byron, T.G., "The Finite Element Method for Engineers", Wiley Student Edition, Fourth Edition 2014, John Wiley & Sons (Asia) Pvt. Ltd., ISBN: 9812-53-154-8
7. Ramamurthi, V., "Finite Element Method in Machine Design", Narosa Publishing House, January 2013, ISBN: 978-81- 7319-965-3.

SMEB5201	ADVANCED VIBRATIONS	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVES

- To understand theoretically the various systems of vibration.
- To understand the practical approaches of different vibration systems.

UNIT 1 FUNDAMENTALS OF VIBRATION 9 Hrs.

Introduction -Sources of Vibration-Mathematical Models- Displacement, velocity and Acceleration-Introduction to Single Degree of Freedom Systems: Free, Forced, Damped and Undamped systems. Two Degree Freedom System: Free, Damped and Undamped systems -Forced Vibration with Harmonic Excitation System – Coordinate Couplings and Principal Coordinates.

UNIT 2 MULTI-DEGREE OF FREEDOM SYSTEMS 9 Hrs.

Introduction - Modeling of Continuous Systems as Multi-degree of Freedom Systems - Using Newton's Second Law to Derive Equations of Motion- Influence Coefficients – Based on Stiffness, Flexibility and Inertia – Eigen value Problem and its solution - Free and Forced Vibration of Un damped Systems Using Modal Analysis-Forced Vibration of Viscously Damped Systems - Self-Excitation and Stability Analysis.

UNIT 3 CONTINUOUS SYSTEMS 9 Hrs.

Introduction - Transverse Vibration of a String or Cable and their Equations of Motion -Initial and Boundary Conditions - Free Vibration of a Uniform String-Free Vibration of a String with Both Ends Fixed - Longitudinal Vibration of a Bar or Rod - Equation of Motion and Solution - Orthogonality of Normal Functions

UNIT 4 VIBRATION CONTROL 9 Hrs.

Introduction - Vibration Nomograph and Vibration Criteria - Reduction of Vibration at the Source - Balancing of Rotating Machines- Single-Plane Balancing - Two-Plane Balancing - Whirling of Rotating Shafts-Equations of Motion-Critical Speeds- Response of the System - Stability Analysis - Control of Vibration- Control of Natural Frequencies-Introduction of Damping - Vibration Isolation - Vibration Isolation System with Rigid Foundation, Base Motion and Flexible Foundation- Vibration Absorbers – Damped and Un damped Dynamic Vibration Absorber.

UNIT 5 VIBRATION MEASUREMENT AND APPLICATIONS 9 Hrs.

Introduction- Transducers - Piezoelectric Transducers- Electrodynamic Transducers - Linear Variable Differential Transformer Transducer- Vibration Pickups -Vibrometer -Accelerometer - Frequency-Measuring Instruments - Vibration Exciters -Mechanical Exciters -Electrodynamic Shaker - Signal Analysis - Spectrum Analyzers - Experimental Modal Analysis -Determination of Modal Data from Observed Peaks- Determination of Modal Data from Nyquist Plot - Measurement of Mode Shapes-Machine Condition Monitoring and Diagnosis - Machine Maintenance Techniques -Machine Condition Monitoring Techniques -Vibration Monitoring Techniques.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Study the fundamentals of free and forced vibration with damped and Undamped vibrations
CO2 - Analyze the mathematical modeling of the multi degrees of freedom systems
CO3 - Describe the vibration measurement by using transducers and vibration exciters
CO4 - Analyze the vibration control technique and vibration absorbers.
CO5 - Study and analyze the various instruments used to measure the vibrations.
CO6 - Excel Condition Monitoring and Diagnosis Techniques.

TEXT / REFERENCE BOOKS

1. Rao S.S., “Mechanical Vibrations”, 6th Edition, Pearson Education Inc., 2018.
2. Grover G.K., “Mechanical Vibrations”, Nemchand& Bros, Roorkee, 8th Edition, 2009, Reprint 2018
3. Ambekar A.G., Mechanical Vibration and Noise control, Prentice Hall India learning Private limited,2006
4. William T Thomson, Marie Dillon Dahleh, Chandramouli Padmanabhan “Theory of Vibrations with application”, 5th Edition, Pearson Edition. Publication, ISBN 13 9788131704820,2007
5. Debasis Bhattacharyya, Practical Case studies on Vibration Analysis: With an Introduction to the Basics of Vibrations, ISBN-13 978-1638507130, 2021

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SMEB5202	MECHANICAL BEHAVIOUR OF ENGINEERING MATERIALS	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVES

- To structure of material over the effects of mechanical properties Comprehension of the defects inside.
- To structure and their effects on the mechanical properties Comprehension of the failure mechanisms.
- To description of the physical mechanisms and/or mechanical behaviour of monocrystals and polycrystals under plastic deformation.

UNIT 1 STRUCTURE OF SOLID MATERIAL & MECHANICAL BEHAVIOUR 9 Hrs.

Structure of metals: Point, line and surface imperfection, relationship between structure and properties, theory of dislocations, strengthening mechanisms. Mechanical properties: Strength, hardness, toughness, ductility, stress-strain relationship, strains, true strains, strain hardening.

UNIT 2 STATIC MECHANICAL BEHAVIOUR FOR MULTIAXIAL STRESSES 9 Hrs.

Stresses, Strains and Strain Energy for Combined Stresses, Theories of Strength, Application to Design.

UNIT 3 FATIGUE BEHAVIOR 9 Hrs.

Introduction to fatigue. Characteristics and theories of fatigue failures. Fatigue testing machines, specimens, test procedures, method of presenting data, statistical analysis of fatigue results, structural changes accompanying fatigue, factors affecting fatigue strength. Low cycle fatigue phenomenon, difference between low and high cycle fatigues, parameters influencing low cycle fatigue behavior. Cumulative fatigue damage, Effect of mean stress, combined stress fatigue, corrosion fatigue - current trends in fatigue testing.

UNIT 4 CREEP 9 Hrs.

Introduction to creep - creep mechanisms, creep curve – Relaxation - Parameters influencing creep - metallurgical factors affecting creep, high temperature alloys, stress rupture testing, Qualitative study of creep in tension, bending, torsion, buckling and combined stress.

UNIT 5 FRACTURE 9 Hrs.

Linear elastic fracture mechanics, Griffith theory, Irwin- Orowan theory, ductile to brittle transition, fracture toughness, different modes of crack extension, concept of stress intensity factor, analysis of some typical crack problems, non-linear fracture on crack extension, concept of modified stress intensity factor, crack opening displacement and J- integrals, Fracture Resistance of Materials, Application of Fracture mechanics.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understanding of the mechanical properties and behavior of materials.

CO2 - Know the behavior of multi axial stress on materials.

CO3 - Describe the fatigue phenomena of material and recent trends in fatigue testing.

CO4 - Understand the linear elastic fracture mechanics and estimate the effects of cracks in material and structure.

CO5 - Identify engineering problem in using plastic deformation, fatigue, fracture and creep.

CO6 - Study the fracture resistance of materials and crack displacement.

TEXT / REFERENCE BOOKS

1. Joseph Marin. “Mechanical behavior of engineering materials”, prentice – Hall of India Pvt. Ltd.,2012.
2. Kennedy, A.J., “Process of Creep and Fatigue of Metals”, Industrial Press,2015.
3. Forrest, P.G., “Fatigue of Metals“, Pregaman Press, 1961.
4. Knott, J.F., “Fundamentals of fracture mechanics “, Worths, 1979.
5. Fracture Mechanics Application - T. L. Anderson, CRC Press 2015.
6. Mechanical Metallurgy, GE Dieter, McGraw-Hill, 2017.
7. Mechanical Behavior of Materials, by William F. Hosford; Cambridge; Cambridge University Press, New York, 2016.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each – No choice **30 Marks**

PART B: 2 Questions from each unit of internal choice; each carrying 14marks **70 Marks**

S32BLH31	ADDITIVE MANUFACTURING	L	T	P	EL	Credits	Total Marks
		3	0	2	2	4	100

COURSEOBJECTIVES

- To explore the technology used in additive manufacturing.
- To understand the importance of additive manufacturing in advance manufacturing process.
- To acquire knowledge, techniques and skills to select relevant additive manufacturing process.
- To explore the potential of additive manufacturing in different industrial sectors.

UNIT 1 INTRODUCTION 6 Hrs.

Overview, Basic principle need and advantages of additive manufacturing, Procedure of product development in additive manufacturing, Classification of additive manufacturing processes, Materials used in additive manufacturing, Challenges in Additive Manufacturing.

UNIT 2 ADDITIVE MANUFACTURING PROCESSES 6 Hrs.

Z-Corporation 3D-printing, Stereolithography apparatus (SLA), Fused deposition modeling (FDM), Laminated Object Manufacturing (LOM), Selective deposition lamination (SDL), Ultrasonic consolidation, Selective laser sintering (SLS), Laser engineered net shaping (LENS), Electron beam free form fabrication (EBFFF), Electron beam melting (EBM), Plasma transferred arc additive manufacturing (PTAAM), Tungsten inert gas additive manufacturing (TIGAM), Metal inert gas additive manufacturing (MIGAM).

UNIT 3 ADDITIVE MANUFACTURING MACHINES AND SYSTEMS 6 Hrs.

Axes, Linear motion guide ways, Ball screws, Motors, Bearings, Encoders/ Glass scales, Process Chamber, Safety interlocks, Sensors. Introduction to NC/CNC/DNC machine tools, CNC programming and introduction, Hardware Interpolators, Software Interpolators, Recent developments of CNC systems for additive manufacturing.

UNIT 4 PRE-PROCESSING IN ADDITIVE MANUFACTURING 6 Hrs.

Preparation of 3D-CAD model, Reverse engineering, Reconstruction of 3D-CAD model using reverse engineering, Part orientation and support generation, STL Conversion, STL error diagnostics, Slicing and Generation of codes for tool path, Surface preparation of materials.

UNIT 5 POST-PROCESSING IN ADDITIVE MANUFACTURING 6 Hrs.

Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques, Brief information on characterization techniques used in additive manufacturing, Applications of additive manufacturing in rapid prototyping, rapid manufacturing, rapid tooling, repairing and coating.

30 Hrs.

LIST OF EXPERIMENTS

1. Introduction to Solid Modeling Packages
2. Working with sketch mode of Solid modeling Package.
3. Working with creating features (Extrude &Revolve)
4. Develop open source code for various analytical and synthetic curves.
5. Working with various editing tools in Solid Modelling.
6. Working with advanced modeling tools (Sweep, Blend & Swept Blend).
7. Assembly modeling using appropriate assembly constrains.
8. Working with CAD Data Exchange formats: IGES, ACIS, DXF STL,AMF.

9. Identification of STL file problems using MAGICS Software.
10. Application of repair algorithms to make the model error –free using MAGICS Software
11. Part orientation, support and Tool path generation in CURA Software.

Max. 60 Hrs.

COURSEOUTCOMES

On completion of the course, student will be able to

CO1 - Define the various process used in Additive Manufacturing.
CO2 - Analyze and select suitable process and materials used in Additive Manufacturing.
CO3 - Identify, analyze and solve problems related to Additive Manufacturing.
CO4 - Apply knowledge of additive manufacturing for various real-life applications.
CO5 - Apply technique of CAD and reverse engineering for geometry transformation in Additive Manufacturing.
CO6 - Understand the basic concept of additive manufacturing application.

TEXT / REFERENCEBOOKS

1. Gibson, I, Rosen, D W., and Stucker,B., Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010.
2. Chua C.K., Leong K.F., and Lim C.S., “Rapid prototyping: Principles andapplications”, 3rd Edition, World Scientific Publishers, 2010.
3. Chee Kai Chua, Kah Fai Leong, 3D Printing and Additive Manufacturing: Principles and Applications: 4th Edition of Rapid Prototyping, World Scientific Publishers, 2014.
4. Gebhardt A., “Rapid prototyping”, Hanser Gardener Publications, 2003.Kenneth G. Budinski& Michael K. Budinski, "Engineering Materials: Properties and Selection", 9th Edition, Pearson, 2009, 792 pages

SMEB6301	CAD lab II-SIMULATION AND ANALYSIS LABORATORY	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVES

- To gain knowledge on analysis of the machine component.
- To understand the concepts of finite element analysis.

SUGGESTED LIST OF EXPERIMENTS

Analysis of Mechanical Components – Use of FEA Packages.

1. Stress analysis of a plate with a circular hole.
2. Stress analysis of rectangular L bracket.
3. Stress analysis of an axi-symmetric component.
4. Stress analysis of beams (Cantilever, Simply supported, Fixed ends).
5. Mode frequency analysis of a 2 D component.
6. Mode frequency analysis of beams (Cantilever, Simply supported, Fixed ends).
7. Harmonic analysis of a 2D component.
8. Thermal stress analysis of a 2D component.
9. Conductive heat transfer analysis of a 2D component.
10. Convective heat transfer analysis of a 2D component.
11. Analysis of Connecting Rod.
12. Analysis of Piston

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Create simple models in Ansys.
CO2 - Create static and Dynamic analysis.
CO3 - Develop the object in Ansys and perform thermal analysis.
CO4 - Develop the product and perform mode frequency analysis.
CO5 - Create a 2D and 3D model and perform heat transfer analysis.
CO6 - Develop a model and perform fluid flow analysis.

SMEB7001	DESIGN FOR MANUFACTURE AND ASSEMBLY	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSEOBJECTIVES

- To introduce the economic process selection principles and general design principles for manufacturability in the development and design of products for various engineering applications. Also, apply design consideration principles of casting in the design of cast products.
- To learn the design consideration principles of forming in the design of extruded, stamped, and forged products
- To learn design consideration principles of machining in the design of turned, drilled, milled, planed, shaped, slotted, and ground products.
- To learn design consideration principles of welding in the design of welded products.

UNIT 1 INTRODUCTION 9 Hrs.

General design principles for manufacturability -strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances Geometric Tolerances – Assembly limits-Datum features-Tolerance stacks. Design to minimize material usage – Design for disassembly – Design for recyclability – Design for manufacture–Design for energy efficiency–Design to regulations and standards.

UNIT 2 FACTORS INFLUENCINGFORMDESIGN 9 Hrs.

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

UNIT 3 COMPONENTDESIGN-MACHININGCONSIDERATION 9 Hrs.

Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, countersunk screws-Reduction of machined area-simplification by separation-simplification by amalgamation-Design for machinability - Design for economy - Design for clampability – Design for accessibility – Design for assembly–Product design for manual assembly-Product design for automatic assembly–Robotic assembly.

UNIT 4 COMPONENTDESIGN– CASTINGCONSIDERATION 9 Hrs.

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

UNIT 5 DESIGNFORADDITIVEMANUFACTURING 9 Hrs.

Introduction to AM, DFMA concepts and objectives, AM unique capabilities, exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Elaborate the design principles for manufacturability
CO2 - Discuss the factors influencing inform design
CO3 - Apply the component design features of various machine.
CO4 - Discuss the design consideration principles of welding in the design of welded products.
CO5 - Discuss the design consideration principles of additive manufacturing.
CO6 - Discuss the Assembly, Identification of markings additive manufacturing.

TEXT / REFERENCE BOOKS

1. JamesG.Bralla, “DesignforManufacturabilityHandbook”, McGraw Hill Professional,2012.
2. O.Molloy, E.A.Warman, S.Tilley, Design for Manufacturing and Assembly: Concepts, Archite ctures and Implementation, Springer, 2015.
3. David M. Anderson, Design for Manufacturability & Concurrent Engineering: How to Designfor Low Cost, Design in High Quality, Design for Lean Manufacture, and Design Quickly forFastProduction,CIMPress,2014
4. Erik Tempelman, Hugh Shercliff, Bruno Ninaber van Eyben, Manufacturing and Design: Understanding the Principles of How Things Are Made, Elsevier, 2014.
5. Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. ReasonPub.,1996.
6. Boothroyd, G, Heartz and Nike, Product DesignforManufacture,MarcelDekker,1994

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SMEB7002	CONCEPTS OF ENGINEERING DESIGN	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSEOBJECTIVES

- To impart knowledge on materials selection and manufacturing processes integrated with Engineering Design.
- To understand the various stages, types of design and optimization.
- To understand the selection of material for design and the principles of design for manufacture and assembly
- To Understand the Probability concepts in Design for Reliability
- To create awareness on legal and ethical issues in Design and Quality

UNIT 1 DESIGN FUNDAMENTAL 9 Hrs.

The design process – Considerations of good design - Morphology of Design – Design Drawings , Computer Aided Engineering – Designing of codes and standards – Concurrent Engineering – Product life cycle – Technological Forecasting – Market Identification– Competition Bench marking – Systems Engineering – Life Cycle Engineering – Human Factors in Design – Industrial Design.

UNIT 2 DESIGN METHODS 9 Hrs.

Creativity and Problem Solving – Creativity methods – Theory of Inventive Problem Solving (TRIZ) - product Design Specifications– Conceptual design – Decision Theory – Decision Tree – Evaluation methods - Embodiment Design – Product Architecture Configuration Design - Parametric Design – Role of models in designs - Mathematical Modeling – Simulation – Geometric Modeling – Finite Element Modeling – Optimization – Search Methods – Geometric Programming – Structural and Shape Optimization.

UNIT 3 MATERIAL SELECTION PROCESSING AND DESIGN 9 Hrs.

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

UNIT 4 PROBABILITY CONCEPTS IN DESIGN FOR RELIABILITY 9 Hrs.

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

UNIT 5 LEGAL AND ETHICAL ISSUES IN DESIGN AND QUALITY ENGINEERING 9 Hrs.

Introduction – The origin of laws – Contracts – Liability – Tort law – Product liability – Protecting intellectual property – Legal and ethical domains – Codes of ethics – Solving ethical conflicts– case studies. Total Quality Concept – Quality Assurance – Statistics Process Control – Taguchi Methods – Robust Design – Failure Model Effect Analysis.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Define and illustrate the basic concepts of Design.
CO2 - Understand and apply the design methods for product design and optimization.
CO3 - Selection of material for design and integrate with the manufacturing process
CO4 - Apply the principles of design for manufacture and assembly
CO5 - Apply the probability concepts in Design of Experiments and Design for Reliability
CO6 - Exposure of legal and ethical issue in design and quality.

TEXT / REFERENCE BOOKS

1. Dieter, George E., "Engineering Design - A Materials and Processing Approach", McGraw Hill, 2017.
2. Karl T. Ulrich and Steven D. Eppinger "Product Design and Development", 7th Edition, McGraw Hill 2020.
3. David G Ullman, "The Mechanical Design Process." McGraw hill Inc Singapore, 2017
4. Ali Jamnia, "Introduction to Product Design and Development for Engineers", 1st Edition, Taylor & Francis, 2018

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**

PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SMEB7003	TRIBOLOGY IN DESIGN	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To develop a solution oriented approach by in depth knowledge of Industrial Tribology.
- To address the underlying concepts, methods and application of Industrial Tribology

UNIT 1 INTRODUCTION 9 Hrs.

Tribology in design, tribology in industry Viscosity, flow of fluids, viscosity and its variation absolute and kinematic viscosity, temperature variation, viscosity index determination of viscosity, different viscometers, Tribological considerations Nature of surfaces and their contact; Physic mechanical properties of surface layer, Geometrical properties of surfaces, methods of studying surfaces; Study of contact of smoothly and rough surfaces

UNIT 2 FRICTION AND WEAR 9 Hrs.

Role of friction and laws of static friction, causes of friction, theories of friction, Laws of rolling friction; Friction of metals and non-metals; Friction measurements. Definition of wear, mechanism of wear, types and measurement of wear, friction affecting wear, Theories of wear; Wear of metals and non-metals.

UNIT 3 LUBRICANTS AND LUBRICATION REGIMES 9 Hrs.

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

UNIT4 HYDRODYNAMIC THEORY OF LUBRICATION 9 Hrs.

Principle of hydrodynamic lubrication, Various theories of lubrication, Petroff's equation, Reynold's equation in two dimensions -Effects of side leakage - Reynolds equation in three dimensions, Friction in sliding bearing, hydro dynamic theory applied to journal bearing, minimum oil film thickness, oil whip and whirl, anti –friction bearing, hydrodynamic thrust bearing

UNIT 5 HYDRODYNAMIC LUBRICATION 9 Hrs.

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

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - To identify the different areas of Industrial Tribology.
CO2 - Develop the knowledge on the surface features and its role on the friction behavior of metals and nonmetals
CO3 - Familiarize the different types of lubricants and lubrication systems in the tribology.
CO4 - Methodology for deciding lubricants and lubrication regimes for different operating conditions.
CO5 - Ability to understand the different types of high pressure contacts and rolling bearings.
CO6 - Use the functions and features of Bearings.

TEXT / REFERENCE BOOKS

1. Rabinowicz.E, "Friction and Wear of materials", John Willey & Sons, UK,1995.

2. Cameron, A. “Basic Lubrication Theory”, Ellis Herward Ltd., UK, 1981.
3. Halling, J. (Editor) – “Principles of Tribology “, Macmillian – 1984
4. Williams J.A. “Engineering Tribology”, Oxford Univ. Press, 1994).
5. Tribology H.G.Phakatkar and R.R.Ghorpade Nirali Publications..
6. G.W.Stachowiak& A.W .Batchelor , Engineering Tribology, Butterworth - Heinemann, UK, 2005
7. S.K.Basu, S.N.Sengupta&B.B.Ahuja ,”Fundamentals of Tribology”, Prentice –Hall of India Pvt Ltd New Delhi, 2005

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**

PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SMEB7004	COMPUTATIONAL FLUID DYNAMICS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To educate students on the fundamentals of Computational Fluid Dynamics
- To involve students to get exposure on different turbulence models
- To help the students on grid generation for different flow problems.

UNIT 1 INTRODUCTION TO CFD & PRINCIPLES OF CONSERVATION 9 Hrs.

CFD Definition, Experimental, Theoretical and Numerical Approach, Historical Background, Applications of CFD, Fundamental principles of conservation, Reynolds transport theorem, Conservation of mass, Navier-Stokes equation, Conservation of Energy, General scalar transport equation

UNIT 2 CLASSIFICATION OF PARTIAL DIFFERENTIAL EQUATIONS 9 Hrs.

Introduction, Physical Classification: Equilibrium Problems & Marching Problems, Mathematical classification of Partial Differential Equation: Elliptic, Parabolic and Hyperbolic partial differential equations

UNIT 3 NUMERICAL SOLUTIONS OF NAVIER-STOKES EQUATIONS 9 Hrs.

Discretization of the Momentum Equation, Stream Function-Vorticity approach and Primitive variable approach, Staggered grid and Collocated grid, SIMPLE Algorithm, SIMPLER Algorithm, SIMPLEC Algorithm, PISO Algorithm

UNIT 4 NUMERICAL GRID GENERATION 9 Hrs.

Definition of Grid, need for grid, Geometric modelling and surface grid, Algebraic grid generation, Automatic generation of unstructured grid, Structured and Unstructured grid, Multi Block grid, Types of grid element, factors affecting the grid.

UNIT 5 TURBULENCE MODELING 9 Hrs.

Introduction to Reynolds Averaged Navier Stokes Modeling, Zero, One and Two equation model

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the underlying theoretical basics of CFD.
CO2 - Illustrate various discretization techniques used to solve PDE.
CO3 - Apply the various discretization methods, solution procedures to solve flow problems.
CO4 - Categorize different numerical techniques used to solve fluid flow problems
CO5 - Understand various turbulence models to solve turbulent flow problems.
CO6 - Differentiate different turbulence models with applications.

TEXT / REFERENCE BOOKS

1. Anderson J.D. (2018), Computational Fluid Dynamics: The Basics with Applications, McGraw-Hill Inc.
2. Anderson, D.A., Tannehill, J.C. and Pletcher, R.H. (2017), Computational Fluid Mechanics and Heat Transfer, Taylor & Francis
3. Versteeg, H. K. and Malalasekara, W. (2017), Introduction to Computational Fluid Dynamics: The Finite Volume Method. Second Edition (Indian Reprint) Pearson Education
4. T. J. Chung, (2018), Computational Fluid Dynamics, Cambridge University Press.
5. S. V. Patankar, (2018), Numerical Heat Transfer and Fluid Flow, McGraw-Hill.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SMEB7005	INDUSTRIAL ROBOTICS AND PROGRAMMING	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the basic concepts associated with the design and functioning and applications of Robots.
- To study about the drives and sensors used in Robots.
- To learn the basics of robot cell design, robot kinematics and robot programming.
- To gain knowledge of application of artificial intelligence and expert systems in robotics.

UNIT 1 ROBOT – INTRODUCTION 9 Hrs.

Robot – Definition, Robot Anatomy – Links and Joints - Co-ordinate Systems, Work Envelope, types and classification, Specifications – Pitch, Yaw, Roll, Joint Notations, Robot Parts and Functions, Need for Robots, Robot Applications. Robot Kinematics - Forward Kinematics, Inverse Kinematics and Differences; Forward Kinematics and Reverse Kinematics of Manipulators with Two, Three Degrees of Freedom, Four Degrees of Freedom, Homogeneous transformations - Robot Dynamics – Derivations and Problems.

UNIT 2 ROBOT DRIVE SYSTEMS AND END EFFECTORS 9 Hrs.

Pneumatic Drives, Hydraulic Drives, Mechanical Drives, Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications and Comparison of Drives, End Effectors, Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

UNIT 3 SENSORS AND MACHINE VISION SYSTEM 9 Hrs.

Requirements of a sensor, Principles and Applications of the following types of sensors – Position sensors, Range Sensors, Proximity Sensors, Touch Sensors, Wrist Sensors, Compliance Sensors and Slip Sensors. Machine vision System - Image Processing and Analysis – Data Reduction: Edge detection, Segmentation Feature Extraction and Object Recognition - Algorithms. Applications of machine vision.

UNIT 4 ROBOT WORK CELL DESIGN AND ECONOMIC ANALYSIS 9 Hrs.

Robot work cell design and control, Safety in Robotics, Robot cell layouts – Multiple Robots and machine interference, Robot cycle time analysis, Economic Analysis of Robots – Pay back Method, Equivalent Uniform Annual Cost (EUAC) Method, Rate of Return Method.

UNIT 5 ROBOT PROGRAMMING AND APPLICATIONS 9 Hrs.

Introduction, Various Programming Methods - Teach Pendant Programming, Lead through programming, Robot programming Languages –VAL II, RAIL and their Features. Programming – Motion Commands, Sensor Commands, End effectors commands, Motion Interpolation, WAIT, SIGNAL & DELAY Commands, Branching, Robot Language Structure and Simple Programming Examples such as Palletizing, Loading a Machine etc., Industrial application of robots, Artificial Techniques-reduction and solution techniques.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Calculate the forward kinematics, inverse kinematics for serial and parallel robots.

CO2 - Analyze the manipulator design including actuator, drive and sensor issues.

CO3 - Identify different types of end effectors and sensors required for specific applications.

CO4 - Discuss various applications of industrial robot systems.

CO5 - Develop programming principles and languages for a robot control system.

CO6 - Develop a robot for simple industrial applications and to program the robot to have controlled motion.

TEXT / REFERENCE BOOKS

1. Groover, M.P. “Industrial Robotics – Technology, Programming and Applications”, McGraw-Hill, 2001.
2. Fu.K.S. Gonzalz.R.C., and Lee C.S.G., “Robotics Control, Sensing, Vision and Intelligence”, McGraw-Hill Book Co., 1987.
3. Yoram Koren, “Robotics for Engineers”, McGraw-Hill Book Co., 1992.
4. Janakiraman.P.A., “Robotics and Image Processing”, Tata McGraw-Hill, 1995.
5. Timothy Jordanides et al,” Expert Systems and Robotics “, Springer –Verlag, New York, May 1991.
6. Richard D. Klafter et al, “Robotic Engineering -an Integrated Approach”, PHI.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SMEB7006	REVERSE ENGINEERING	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the Reverse Engineering (RE) Methodology.
- To understand Computer-Aided RE.
- To understand RE applications in software engineering.
- To impart knowledge to the students about the need for and the various tools required for reverse engineering with exposure to the software needed for implementing reverse engineering.
- The course will illustrate the most recent findings concerning Reverse Engineering.
- Students will achieve first a global understanding of product development processes.

UNIT 1 INTRODUCTION 9 Hrs.

Need of reverse engineering, Methodologies for Reverse Engineering, understanding of Reverse Engineering through example, reasons for reverse engineering, process for Reverse Engineering, Phases of Reverse Engineering, conceptual System Reasons for Reverse Engineering, Difficulties in Reverse Engineering, Levels of abstraction: Application level, Functional level, Structural level]

UNIT 2 RAPID PRODUCT 9 Hrs.

Rapid Product Development - As Overview virtual prototyping and testing technology, Physical Prototyping and Rapid Manufacturing technologies and Synergic Integration Technologies.

UNIT 3 DESIGN PROTOTYPE 9 Hrs.

Physical Prototyping and Rapid Manufacturing Computer Numerical Control: Comparison between NC and conventional machines, features of CNC Machine Tool and programming Robotics: classification, programming, sensors and applications Computer Aided Process Planning: Methodology, evaluation, types, CAD/CAM Integration and CAPP Features

UNIT 4 REVERSE ENGINEERING 9 Hrs.

Basic concept, Digitization techniques, Model Reconstruction, Data Processing for Rapid Prototyping, Reverse Engineering (RE)Methodologies and Techniques, Selection of RE systems, RE software hardware, RE in product development.

UNIT 5 RE APPLICATIONS 9 Hrs.

Design, Engineering Analysis and planning applications, Rapid Tooling, Reverse Engineering, Medical Applications of RP.Rapid Prototyping and Rapid Tooling:Methods, Stereo lithography, Fused-deposition modeling, Selective laser sintering, Laminated-object manufacturing, Ballistic particle manufacturing, Solid base curing and Direct manufacturing and rapid tooling.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Recall the fundamentals and control theory of automation systems.
CO2 - Understand the basics components, such as Design, Manufacturing and advanced techniques
CO3 - Examine various automations systems and techniques used for machine tools and quality.
CO4 - Implement Analyze a framework for robust system and process design.
CO5 - Disassemble products and specify the interactions between its subsystems and their functionality
CO6 - Analysis the Computer-Aided RE and Rapid Prototyping Technology

TEXT / REFERENCE BOOKS

1. Chua C K, Leong K F, Chu S L, “Rapid Prototyping: Principles and Applications inManufacturing”, World Scientific.2018.
2. Noorani R, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley &Sons.", 2017.
3. Manufacturing Processes for Engineering Materials SeropeKalpakjion and Steven R. Schmid-Pearson Education., 2021.
4. Reverse Engineering, Wills, Linda M., Newcomb, Philip (Eds.), Springer., 2021.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**

PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SMEB7007	CONCURRENT ENGINEERING	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To have knowledge about Information Technology and Design in Concurrent Engineering.
- To understand the Manufacturing concept and Management related to Concurrent Engineering.
- To familiarize with the basics of concurrent engineering.
- The tools and methodologies available in CE.

UNIT 1 INTRODUCTION TO CONCURRENT ENGINEERING 9 Hrs.

Idealized model for Integrated Product Development, Integration between project andmanagement, Integration with other development activities, understanding the IPD model,Validity of the IPD model. Extensive definition of CE - CE design methodologies - Organizing for CE - CE tool box collaborative product development.

UNIT 2 USE OF INFORMATION TECHNOLOGY 9 Hrs.

IT support - Solid modeling - Product data management - Collaborative product commerce - Artificial Intelligence – Expert systems - Software hardware co-design.

UNIT 3 DESIGN STAGE 9 Hrs.

Life-cycle design of products - opportunity for manufacturing enterprises - modality of Concurrent Engineering Design - Automated analysis idealization control - Concurrent engineering in optimal structural design - Real time constraints. Advanced LSS (Lean Six-sigma). Inefficient end-to-end processes

UNIT 4 MANUFACTURING CONCEPTS AND ANALYSIS 9 Hrs.

Manufacturing competitiveness - Checking the design process - conceptual design mechanism - Qualitative physical approach - An intelligent design for manufacturing system - JIT system - low inventory – modular. Rapid Prototyping: Need and use of RP, various RP technologies, Design for Reliability: Reliability fundamentals and design for reliability principles, Design for Serviceability: Factors affecting serviceability, serviceability evaluation, Design for Maintainability and Economics.

UNIT 5 PROJECT MANAGEMENT 9 Hrs.

Life Cycle semi realization - design for economics - evaluation of design for manufacturing cost - concurrent mechanical design - decomposition in concurrent design - negotiation in concurrent engineering design studies - product realization taxonomy - plan for Project Management on new product development - bottleneck technology development.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Design and implement a product development program.
CO2 - Analyze and demonstrate knowledge of computer-aided tolerance analysis.
CO3 - Evaluate appropriate rapid manufacturing modelling techniques.
CO4 - Implement Analyze a framework for robust system and process design.
CO5 - Recall the management and engineering philosophy for improving quality and reducing costs and lead time.
CO6 - Recognize the importance of current industry sequential practices.

TEXT / REFERENCE BOOKS

1. William B. Bonvillian, Peter L. Singer,"Advanced Manufacturing"., 2018.
2. Ramy Harik, Thorsten Wuest, "Introduction to Advanced Manufacturing", 2019.
3. Dilshad Ahmad Khan,, "Magnetic Field Assisted Finishing", CRC Press., 2021.
4. DyutiSarker,, "Metal Additive Manufacturing", Wiley., 2021.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**

PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SMEB7008	MANUFACTURING INFORMATION SYSTEMS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the various procedures involved in the Manufacturing Database Design Process based on strength requirements.
- To provide an importance of databases and its application in manufacturing systems that prepare students for their engineering practice by organization by conversant with order policies, data base terminologies, designing, manufacturing considerations.

UNIT 1 INTRODUCTION 9 Hrs.

The Evolution of order policies, From MRP I, MRP II, MRP III to ERP – Agile Manufacturing Information Systems, Manufacturing Database Integration.

UNIT 2 DATABASE 9 Hrs.

Data modelling for a database, records and files, abstraction and data integration. Three level architecture for DBMS, Components of DBMS, Advantages and disadvantages of DBMS. Terminologies – Entities and attributes – Data models, schema and subschema - Data Independence – ER Diagram – UML notation for describing the enterprise–wide data objects Trends in database, Team center Introduction.

UNIT 3 DESIGNING DATABASE 9 Hrs.

Hierarchical model – Network approach- Relational Database concepts, principles, keys,– functional dependency – Normalization types – relational operations- Query Languages-Case studies.

UNIT 4 MANUFACTURING CONSIDERATION 9 Hrs.

The product and its structure, inventory and process flow – Shop floor control Data structure and procedure – various models – the order scheduling module, Input/output analysis module, and stock status database – the complete IOM database – Case studies.

UNIT 5 INFORMATION SYSTEM FOR MANUFACTURING 9 Hrs.

Parts oriented production information system – concepts and structure – Computerized production scheduling, online production control systems, Computer based production m a n agreement system, computerized manufacturing information system -RFID-Telecommunication– case study.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Explain how information systems transform to data base integration.
CO2 - Identify the impact information systems have on an organization.
CO3 - Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making.
CO4 - Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses.
CO5 - Analysis the process and evaluate the role of each process parameter during machining of various advanced materials.
CO6 - Understand requirements to achieve the best quality of machined surface while machining various engineering materials.

TEXT / REFERENCES BOOKS

1. Date, C.J., "An Introduction to Database Systems" Addison Wesley", 8th Edition, 2003.
2. Oliver, G. and Wolfhard, K., "RFID in Manufacturing", Kubach.vwe.,2008.
3. Franjo, C., "Manufacturing Information & Data Systems Analysis, Design & Practice", Butterworth - Heinemann, 2002.
4. Weiming S, "Information Technology for Balanced Manufacturing Systems", Springer, 2006.
5. www.ist.psu.edu.
6. www.cse.wustl.edu (UML Notation Guide).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**

PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SMEB7009	ADVANCED COMPOSITE MATERIALS AND MECHANICS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To introduce the fundamental concepts of composite materials
- To understand the mechanics of composite materials at different length scales
- To study the various failure modes and mechanisms in composite materials
- To learn the manufacturing techniques and quality control of composite materials
- To apply the knowledge of composite materials to real-world engineering problems

UNIT 1 INTRODUCTION TO COMPOSITE MATERIALS 9 Hrs.

Overview of composite materials, Types of composite materials and their properties, Constituent materials and their properties, Manufacturing processes of composite materials, Applications of composite materials.

UNIT2 MICROMECHANICS OF COMPOSITE MATERIALS 9 Hrs.

Stress and strain analysis of composites, Elastic properties of composite materials, Failure criteria for composite materials, Micromechanical modeling of composite materials, Homogenization techniques for composite materials.

UNIT 3 MACROMECHANICS OF COMPOSITE MATERIALS 9 Hrs.

Laminate theory, Classical plate theory, Finite element analysis of composite materials, Structural behavior of composite materials under different loading conditions, Delamination and interlaminar stresses in composite materials.

UNIT 4 ADVANCED TOPICS IN COMPOSITE MATERIALS 9 Hrs.

Nanocomposites, Functionally graded materials, Self-healing composites, Bio composites, Composite materials for aerospace applications

UNIT 5 MANUFACTURING AND TESTING OF COMPOSITE MATERIALS 9 Hrs.

Design of composite materials, Manufacturing processes for composites, Quality control and inspection of composite materials, Mechanical and physical testing of composite materials, Nondestructive testing of composite materials

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Ability to describe the properties and characteristics of composite materials
CO2 - Ability to analyze the stress and strain behavior of composite materials
CO3 - Ability to determine the elastic properties of composite materials
CO4 - Ability to design and manufacture composite materials for specific engineering applications
CO5 - Ability to analyze the performance of composite materials in various engineering applications
CO6 - Ability to communicate effectively about composite materials in written and oral forms.

TEXT / REFERENCE BOOKS

1. "Composite Materials: Science and Applications" by Deborah D. L. Chung (2017, Springer)
2. "Mechanics of Composite Structures" by László P. Kollár and George S. Springer (2016, Cambridge University Press)
3. "Design and Analysis of Composite Structures: With Applications to Aerospace Structures" by Christos Kassapoglou (2017, Wiley)
4. "Advanced Composites in Bridge Construction and Repair" edited by Yail Jimmy Kim (2015, Woodhead Publishing)
5. "Advances in Characterization and Analysis of Expansive Soils and Rocks" edited by BuddhimaIndraratna, Jian Chu, and Cholachat Rujikiat kamjorn (2018, Springer)
6. "Manufacturing Technology for Aerospace Structural Materials" edited by Flake C. Campbell Jr. and Mark J. Schulz (2017, Elsevier)
7. "Fatigue of Composite Materials" by Anastasios P. Vassilopoulos (2019, Woodhead Publishing)
8. "Multiscale Analysis of Deformation and Failure of Materials" edited by Zdeněk P. Bažant and Luigi Cedolin (2016, Wiley)
9. "Environmental Effects on Structural Materials and Lifetime Behavior" edited by Adelia J. A. Aquino, Victor M. F. Barros, and Diogo M. Camacho (2019, Springer)
10. "Nanomaterials in Advanced Composites: Synthesis, Properties and Applications" edited by Liangbing Hu and Luyi Sun (2019, Elsevier)

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SMEB7010	SMART MATERIAL AND APPLICATIONS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To introduce students to the fundamental principles and characteristics of smart materials.
- To provide an overview of the types of smart materials and their applications.
- To teach students about the design, fabrication, and characterization of smart materials and devices.
- To explore the limitations and challenges in using smart materials in real-world applications.
- To familiarize students with the latest research and developments in the field of smart materials and applications.

UNIT 1 INTRODUCTION TO SMART MATERIALS 9 Hrs.

Overview of smart materials and their applications, Types of smart materials (piezoelectric, shape memory, magnetostrictive, etc., Basic properties and characteristics of smart materials, Design considerations and limitations of smart materials.

UNIT 2 PIEZOELECTRIC MATERIALS AND APPLICATIONS 9 Hrs.

Introduction to piezoelectricity and piezoelectric materials, Properties and characteristics of piezoelectric materials, Applications of piezoelectric materials (sensors, actuators, energy harvesting, etc.), Design and fabrication of piezoelectric devices.

UNIT 3 SHAPE MEMORY ALLOYS AND APPLICATIONS 9 Hrs.

Introduction to shape memory alloys (SMAs), Properties and characteristics of SMAs, Applications of SMAs (actuators, medical devices, aerospace, etc.), Design and fabrication of SMA devices.

UNIT 4 MAGNETOSTRICTIVE MATERIALS AND APPLICATIONS 9 Hrs.

Introduction to magnetostriction and magnetostrictive materials, Properties and characteristics of magnetostrictive materials, Applications of magnetostrictive materials (sensors, actuators, etc.), Design and fabrication of magnetostrictive devices.

UNIT 5 OTHER SMART MATERIALS AND APPLICATIONS 9 Hrs.

Overview of other types of smart materials (electrochromic, thermochromic, etc.), Properties and characteristics of other smart materials, Applications of other smart materials (energy efficiency, automotive, etc.), Design and fabrication of devices using other smart materials.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Ability to Understand the basic principles and properties of different types of smart materials.
CO2 - Ability to Identify and analyze the various applications of smart materials in different fields.
CO3 - Ability to Design, fabricate, and characterize smart materials and devices.
CO4 - Ability to Evaluate the limitations and challenges in using smart materials in real-world applications.
CO5 - Ability to Analyze and interpret research papers and scientific literature related to smart materials and applications.
CO6 - Ability to Apply knowledge of smart materials to solve real-world problems in a variety of fields such as engineering, healthcare, and environmental monitoring.

TEXT / REFERENCE BOOKS

1. "Smart Materials-Based Actuators at the Micro/Nano-Scale: Characterization, Control, and Applications" edited by Mojtaba Ahmadi and Mohammad Elahinia (2015, Springer)
2. "Smart Materials for Advanced Environmental Applications" edited by Wenbin Cao, Weichang Hao, and Bo Li (2016, Wiley)
3. "Advances in Smart Medical Textiles: Treatments and Health Monitoring" edited by Lieva Van Langenhove and Sundaresan Jayaraman (2015, Woodhead Publishing)
4. "Smart Materials for Energy, Communications and Security" edited by Azlinah Mohamed and Hasimah Ali (2016, Springer)
5. "Emerging Trends in Smart Materials and Structural Systems: Proceedings of the 5th ECCOMAS Thematic Conference on Smart Structures and Materials" edited by Francisco J. F. Caetano and J. N. T. Silva (2019, Springer)
6. "Smart Materials and Structures: New Research" edited by Sergio P. Santos and Fernanda M. Araújo (2018, Nova Science Publishers)
7. "Smart Materials for Tissue Engineering: Fundamental Principles" edited by Qun Wang (2016, Elsevier)
8. "Smart Materials and Structures in Aerospace Applications" edited by Ashok B. M. Kumar and Ramesh K. Agarwal (2017, CRC Press)
9. "Smart Materials and Structures for the Architecture and Civil Engineering Fields" edited by Ana Maria M. F. de Oliveira and Hugo A. M. Santos (2017, Springer)
10. "Smart Materials in Civil Engineering" edited by Huiming Tang and Xilin Lu (2020, Elsevier)

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**

PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SMEB7011	INDUSTRIAL SAFETY ENGINEERING	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the safety functions and safety audit.
- To understand the types of operational safety like hot metal operation and gold metal operation.
- To understand the safety consideration with health, Welfare Act.
- To learn the safety performance monitoring and management techniques

UNIT 1 INTRODUCTION TO INDUSTRY 9 Hrs.

Evaluation of modern safety concepts - Safety management functions - safety organization, safety department - safety committee, safety audit - performance measurements and motivation - employee participation in safety - safety and productivity, Methods of promoting safe practice –OSHA – Safety controls, safety training.

UNIT 2 OPERATIONAL SAFETY 9 Hrs.

Hot metal operation – safety in Cutting – safety in welding – safety in Boilers- Pressure vessels – Furnace (all types) - Heat treatment processes shops – electroplating – grinding – forming processes- rolling – forging - surface hardening – casting – Moulding – coiling. Operational safety (cold metal operation), Safety in Machine shop - Cold bending and chamfering of pipes - metal cutting - shot blasting, grinding, painting - power press and other machines.

UNIT 3 SAFETY, HEALTH, WELFARE AND LAW 9 Hrs.

Features of Factory Act – explosive Act – boiler Act – ESI Act – workman's compensation Act – industrial hygiene – occupational safety – diseases prevention – ergonomics - Occupational diseases, stress, fatigue - Health, safety and the physical environment - History of legislations related to Safety-pressure vessel act-Indian boiler act - The environmental protection act - Electricity act - Explosive act.

UNIT 4 PERSONAL PROTECTIVE EQUIPMENT 9 Hrs.

Introduction, Selectivity of PPE, Protective Equipment for Eyes, Types, Protection of Face, Eye, Arms, Hands, Fingers, Foot, Legs, Head, Ears and Respiration System, Safety Belt for Industrial Operation.

UNIT 5 SAFETY PERFORMANCE AND MANAGEMENT 9 Hrs.

Permanent total disabilities, permanent partial disabilities, temporary total disabilities -Calculation of accident indices, frequency rate, severity rate, frequency severity-incidence, incident rate, accident rate, safety "t" score, safety activity rate. Case study roll of management and roll of Govt. in industrial safety - safety analysis Industrial fatigue- role of industrial psychology- risk analysis - accident and near miss investigations- promotional measures to avoid accidents - human reliability - safety management characteristics-industrial safety policies and implementation

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the safety audit committee and management functions.
CO2 - Evaluate the modern safety concepts, measurements and motivations.
CO3 - Obtain knowledge on different types of operational safety in hot metal and cold metal working process,
CO4 - Analyze function and uses of the personal protective equipment's. .
CO5 - Examine the safety performance monitoring and evaluations of accident rate.
CO6 - Analyze and implementing management techniques.

TEXT / REFERENCE BOOKS

1. R.K.Jain, Industrial safety, Health and Environmental Management System, Khanna Publishers, First reprint, 2017.
2. Deshmukh, Industrial Safety Management, Tata McGraw Hill, New edition, 2017.
3. Thomas D. Schneid, Legal Liabilities in Safety and Loss Prevention, CRC Press, 3rd Edition, 2019.
4. Roy Asfatil C, David W Rieske, Industrial safety and Health Management, Pearson, 7th Edition, 2018.
5. Joseph F. Gustin, Safety Management: A Guide for facility Management, River Publisher, 2008

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SMEB7012	COST MANAGEMENT OF ENGINEERING PROJECTS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To en light the knowledge in Cost Management process and Costing System.
- To discuss the concepts of Project Management, pricing, and cost control

UNIT 1 INTRODUCTION TO COSTING 9 Hrs.

Introduction and Overview of the Strategic Cost Management Process, Cost concepts in decision-making; relevant cost, Differential cost, Incremental cost, Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

UNIT 2 INTRODUCTION TO PROJECT MANAGEMENT 9 Hrs.

Objectives of Project Management- Importance of Project Management- Types of Projects Project Management Life Cycle, Project Selection – Feasibility study: Types of feasibility Steps in feasibility study, Project Scope- Estimation of Project cost – Cost of Capital – Project Representation and Preliminary Manipulations - Basic Scheduling Concepts - Resource Leveling – Resource Allocation.

UNIT 3 PRICING 9 Hrs.

Determinants of price – Pricing under different objectives – Pricing under different market structures – Price discrimination – Pricing of Joint products – Pricing methods in practice.

UNIT 4 PRODUCTION COST ANALYSIS 9 Hrs.

Production Analysis – Production function, Returns to a factor, Returns to scale, ISO quants and Least cost combination of inputs. Cost Analysis – Cost concepts, Determinants of cost, Short-run cost-output Relationship, Long-run cost output relationship, Economies and Dis-economies of scale and Estimating cost – Output Relationship.

UNIT 5 COST ESTIMATION 9 Hrs.

Introduction to Estimation and Costing – Elements of costs – Allocation of overheads – Estimation of Material cost – Estimation of Labour cost,-Estimation in Machine shop – Estimation in Sheet metal shop – Estimation in Forging shop – Estimation in welding shop – Estimation in Foundry shops.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Explain the concept of costing, types, objectives and functions of cost management.
CO2 - Discuss the functions of project management.
CO3 - Apply project management principles in business situations to optimize time and resource utilization.
CO4 - Evaluate the principles of micro economics and cost estimation.
CO5 - Apply these principles to appreciate the functioning of product and input market as well as the economy.
CO6 - Analyse the structure of cost analysis.

TEXT / REFERENCE BOOKS

1. Arun Kanda, “Project Management A Life Cycle Approach”, Prentice Hall of India, 2018
2. R.B.Khanna, “Project Management”, Prentice Hall of India, 2011
3. R.Panneerselvam and P.Senthilkumar, “Project Management”, Prentice Hall of India, 2019
4. T.R.Banga and S.C.Sharma, Mechanical Estimating and Costing, Khanna Publishers, 2008
5. V.L.Mote, Samuel Paul and G.S.Gupta, Managerial Economics – concepts and cases, TMH, 40th reprint 2017

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**

PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SMEB7013	APPLICATIONS OF ROBUST DESIGN	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To impart knowledge about Design of Experiments, Taguchi's Methods and Robust Design.

UNIT 1 INTRODUCTION 9 Hrs.

Importance of experiments, experimental strategies, Planning of Experiments- Experimental design-basic principles of Experimental design, terminology, steps in experimentation, sample size, normal probability plot, Simple linear regression models, Analysis of variance (ANOVA) – one way and two way.

UNIT 2 SINGLE FACTOR EXPERIMENTS 9 Hrs.

Completely randomized design, Randomized block design, Latin square design, Statistical analysis and estimation of model parameters, model adequacy checking, pair wise comparison tests.

UNIT 3 MULTIFACTOR EXPERIMENTS 9 Hrs.

Two and three factor full factorial experiments, Randomized block factorial design, Experiments with random factors, rules for expected mean squares, approximate F- tests. 2K factorial Experiments.

UNIT 4 ROBUST DESIGN PROCESS 9 Hrs.

Classical design of Experiments- Taguchi's design of experiments –Comparison of classical and Taguchi' approach- Factor selection-variability due to noise factors- Principle of robustization, classification of quality characteristics and parameters, objective function in robust design, S/N ratios.

UNIT 5 TAGUCHI METHODS AND PRODUCT / PROCESS OPTIMIZATION 9 Hrs.

Orthogonal Arrays, Variable data analysis, Robust design- control and noise factors, S/N ratios, parameter design, Multi-level experiments, Inner and outer OA experiments, Optimization using S/N ratios, attribute date analysis, a critique of robust design.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the basic framework of Design of Experiments.
CO2 - Examine the various research design and techniques.
CO3 - Get knowledge on Full Factorial for research data analysis.
CO4 - Get knowledge on Taguchi Design and their significance.
CO5 - Get ability to utilize the Minitab Software Tools to enhance the value of the data analysis.
CO6 - Recognize various steps in Orthogonal Array Experiments

TEXT / REFERENCEBOOKS

1. Krishnaiah, K. and Shahabudeen, P. Applied Design of Experiments and Taguchi Methods, PHI learning private Ltd., 2016.
2. Montgomery, D.C., Design and Analysis of experiments, John Wiley and Sons, Eighth edition, 2018.
3. Nicolo Belavendram, Quality by Design; Taguchi techniques for industrial experimentation, Prentice Hall, 1995.
4. Phillip J.Rose, Taguchi techniques for quality engineering, McGraw Hill, 2018.
5. Montgomery, D.C., Design and Analysis of Experiments, Minitab Manual, John Wiley and Sons, Seventh edition, 2016.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**

PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SMEB7014	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- Acquire knowledge about the Artificial Intelligence
- Acquire knowledge about Machine Learning
- Acquire knowledge about application of Artificial Intelligence and Machine Learning

UNIT 1 INTRODUCTION TO ARTIFICIAL INTELLIGENCE 9 Hrs.

Introduction – Foundations of AI – History of AI – Intelligent agent – Types of agents - Structure – Problem solving agents – Uninformed search strategies – Breadth first search – Uniform cost search – Depth first search – Depth limited search – Bidirectional search – Searching with partial Information.

UNIT 2 INFORMED SEARCH AND GAME PLAYING 9 Hrs.

Informed search – Strategies – A* Heuristic function – Hill Climbing – Simulated Annealing – Constraint Specification problem – Local Search in continuous space – Genetic algorithm – Optimal decisions in games - Pruning – Imperfect decisions –Alpha-Beta pruning – Games that include an element of chance.

UNIT 3 INTRODUCTION TO MACHINE LEARNING 9 Hrs.

Machine learning - examples of machine learning applications - Learning associations - Classification - Regression - Unsupervised learning - Supervised Learning - Learning class from examples - PAC learning -Noise, model selection and generalization - Dimension of supervised machine learning algorithm.

UNIT 4 DECISION THEORY 9 Hrs.

Bayesian Decision Theory- Introduction- Classification - Discriminant function-Bayesian networks-Association rule - Parametric Methods - Introduction - Estimation –Multivariate methods-Data Parameter estimation–Dimensionality Reduction PCA-Linear discriminant analysis.

UNIT 5 APPLICATION OFARTIFICIAL INTELLIGENCE AND MACHINE LEARNING 9 Hrs.

AI applications – Language Models – Information Retrieval- Information Extraction – Natural Language Processing –Machine Translation – Speech Recognition – Robot – Hardware – Perception – Planning – Moving, Flexible manufacturing based on autonomous system, Industrial automation process, AI and ML based Case study

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the concept of Artificial Intelligence and Machine Learning.
CO2 - Explain the use of informed search and game playing.
CO3 - Select an appropriate AI and ML tools for a process.
CO4 - Apply the knowledge of Decision theory
CO5 - Develop an application based program using AI and ML
CO6 - Design and develop a project based on AI and ML

TEXT / REFERENCE BOOKS

1. Stuart J.Russel, Peter Norvig, “Artificial Intelligence A Modern Approach”, 3rdEdition, Pearson Education, 2009.
2. Elaine Rich, Kevin Knight, “Artificial Intelligence", 3rd Edition, Tata McGraw Hill, 2009.
3. M. Tim Jones, “Artificial Intelligence: A Systems Approach (Computer Science)”, Jones and Bartlett Publishers, Inc., First Edition, 2008.
4. EthemAlpaydin, “Introduction to Machine Learning”, MIT Press, 2004.
5. Tom Mitchell, “Machine Learning”, McGraw Hill, 1997.
6. Shai Shalev-Shwartz and Shai Ben-David, “Understanding Machine Learning: From Theory to Algorithms”,Cambridge University Press, 2014.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**

PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SMEB8001	OPTIMIZATION TECHNIQUES IN DESIGN	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSEOBJECTIVES

- To apply the concepts of optimization in design problems.
- To enable the students to use the concepts of non-traditional optimization techniques in Engineering Design.
- To enable to model engineering minima/maxima problems as optimization problems.
- To enable to use MATLAB to implement optimization algorithms.

UNIT 1 INTRODUCTION TO OPTIMIZATION 9 Hrs.

Engineering Applications of Optimization - Classification of Optimization Problems - Applications of Linear Programming – Problem Formulation-Standard Form of a Linear Programming Problem -Geometry of Linear Programming Problems- Solution by Simplex method- Sensitivity Analysis- Applications of Computer Software used in Optimization problems at industrial level.

UNIT 2 MINIMIZATION METHODS 9 Hrs.

Introduction - Unimodal Function –Elimination Methods - Unrestricted Search - Search with Fixed Step Size - Search with Accelerated Step Size - Exhaustive Search - Dichotomous Search- Interval Halving Method - Fibonacci Method - Golden Section method - Comparison of Elimination Methods.

UNIT 3 DECISION ANALYSIS 9 Hrs.

Decision Trees, Utility theory, Multi Objective Optimization, MCDM - Analytic Hierarchy Process (AHP), Analytic Network Process (ANP), Dynamic Programming - Multistage Decision Processes.

UNIT4 UNCONSTRAINED OPTIMIZATION METHODS 9 Hrs.

Multi variable unconstrained optimization techniques: Direct search methods: Random search method univariate method, pattern search method, rosenbrock's method of rotating coordinate, steepest descent method and Conjugate gradient method.

UNIT 5 HEURISTIC ALGORITHM 9 Hrs.

Genetic Algorithms, Simulated Annealing, Neural Network, Optimization using fuzzy systems, Tabu Search and Scatter Search, Ant colony algorithm, Multi Response optimization - Gray Relational Analysis. Industrial application based course project (Modeling or Simulation or Experimental).

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Feasibility study for solving an optimization problem.
CO2 - Evaluate and measure the performance of an algorithm.
CO3 - Understand optimization techniques using algorithms.
CO4 - To design algorithms, the repetitive use of which will lead reliably to finding an approximate solution.
CO5 - Describe clearly a problem, identify its parts and analyze the individual functions.
CO6 - Investigate, study, develop, organize and promote innovative solutions for various applications.

TEXT / REFERENCEBOOKS

1. Rao, Singaresu, S., "Engineering Optimization – Theory & Practice", New Age International (P) Limited, New Delhi, 2018.
2. Kalyanmoy Deb, "Optimization for Engineering Design: Algorithms and Examples", Prentice-Hall of India Private Limited, 2005.
3. Kalyanmoy Deb, "Multi-Objective Optimization Using Evolutionary Algorithms", Wiley, 2009.
4. Lihui Wang, Amos H. C. Ng, Kalyonmoy Deb, "Multi-Objective Evolutionary Optimisation for Product Design and Manufacturing", Springer-Verlag London Limited, 2011.
5. Ravindran – Phillips –Solberg, "Operations Research – Principles and Practice", John Wiley India, 2006.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**

PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SMEB8002	INDUSTRY 4.0 , 5.0 TECHNOLOGIES AND APPLICATIONS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand different contributing technologies that enable industry 4.0 and 5.0.
- To make aware of how the industry 4.0 and 5.0 technologies can be applied to diverse applications.

UNIT 1 INTRODUCTION TO INDUSTRY 4.0 AND 5.0 9 Hrs.

History of industrial revolutions, Industry 4.0: Definition, core values, contributing technologies, and challenges. Industry 5.0: Definition, core values, contributing technologies, and challenges.

UNIT 2 CONTRIBUTING TECHNOLOGIES TO INDUSTRY 4.0 9 Hrs.

Industrial internet of things, 5G, Smart sensors, Digital twins and simulations, Augmented reality, Virtual Reality, Computer vision systems, Robotics and automation, 3D Printing, Cloud computing, Cyber security, and Big data analytics.

UNIT 3 INDUSTRY 4.0 FOR DESIGN, MANUFACTURING & FACTORY OPERATIONS 9 Hrs.

Cyber-physical systems, Product development: AR/VR enabled CAD, Customized CAD, Cloud based CAD, Digital twin and live simulation, and Additive manufacturing. Smart Manufacturing: Digital manufacturing, Cloud based manufacturing, IoT based manufacturing, Advanced CNC machines and programming, and Micro electro mechanical systems.

UNIT 4 ADDITIONAL CONTRIBUTING TECHNOLOGIES TO INDUSTRY 5.0 9 Hrs.

Extended reality, Cobots and exoskeletons, Smart sensors and bio-based technologies, Artificial intelligence and machine learning, Enhanced additive manufacturing (4D printing), Cloud, cognitive and edge computing, 6G and beyond, Internet of everything, Industrial block chain, Network slicing, Private mobile networks, and Individualized human-machine interaction technologies, Autonomous Vehicles like self-propelled vehicles, drones, and unmanned vehicles.

UNIT 5 INDUSTRY 5.0 FOR MASS PERSONALIZATION, SOCIETY 5.0 AND SDGs 9 Hrs.

Realization of sustainable development goals (SDGs), Society 5.0, and Mass personalization with industry 5.0 technologies, Focus on customer experiences, Hyper-customization, Responsive and distributed supply chain management, Interactive products, Human cyber-physical systems, Collaborative production,

Case Studies: Case studies on the diverse applications of Industry 4.0 and Industry 5.0 like transportation, energy, infrastructure, factory operations, logistics, autonomous mobility, product design, smart cities, smart nation, clean environment, etc.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Explain the core values, contributing technologies, and challenges of industry 4.0 and 5.0.

CO2 - Justify how different technologies contribute to industry 4.0.

CO3 - Recommend the industry 4.0 technologies to product design, manufacturing, and factory operations.

CO4 - Justify how different technologies contribute to industry 5.0.

CO5 - Recommend industry 5.0 contributing technologies to realize SDGs, Society 5.0 and mass personalization.

CO6 - Prepare a report with the current trends, what industry 4.0 and/or 5.0 technologies can help make these operations smarter, and the benefits and challenges of their implementation for the given case study/ application.

TEXT / REFERENCE BOOKS

1. Uthayan Elangovan, “Industry 5.0: The Future of the Industrial Economy”, CRC Press, 2021.
2. Mahmoud Numan Bakkar and Elspeth McKay, "Advanced Research and Real-World Applications of Industry 5.0", IGI Global Publisher, 2023.
3. Klaus Schwab, “Fourth Industrial Revolution”, Random House USA Inc, New York, USA,2017.
4. Jean-Claude André, “Industry 4.0: Paradoxes and Conflicts”, Wiley Publications, 2019.
5. Oliver Grunow, “Smart Factory and Industry 4.0. The current state of Application Technologies”, Study lab Publications,2016
6. Sang C. Suh, U. John Tanik, John N Carbone, and Abdullah Eroglu, “Applied Cyber-Physical Systems”, Springer Publications, New York,2013.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

PART A : 10 Questions of 2 marks each-No choice **20 Marks**

PART B : 2 Questions from each unit with internal choice, each carrying 16 marks **80 Marks**

SMEB8003	QUALITY CONCEPTS IN DESIGN	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the concepts in material selection, design and manufacturing processes.
- To apply various quality tools to improve quality of a product or services
- To implement failure analysis technique to uphold the status of six sigma
- To impart knowledge on statistical tools and design of experiments to develop a robust product or service

UNIT 1 BASICS OF DESIGN AND MATERIAL SELECTION 9 Hrs.

Design Process, Morphology – Role of computer in design and process planning – concept of computer aided engineering, Concurrent Engineering –Bench Marking – Creativity – Theory of Problem solving (TRIZ) – Value Analysis - Design for Manufacture, Assembly, Casting, Metal Forming, Machining and Welding.

UNIT 2 QUALITY DESIGN 9 Hrs.

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

UNIT 3 FAILURE MODE EFFECTIVE ANALYSIS ANDSIX SIGMA DESIGN 9 Hrs.

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

UNIT 4 DESIGN OF EXPERIMENTS 9 Hrs.

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

UNIT 5 STATISTICAL METHODS AND RELIABILITY 9 Hrs.

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

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Explain basics of design process and material selection for making a quality product
CO2 - Apply the quality tools to develop a robust product or service
CO3 - Implement Failure Mode Effective Analysis and six sigma principles on a product to enhance its quality
CO4 - Apply different experimental designs to conduct experiments
CO5 - Analyze the experimental results to identify the predominant control factors
CO6 - Implement various statistical tools to enhance its quality and reliability

TEXT / REFERENCE BOOKS

1. Amitava Mitra,"Fundamentals of Quality control and improvement", John Wiley & Sons, 2017
2. George E.Dieter,LindaC.Schmidt,"EngineeringDesign",McGrawHillEducationPvt.Ltd., 2020
3. Dr. Ali Jamnia, Introduction to Product Design and Development for Engineers,CRC Press, 2018.
4. Richard Morris, The Fundamentals of Product Design, Bloomsbury Academic, 2017.
5. Montgomery, D.C.,"DesignandAnalysisofexperiments",JohnWileyandSons,2017.
6. Madhav Phadke, Quality Engineering Using Robust Design, Phadke Associates, Inc., 2021

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**

PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**