SCHOOL OF ENGINEERING AND TECHNOLOGY

SRI PADMAVATI MAHILA VISVAVIDYALAYAM

(WOMEN'S UNIVERSITY)

Accredited by NAAC with 'A' Grade

ISO 9001:2021 Certified

Syllabus

for

Honors Degree Programme– R20

Department of Mechanical Engineering

Semester II-II

20METH01: FRACTURE MECHANICS

Credits – 4 **Sessional Marks: 30**
L:T:P :: 3:1:0 **University Exam Marks: 70**

Course Objectives

To expose the students to the following

1. Understanding of phase transformation by heat treating and stress-induced hardening, linear and nonlinear elastic behavior.
2. Understanding the deformation under multi-axial loading, plastic deformation and yield criteria, dislocation plasticity and strengthening mechanisms, creep, stress concentration effects, brittle versus ductile fracture, fracture mechanisms at different scales, fatigue, contact deformation, and wear.

Course Outcomes:

After successful completion of course the student should be able to

CO1.Understand the different modes of failures like fracture, fatigue and creep of ductile and brittle materials.
CO2. Understand the phase transformation by heat treating and stress-induced hardening.
CO3. Understand the strengthening mechanisms of ductile and brittle Materials.
CO4. Understand the fracture mechanisms at different scales
CO5. Comparison of creep performance under different conditions

UNIT-I

Fracture: Introduction, Types of Fracture in Metals, Griffith Theory of Brittle Fracture, Fracture of Single Crystals, Ductile Fracture, Concept of the Fracture Curve.

UNIT-II

Fracture Mechanics: Strain Energy Release rate, Fracture Toughness and Design, Crack Opening Displacement, J-Integral, R Curve,

UNIT-III

Fatigue-I: Introduction, Stress Cycles, S-N Curve, Effect of Mean Stress on Fatigue, Cyclic Stress strain curve, Low Cycle Fatigue, Strain Life Equation, Structural Features of Fatigue, Fatigue Crack Propagation, Effect of Metallurgical Variables on Fatigue.

UNIT-IV

Fatigue-II: Effect of stress concentration on Fatigue, Size Effect, Surface effects on Fatigue, Fatigue under Combined stresses, Design for Fatigue, Machine Design approach-Infinite life design, Local strain approach, Corrosion Fatigue, Effect of Temperature on fatigue.

UNIT-V

Creep deformation: The evolution of creep damage, primary, secondary and tertiary creep, Micro mechanisms of creep in materials and the role of diffusion, Ashby creep deformation maps, Stress dependence of creep –

power law dependence. Comparison of creep performance under different conditions – extrapolation and the use of Larson-Miller parameters, Creep-fatigue interactions, Examples.

Text Books

1. Mechanical Metallurgy by G. E. Dieter, McGraw Hill, (1988)
2. Thin Film Materials L.B. Freund and S. Suresh, Cambridge University Press (2003).

Reference Books:

1. Fracture Mechanics Fundamentals and Applications by T.L. Anderson, 2nd Ed. CRC press, (1995)
2. Fracture of Brittle Solids by B. Lawn, Cambridge Solid State Science Series 2nd ed1993.
3. Fundamentals of Fracture Mechanics by J.F. Knott, Butter worths (1973)
4. Worked examples in Fracture Mechanics by J.F. Knott, P Withey, Institute of Materials.
5. Fracture Mechanics by H.L.Ewald and R.J.H. Wanhill, Edward Arnold, (1984).
6. Fatigue of Materials by S. Suresh, Cambridge University Press, (1998)
7. Inelastic Deformation of Metals by D.C. Stouffer and L.T. Dame, Wiley (1996)
8. The Physics of Creep by F.R.N. Nabarro, H.L. de Villiers, Taylor and Francis, (1995)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	L	H	H			L	H		M	L		H	M	
CO2	M	H	L		H		M			M	L	L	M	H	M
CO3	H	L	M				M	M		M	M	L	M	L	L
CO4	M		M	H	M		L	H		M	M		L		
CO5	M	H	L	L			M			M		L	M	H	M

Semester: III-I

20METH02: ADVANCED FLUID MECHANICS

Credits – 4 **Sessional Marks: 30**

L: T: P:: 3:1:0 **University Exam Marks: 70**

COURSE OBJECTIVES

To expose the students to the following

1. Impart brief knowledge on Governing equations in Fluid dynamics.
2. Familiarize student with Potential and Internal flows.
3. Make the student learn about Laminar boundary layers.
4. Enable the student to know about turbulent flow.
5. Make the student understand about fluid flow experiments.

COURSE OUTCOMES

After successful completion of course the student should be able to

CO1: Derive the Governing equations in Fluid dynamics..

CO2: Describe Potential flows.

CO3: Explain Laminar boundary layers and find solution methodology for boundary layer equations.

CO4: Summarize turbulent flow and derive governing equations of turbulent flow.

CO5: Conduct fluid flow experiments.

UNIT – I

Governing equations in Fluid mechanics: Derivation of Continuity and Momentum equations using integral and differential approach, dimensionless form of governing equations, integral quantities, Exact Solutions of Navier-Stokes Equations: Fully developed flows, parallel flow in straight channel, Couette flow, Creeping flows.

UNIT – II

Potential Flow: Kelvin's theorem, Irrotational flow, Stream function- vorticity approach Application of empirical relations to various geometries for Laminar and Turbulent flows.

Internal flows: Use of empirical correlations. Reynolds – Colburn Analogy - Application of empirical relations to various geometries for Laminar and Turbulent flows.

UNIT – III

Laminar Boundary layers: Boundary layer equations, flow over flat plate, Momentum integral equation for boundary layer, approximate solution methodology for boundary layer equations

UNIT – IV

Turbulent Flow: Characteristics of turbulent flow, laminar turbulent transition, time mean motion and fluctuations, derivation of governing equations for turbulent flow, shear stress models, universal velocity distribution.

UNIT – V

Experimental Techniques: Role of experiments in fluid, layout of fluid flow experiments, sources of error in experiments, data analysis, design of experiments, review of probes and transducers, Introduction to Hot wire Anemometry, Laser Doppler Velocimetry and Particle Image Velocimetry.

TEXT BOOKS

1. Frank M. White, Fluid Mechanics, Mc Graw Hill, 8th Edition
2. Irving H. Shames, Mechanics of Fluids, McGraw Hill, 4th Edition, 2003.
3. Philip J. Pritchard, Fox and McDonaldIntroduction to Fluid Mechanics, John Wiley and Sons Inc, 8th Edition, 2011.

REFERENCES

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1. D. Rama Durgaiah , Fluid Mechanics and Machinery, New Age Publications, 1st edition.
2. K.Muralidhar & G.Biswas, Advanced Engineering Fluid Mechanics, Alpha Science International Ltd., 2nd revised Edition, 2005
3. Hermann Schlichting, Boundary layer theory, Mcgraw Hill Education, 7th edition.

Course Outcomes - Program Outcomes - Program Specific Outcomes (CO-PO-PSO) Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1	M	L	H	H			L	H		M	L		H	M	
CO 2	M	H	L		H		M	M		M	L	L	M	H	M
CO 3	H	L	M				M	M		M	M	L	M	L	L
CO 4	M	L	M	H	M		L	H		M	M	L	L	H	
CO 5	M	H	L	L			M	H		M		L	M	H	M

Semester: III-II

20BSTH01: ADVANCED ENGINEERING MATHEMATICS

Credits - 4 **Sessional Marks: 30**

L: T: P :: 3:1:0 **University Exam Marks:70**

UNIT I

LINEAR ALGEBRA: Vector space, Basis, System of Linear equations, Linear Dependence and independence, Eigen values and Eigenvectors, Quadratic Forms.

UNIT II

SPECIAL FUNCTIONS: Legendre's Linear Differential Equations, Legendre's function of first kind $P_n(x)$, Legendre's function of second kind $Q_n(x)$, Legendre's polynomials, Generating functions, Recurrence relations, Bessel functions.

UNIT III

PARTIAL DIFFERENTIAL EQUATIONS: Lagrange's Partial Differential equations, Partial Differential equations nonlinear in p and q, Charpits method, Cauchy's method of characteristics.

UNIT IV

PROBABILITY: Random variables conditional probability, Baye's Theorem, Binomial Distribution, Poisson Distribution, Normal Distribution, Mean, Median, Mode and Standard deviation, Joint conditional distribution.

UNIT V

COMPLEX VARIABLES: Analytic functions, Cauchy-Reimann equations, Cauchy'S Integral theorem, Cauchy's Integral formula,Cauchy's Residue theorem, Taylor's and Laurent's series.

Text books:

- Grewal, B.S. Higher Engineering Mathematics, Khanna Publishers, 42nd Edition.

Reference Books:

- T.K.V.Iyengar & B.Krishna Gandhi et., Engineering Mathematics – I, II, III; S.Chand & Company.
- T.K.V.Iyengar & B.Krishna Gandhi et. al, "Probability and Statistics", S.Chand & Company, Vol.III.
- Irwin Miller, John E.Freund, "Probability and Statistics for Engineers", PearsonGlobal edition, 9 th edition.
- S C Gupta and V.K.Kapoor,"Fundamentals of Mathematical Statistics", S. Chand& Son's, 10 th edition 2000.
- Shahnaz Bathul,"A text book of Probability and Statistics", Ridge Publications,2nd edition.

Course Outcomes - Program Outcomes - Program Specific Outcomes (CO-PO-PSO) Mapping

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CO 1	M	L	H	H			L	H		M	L		H	M	
CO 2	M	H	L		H		M	M		M	L	L	M	H	M
CO 3	H	L	M				M	M		M	M	L	M	L	L
CO 4	M	L	M	H	M		L	H		M	M	L	L	H	
CO 5	M	H	L	L			M	H		M		L	M	H	M

Semester: III-II

20METH03: METAL FORMING PROCESSES

Credits – 3 **Sessional Marks: 30**

L:T:P :: 2:1:0 **University Exam Marks: 70**

Course Objectives

To expose the students to the following

1 . Stress-strain concepts of materials during plastic deformation.

2. Applying the theory of plasticity and its application for analyzing various metal forming Processes.

3. Principle of extrusion and drawing for load calculations and its applications.

4. Explain the various sheet metal forming methods and its applications.

Course Outcomes

After successful completion of course the student should be able to

CO1. Upon completion of the course, the students should have the ability to understand the importance of the metal forming processes.

CO2: Choose right metal forming machine tools

CO3: Select suitable processes to fabricate an engineering product.

CO4: Students are expected to determine the forming force, stress and strain experimentally as well as analytically

CO5: Understand the mechanisms of different High Energy Rate forming processes

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UNIT I

Classification of forming processes – flow curves and their significance in forming – Effect of temperature, speed and metallurgical structure on forming processes – Effect of friction on forming processes. Basic concepts of yield criteria –types.

UNIT II

Classifications of forging processes - Forging equipment – forging die design procedure for simple products – forging defects – determination of forging load – concept of P/M forging – Applications.

UNIT III

Rolling mills – Estimation of rolling load and power – rolling defects – Applications. Direct extrusion equipment - hydrostatic extrusion - extrusion of tubes – determination of extrusion stress - extrusion defects – Applications

UNIT IV

Drawing of rods, wires and tubes-Determination of drawing loads through conical dies, sheet metal forming: Shearing, blanking, bending, punching, piercing, stretch forming, deep drawing, rubber pad forming – Applications

UNIT IV

High-rate energy forming processes: Introduction - Effect on mechanical properties and microstructures – Explosive forming, Electro hydraulic forming – Electromagnetic forming, Water hammer forming.

TEXT BOOKS:

1. Dieter, Mechanical Metallurgy, McGraw-Publishing Co., New York,1998.

2.Serope Kalpakjian, Steven R Schmid, "Manufacturing Process for Engineering Materials"

Pearson Education, 4th Edition,2003.

3. P.C. Sharma,ProductionEngineering,S. Chand&Co., NewDelhi,1995.

REFERENCES:

1.. GyrilDonaldson, ToolDesign,TataMcGrawHillPublishingCo.Ltd.,1989.

2..AltanT.,MetalformingFundamentalsandapplicationsAmericanSocietyofMetals,MetalsPark,200

Course Outcomes – Program Outcomes – Program Specific Outcomes (CO-PO-PSO) Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	L	M	M								L	M	M	L
CO2	H	L	M	M								L	M	M	L
CO3	H	L	M	M								L	M	M	L
CO4	H	L	M	M								L	M	M	L
CO5	H	L	M	M		L				M		L	L	M	L

Semester: IV-I

20METH04: TOOL DESIGN

Credits – 3 **Sessional Marks: 30**
L: T: P:: 2:1:0 **University Exam Marks: 70**

Course Objectives

To expose the students to the following

1. Impart overall Knowledge of about the metal cutting operations.
2. Ability to analyze wear and tool life of single point cutting tool.
3. Analyze material characteristics and the knowledge about basic need for various types of tools.
4. Know about the various press working operations and their capable analyzing the economic costs of tools.
5. Impart the basic principles of jigs and Fixtures.

Course Outcomes

After completion of the course the student will be able to

CO1.Demonstrate various press working operations for mass production of sheet metal parts

CO2.Identify press tool requirements to build concepts pertaining to design of press tools.

CO3.Prepare working drawings and setup for economic production of sheet metalcomponents

CO4.Select suitable materials for different elements of press tools

CO5.Select suitable machining process for suitable materials.

UNIT I

Tool Design Introduction: Cutting Tools Classification – Nomenclature of single point cutting tool – Difference between orthogonal and oblique cutting – Mechanism of metal cutting – Types of chips– Chip breakers – Forces acting on tool – Merchant circle diagram – Velocity relations – Specific energy in cutting.

UNIT II

Machinability: Tool Wear – Tool life – Tool failure - Factors affecting tool life – Taylor's Tool life Equation – Tool wear mechanisms – Types of tool wear – Heat distribution in metal cutting – Measurement of temperature in metal cutting – Lathe tool Dynamometer – Cutting fluids – Selection and applications.

UNIT III

Cutting Tool Materials: Requirements of tool materials, Abrasive materials - advances in tool materials, HSS, Coated HSS, Carbides ,Coated Carbides, Ceramics, Cold pressed, Hot Pressed , Ceramic composites, CBN, Diamond- properties, Advantages and limitations; Specifications for Inserts and tool holders. Design of single point cutting tool and form for Lathe work- Design of Milling and Broach tools - Shapes of grinding wheels.

UNIT IV

Press Working and Economics of Machining: Press working operations- Press selection and Tonnage- Centre of Pressure- Cutting forces and clearances for Die Design – Compound and Progressive Die, Strip layout. Costs associated with machining operations- Optimum cutting speed for minimum cost and maximum production, cutting speed for minimum cost in Turning – Forging dies parts.

UNIT V

Jigs & Fixtures: Uses- Locating devices, 3-2-1 principle of location – pin location- Radial location- 'V' location- Diamond locators. Types of clamping devices- principles of clamping. Design principles to Jigs & Fixtures – Drill Jigs, types- Drill Bushes, types- Fixtures for Turning, Milling and Welding – Grinding and Forging**.**

Text Books

1. G. R. Nagpal, "Tool Engineering And Design",Khanna Publishers.

2.Cyril Donaldson, George H. LeCain, V. C. Goold, Joyjeet Ghose Tata McGraw-Hill

3. Kempster M.H.A., Introduction to Jigs and Fixtures, ELBS Edition, 1976

Reference Books

1. Juneja and Sekhan, "Fundamental of Metal Cutting and Machine Tools", New Age International Publishers.

2. Shaw, Milton C.-Metal Cutting Principles-Oxford University Press (2005).

3. Paquin, Die Design Fundamentals, Industrial Press Inc, New York, 1979
4.ASTME, Fundamentals of Tool design, Prentice Hall 1974

Course Outcomes - Program Outcomes - Program Specific Outcomes (CO-PO-PSO) Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	L				H	H			M	M		H	M	
CO2	M	M	H							M			H	H	
CO3			H							M	M	H	M	L	
CO4					H					M			M	M	
CO5			H		L					M			M	M	

Semester: III-II

20METH05: TOTAL QUALITY MANAGEMENT AND RELIABILITY

Credits – 3 **Sessional Marks: 30**

L: T: P:: 2:1:0 **University Exam Marks: 70**

COURSE OBJECTIVES

The Objective of this course to

To impart knowledge about the total quality management principles

2. To demonstrate the importance of statistical process control for process monitoring

3. To familiarize with the concepts of TQM techniques and quality management systems

4. To impart knowledge on system reliability and system maintenance.

COURSE OUTCOMES

On successful completion of this course the student will be able to

CO1.Develop action plans for customer centric business on the basis of various quality philosophies.

CO1.Apply total quality management techniques for design and manufacture of highly reliable products and services.

CO2.Develop statistical process control charts for monitoring the health of manufacturing systems.

CO3. Solve various industrial problems using Six Sigma and related techniques.

CO4. Establish quality management system and environmental management system for product and service industries.

CO5. Design systems with a focus on enhancing reliability and availability.

UNIT I

Quality: Introductory Concepts : Definition of Quality, Differing perspectives of quality by Design, Manufacturing, Service, etc. Contributions of Deming, Juran and Crosby. Customer orientation and Customer satisfaction measurement, Quality Control, Quality assurance and Total Quality Management definitions, Employee involvement, Quality Awards.

UNIT II

TQM Techniques : Principles of TQM, TQM Framework, FMEA, QFD, Bench Marking, 5S, PDCA, Poka Yoke, TPM, 5S, Corrective and Preventive actions with examples.

UNIT III

Statistical Process Control : 7 QC tools, New Management tools, Statistical Process control, Control charts, Process capability, Cp, Cpk analysis, Design of Experiments.

UNIT IV

Six Sigma : Features of six sigma, Goals of six sigma, Design for Six Sigma , DMAIC, Six Sigma implementation. TRIZ, Taguchi Loss function. Case studies and problems.

Quality Systems

ISO 9000, ISO 9000:2000, ISO 14000, other quality systems.

UNIT V

Reliability , Availability & Maintainability (RAM):

Introduction to reliability, Failure rate, System reliability- Series, Parallel and mixed configuration, Problems, Weibull distribution and application. Mean time to repair, Mean time between failures, Predictive , Preventive maintenance, Reliability Centered Maintenance, Reliability improvement – Redundancy – Element – Unit and stand by redundancy – Reliability allocation for a series system – Maintainability and availability – System downtime – Reliability and Maintainability trade off – Simple problems.

Text Book(s)

1. Total Quality Management and Operational Excellence: Text with Cases**,** Routledge, 2014.
2. A Textbook of Reliability and Maintenance Engineering, Charles Ebeling, Universal Books Stall Publishers ‘Distributors, 2017.

Reference Books

1. Dr. Kiran, Total Quality Management, B.S.Publications, 2017.
2. E. Balagurusamy, Reliability Engineering, Universal Books Stall Publishers ‘Distributors, 2017.

Course Outcomes - Program Outcomes - Program Specific Outcomes (CO-PO-PSO) Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	L	H		H		L			M			H	M	
CO2	M	H	L	M			M			M		L	M	H	M
CO3	H	L	M				M			M		L	M	L	L
CO4	M	L	M	H	M		L			M		L	L	H	
CO5	M	H	L	L			M			M		L	M	H	M
CO6	H	H	M				M					M	M	H	M

Semester: IV-I

20METH06: PRODUCTION AND OPERATIONS MANAGEMENT

Credits – 3 Sessional Marks: 30

L: T: P:: 2:1:0 University Exam Marks: 70

Course Objectives

To expose the students to the following

1. Understand the importance of Production operations management

2. Know the aggregate planning & work study and MRP

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

CO1.Understand the importance of production and operations Management, for getting the Competitive edge

CO2. Do value analysis for a given product and design the plant layout for the specified production system.

CO3.Do Aggregate planning, MRP Work study, and scheduling able to apply the project management techniques

UNIT- I

Overview of Production & Operations Management (POM): Introduction-Definition-Importance- Historical Development of POM-POM scenario today.

Product & Process design: Role of product development- Product development process-Tools for efficient product development(briefly)- Determination of process characteristics-Types of processes and operations systems- Continuous –Intermittent-Technology issues in process design- Flexible Manufacturing Systems- Automated Material Handling Systems

UNIT -II

Value Analysis: Definition - Objectives-Types of Values-Phases- Tools -FAST diagram-Steps- Advantages-Matrix method-Steps.

Plant Location& Plant layout: Factors affecting locations decisions-Location planning methods-Location factor rating -Centre of Gravity method-Load distance method. Plant layout- Definition-Objectives-Types of layouts-Design of product layout-Line balance-Terminology-RPW method.

UNIT- III

Aggregate Planning: Definition- Objectives-Basic strategies for aggregate production planning- Aggregate production planning method-Transportation model- Master Production Scheduling.

Material Requirement Planning: Terminology-Logic-Lot sizing methods-Advantages & Limitations

UNIT - IV

Work Study: Work study: method study –definition-objectives-steps-Charts used- Work measurement-Time study- Definition-steps- Determination of standard time- Performance rating- Allowances. Work sampling- steps- comparison with time study.

Quality Management: Economics of quality assurance-Control charts for variables and for attributes –Acceptance sampling plans-Total Quality Management-ISO 9000 series standards-Six sigma

UNIT - V

Scheduling: Need-basis for scheduling- Scheduling rules- Flow shop & Job shop scheduling. Line of Balance.

Project management: PERT- Critical path determination- Probability of completing project in a given time- CPM- Types of floats- Critical path determination- Crashing of simple networks- Optimum project schedule.

TEXT BOOKS:

1. Operations Management for Competitive Advantages- Chase Aquinano-TMH,2009
2. Operations Management: Theory and Practice: B.Mahadevan Pearson.
3. Industrial Engineering and Management: Dr. Ravi Shankar- Galgotia.

REFERENCES:

1. Modern Production and Operations Management: Buffa, Wiley
2. Theory and Problems in Production and Operations Management: SN Chary TMH.
3. Operations Management 8e Process and Value Chains: Lee Krajewskiet. all Pearson

Course Outcomes - Program Outcomes - Program Specific Outcomes (CO-PO-PSO) Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	H								M	H		H	M	M
CO2	H	M		H						M			H	H	H
CO3		M		M						M			M	H	
CO4		H	H		M	M				M			H	H	
CO5	M			M	H					M			H	M	

Semester: III-II

20METH07: MECHANICS OF COMPOSITE MATERIALS

Credits – 3 **Sessional Marks: 30**

L:T:P :: 2:1:0 **University Exam Marks: 70**

Course Objectives

To expose the students to the following

1. Discuss the basic structure of composites
2. Define Elastic constants and Hygro-thermal stresses
3. Identify stress-strain relations in composites
4. Describe the behaviour and Design with composites
5. Demonstrate the basic equations of plate bending

Course Outcomes:

After successful completion of course the student should be able to

CO1. Demonstrate knowledge of composites and their structure

CO2. Predict the Elastic constants and Hygrothermal stresses

CO3. Analyse the stress - strain relationship in composites

CO4. Summarise and apply the Design procedure and the failure criteria.

CO5. Formulate Plate bending equations for various Boundary conditions of composite plates.

UNIT I

Composite Materials: Composite materials terminology. Classifications: Polymer matrix, metal matrix, ceramic matrix, carboncarbon matrix composites. Fabrication of Fibers: Glass fibers, carbon/ graphite fibers, aramid fibers, boron fibers, banana and bamboo fibers. Application of Composite Materials: Automotive, space, marine and aircraft application.

UNIT II

Mechanical Behavior of Lamina: Hooke's Law, stiffness and compliance matrix for generally anisotropic materials, orthotropic materials, transversely isotropic materials and isotropic materials. Relations between engineering constants and elements of stiffness and compliance matrix. Stress strain relations for plane stress in a unidirectional orthotropic material and arbitrary oriented orthotropic material.

UNIT III

Micro-Mechanical Behavior of Lamina: Introduction, Mechanics of materials approach to stiffness to determine Young's modulus, Poisson's ratio and rigidity modulus. Elasticity approach to stiffness by bounding techniques of elasticity.

UNIT IV

Macro Mechanical Behaviour of Laminate: Classical Lamination Theory: Lamina stress-strain behavior, stress and strain variation in a laminate, resultant laminate forces and moments. Special Cases of Laminate Stiffness: Single-layered, symmetrical laminates, anti-symmetrical laminates, unsymmetrical laminates.

UNIT V

Performance of Composite Materials: Strength Criteria of Orthotropic Lamina: Maximum stress failure criterion, maximum strain failure criterion, Tsai-Hill failure criterion, Hoffman failure criterion and Tsai-Wu failure criterion. Design of Composite Structures: Elements of design, structural design process, design objectives and design drivers, design analysis stages. Material selection factors, fiber selection factors, matrix selection factors.

Text Book(s)

1. R M Jones, Mechanics of Composite Materials, 2/e, Taylor and Francis, 1999.

2. Madhujit Mukhopadhyay, Mechanics of Composite Materials and Structures, Universities Press, 2005

3. Carlos A. Mota Soares, Cristóvão M. Mota Soares, Manuel J.M. Freitas Springer Science & Business Media, 2013.

References

1. Nicholas J. Pagano, Reddy J.N, Mechanics of Composite Materials, Kluwer Academic Publishers, 1994.

2. Agarwal. B. D, Broutman. L. J, Chandrasekhara K, Analysis and Performance of Fiber Composites, 3/e, John Wiley and Sons, 2006.

3. Mallick P.K, Fiber Reinforced Composites, 3/e, CRC Press, 2013. 4. Autar K Kaw, Mechanics of Composite Materials, 2/e, Taylor and Francis,2013

Course Outcomes - Program Outcomes - Program Specific Outcomes (CO-PO-PSO) Mapping

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CO1	M	L	H				L			M			H	M	
CO2	M	H	L				M			M		L	M	H	M
CO3	H	L	M				M			M		L	M	L	L
CO4	M	L	M	H	M		L			M		L	L	H	
CO5	M	H	L	L			M			M		L	M	H	M

Semester: IV-I

20METH08: TRIBOLOGICAL SYSTEMS DESIGN

Credits – 3 **Sessional Marks: 30**
L:T:P :: 2:1:0 **University Exam Marks: 70**

Course Objectives

To expose the students to the following

1. Apply the basic theories of friction, wear and lubrication to predictions about the frictional behavior of commonly encountered sliding interfaces.
2. Characterize features of rough surface and liquid lubricants as they pertain to interface sliding.
3. Interpret the latest research on new topics in tribology including its application to nanoscale devices and biological systems.

Course Outcomes

After successful completion of course the student should be able to

CO1. Analyze properties of lubricant and select proper lubricant for a given application.
CO2. Determine tribological performance parameters of sliding contact in different lubrication regimes.
CO3. Design and select appropriate bearings for a given application
CO4. Predict the type of wear and volume of wear in metallic and non metallic surfaces.
CO5. Analyse the type of wear and volume of wear in non metallic surfaces.

UNIT I

Historical background : Viscosity - Viscometry - Effect of temperature on viscosity - Effect of pressure in viscosity - Other physical properties of mineral oils –The generalized Reynolds equation - Flow and shear stress - The energy equation –The equation of state - Mechanism of development.

UNIT II

Hydrodynamic Lubrication: Oil flow through a bearing having a circumferential oil groove -Heat generation and lubricant temperature - Heat balance and effective temperature -Bearing design: Practical considerations - Design of journal bearings - Parallel surface bearing - Step bearing - Some situations under squeeze film lubrication - The mechanism of hydrodynamic instability - Stiffness and damping coefficients - Stability.

UNIT III

Elasto hydrodynamic Lubrication: Theoretical consideration - Grubin type solution -Accurate solution - Point contact - Dimensionless parameters - Film thickness equations -Different regimes in EHL contact - Deep-groove radial bearings - Angular contact bearings - Thrust ball bearings - Geometry - Kinematics - Stress and deformations –Load capacity.

UNIT IV

Surface Topography: Surface characterization - Apparent and real area of contact -Derivation of average Reynolds equation for partially lubricated surface - Effect of surface roughness on journal bearings

UNIT V

Laws of Friction : Friction theories - Surface contaminants - Frictional heating - Effect of sliding speed on friction - Classification of wear - Mechanisms of wear –Quantitative laws of wear - Wear resistance materials.

Text Books

1. Stachowaik, G.W., Batchelor, A.W., "Engineering Tribology", 3rd Ed., Elsevier, 2010.
2.Majumdar B.C, "Introduction to bearings", S. Chand & Co., Wheeler publishing, 1999.
3. Andras Z. Szeri, "Fluid film lubrication theory and design", Cambridge University press, 1998.

Reference Books

1. Majueprmdar, "Introduction to Tribology of Bearings", B.C.
2. Neale MJ, "Tribology Hand Book", CBS Publications, 2012.
3. Williams JA, "Engineering Tribology", Oxford Univ. Press, 2001.
4. Cameron A, "Basic lubrication theory", Ellis Horwood Ltd., 2002.

Course Outcomes - Program Outcomes - Program Specific Outcomes (CO-PO-PSO) Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	L	H				L			M			H	M	
CO2	M	H	L				M			M		L	M	H	M
CO3	H	L	M				M			M		L	M	L	L
CO4	M	L	M	H	M		L			M		L	L	H	
CO5	M	H	L	L			M			M		L	M	H	M

Semester: III-II

20METH09:ADVANCED I C ENGINES AND AUTOMOBILE ENGINEERING

Credits – 3 **Sessional Marks: 30**

L: T: P:: 2:1:0 **University Exam Marks: 70**

Course Objectives

To expose the students to the following

1. Familiarize about the fuels.
2. Understand analytical techniques of internal combustion engines performance.
3. Know environmental and fuel economy challenges of internal combustion engines.
4. Basics principles of actual automobile systems.
5. Importance and features of different systems like axle, differential, brakes, Steering, suspension, and balancing etc
6. Modern trends in Automotive Vehicles.

Course Outcomes

After successful completion of course the student should be able to

CO1. Know about various types of fuels in conventional as well as alternative.

CO2. Analyze engineering systems performance in controlled laboratory environments.

CO3. Identify Modern technology and safety measures used in Automotive Vehicles

CO4. Identify Construction, working, preventive maintenance, trouble shooting and diagnosis of various Automobile Systems.

CO5. Understand importance and features of different systems like axle, differential, brakes, steering, suspension, and balancing etc.

UNIT-I

Conventional and Alternative Fuels for I C Engines: Desirable characteristics of gasoline - desirable characteristics of diesel - alternative fuels for S I Engines and C I Engines - Esterification - Transesterification Processes.

UNIT-II

Engine Modification Techniques : EGR - Catalytic convertors - Engine timings - Variable Compression ratios - Fuel Injector - Air Fuel mixture proportions, CRDI

UNIT-III

Automobile Engineering Introduction: Components of Automobile - General considerations of engine dynamic balancing - firing order, load performance curves, NVH

Engine Management Systems: Recent developments including electronic monitoring and control of engines

UNIT-IV

Transmission system: Construction - Chassis - Clutch - requirements of single plate friction clutch and multi plate clutch, clutch adjustments, clutch troubles and remedies - Gear Boxes - sliding mesh, constant mesh and

synchromesh gear box, function of over drives, trouble shooting and remedies. Propeller shaft - differential - hotchkiss drive - torque tube drive - final drive - types of rear axles.

UNIT-V

Braking system: Mechanical - hydraulic – power - air - vacuum brakes - maintenance of brakes

Steering system: Steering gears - steering gear ratio - wheel alignment - steering geometry & their effects - Introduction of power steering.

Suspensions: Types of Rigid, axle and independent suspension system, shock absorbers.

Text Books

1. Internal combustion engine - V Ganeshan, 3rd edition, TMG
2. Automobile Engineering - Kirpal Singh, Vol. I & II, Standard Publishers Distributors.

Reference Books

1. Internal combustion Engines Fundaments - John B. Heywood- McGraw Hill.
2. Internal combustion Engines - Collin R. Ferguson & Allan T. Kirkpatrick
3. Automobile Engineering - R. K. Rajput, Laxmi Publication
4. Automobile Engineering - R.K. Mohanty, Vol I & II, Standard Book House

Course Outcomes - Program Outcomes - Program Specific Outcomes (CO-PO-PSO) Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	M				L				M			H	L	
CO2		M	H							M			M	H	L
CO3	L	M	H							M			H	M	L
CO4		H	L	M			M			M				H	M
CO5	H	M	M							M	L		M	H	

Semester: IV-I

20METH10: TURBO MACHINERY

Credits – 3 **Sessional Marks: 30**

L: T: P:: 2:1:0 **University Exam Marks: 70**

COURSE OBJECTIVES

The Objective of this course to

1. Gain Knowledge in classification of turbo machines
2. Calculate energy transfer through a turbo machine
3. Understand energy transfer and losses in centrifugal compressors, axial fans and steam turbines
4. Understand an overview of different types of turbo machinery used for energy transformation, such as pumps, fans, compressors, as well as hydraulic and steam turbines.
5. Understand the applications of turbo machinery in power generation, power absorption and transportation sectors.
6. Explain the working principles of turbo machines and apply it to various types of machines

COURSE OUTCOMES

On successful completion of this course the student will be able to

CO1: Able to give precise definition of turbo machinery.

CO2: Identify various types of turbo machinery.

CO3: Apply the Euler's equation for turbo machinery to analyze energy transfer in turbo machines.

CO4: Understand the principle of operation of pumps, fans, compressors and turbines.

CO5: Perform the preliminary design of turbo machines like pumps, rotary compressors and turbines.

CO6: Summarize the different types of techniques used in turbines.

UNIT I

Introduction: Introduction to Turbo machines- Definition of turbo machine, parts of turbo machines, Classification of Turbo machines and applications of Turbo machines. Second Law of Thermo dynamics - turbine/compressor work, Nozzle/diffuser work, Basics of isentropic flow – static and stagnation properties – diffuser and nozzle configurations – mass flow rate – critical properties. Energy transfer between fluid and rotor velocity triangles for a generalized turbo machines - velocity diagrams (basic theory only)

UNIT II

COMBUSTION CHAMBER: Basics of combustion. Structure and working of combustion chamber – combustion chamber arrangements - flame stability – fuel injection nozzles.Flame stabilization - cooling of combustion chamber. Degree of reaction in turbo-machines – various efficiencies – isentropic, mechanical, thermal, overall and polytrophic- Simple problems.

UNIT III

Elementary theory of axial and radial flow turbines - stage parameters- multi-staging - stage loading and flow coefficients- Problems. Degree of reaction - stage temperature and pressure ratios – single and twin spool arrangements – performance. Matching of components, Blade Cooling.Radial flow turbines.

UNIT IV

GENERAL ANALYSIS OF POWER ABSORBING TURBOMACHINES: Various types of velocities and Mach number; Classification of fluid flow based on Mach number; Stagnation and static properties and their relations. Euler's Turbine Equation - Alternate form of Euler turbine equation - components of energy transfer. Dimensionless ratios to describe turbo machinery -Numerical problems

UNIT V

Turbo charger: Introduction- Turbo charging (vs) supercharging- Operating principle. Key components (Turbine - Twin-turbo- Twin-scroll- Variable-geometry- E-Turbo Technology- Compressor Side- Hot / Exhaust side- Ported shroud). Additional technologies commonly used in turbocharger installations - Intercooling- Top-mount (TMIC) vs. Front-mount intercoolers (FMIC)-Methanol/water-Injection-Fuel-air-mixture ratio. Fundamentals of turbo expander design and operation- Compressor surge control - Automatic thrust balancing system -Turbo machinery applications – General- Power generation- Aerospace – Marine sectors.

TEXT BOOKS

1. V. Kadambi and Manohar Prasad, An Introduction to Energy Conversion, Volume III, Turbo machinery, New Age International Publishers, reprint 2008
2. S. M. Yahya, Turbines, Compressors & Fans, Tata McGraw Hill Co. Ltd., 2nd edition, 2002

REFERENCES

1. M. S. Govindegouda and A. M. Nagaraj, Text Book of Turbo machines, M. M. Publications, 4Th Ed, 2008
2. S. L. Dixon, Fluid Mechanics & Thermodynamics of Turbo machines, Elsevier 2005
3. D. G. Shepherd, Principals of Turbo machines, The Macmillan Company,1964

Course Outcomes - Program Outcomes - Program Specific Outcomes (CO-PO-PSO) Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	L	H		H		L			M			H	M	
CO2	M	H	L	M			M			M		L	M	H	M
CO3	H	L	M				M			M		L	M	L	L
CO4	M	L	M	H	M		L			M		L	L	H	
CO5	M	H	L	L			M			M		L	M	H	M
CO6	H	H	M				M					M	M	H	M

Semester: III-II

20METH11: Smart Manufacturing

Credits – 3 **Sessional Marks: 30**

L: T: P:: 2:1:0 **University Exam Marks: 70**

Course Objective:

1. Provide concept & knowledge of IOT & Smart manufacturing
2. Understanding the design layout of smart factories
3. Framing the cyber physical systems for smart manufacturing using AI & ML
4. Arriving the smart solutions for manufacturing process using Virtual & Augmented reality
5. Application of IIOT for smart manufacturing systems
6. Able to design the cloud computing solutions for manufacturing systems

Course Outcomes:

CO 1. Able to design layout of smart factories
CO 2. Able to frame the cyber physical systems for smart manufacturing using AI & ML
CO 3. Able to arrive the smart solutions for manufacturing process using Virtual & Augmented reality
CO 4. Able to design the IIOT based business models & architectures for smart manufacturing.
CO 5. Able to design the cloud computing solutions for manufacturing systems

Unit 1

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

Unit II

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

Unit III

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

Unit IV

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

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

Unit V

Industrial IoT- Application Domains: Factories and Assembly Line, Food Industry. Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management.Industrial IoT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Mini project

TEXT BOOKS AND REFERENCES

1.Alasdair Gilchrist ,Industry 4.0: The Industrial Internet of Things, Apress

2. Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat,Industrial Internet of Things: CybermanufacturingSystems,Springer

3. Research papers.

Course Outcomes - Program Outcomes - Program Specific Outcomes (CO-PO-PSO) Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	L	H		H		L			M			H	M	
CO2	M	H	L	M			M			M		L	M	H	M
CO3	H	L	M				H			M		L	M	L	L
CO4	M	L	M	H	M		L			M		L	L	H	
CO5	M	H	L	L			M			M		L	M	H	M
CO6	H	H	M				H					M	M	H	M

Semester: IV-I

20METH12: ADDITIVE MANUFACTURING

Credits – 3 **Sessional Marks: 30**

L: T: P:: 2:1:0 **University Exam Marks: 70**

Course Objectives:

1. study methods used in additive manufacturing, theories governing the additive manufacturing, give information on materials, explain relations between materials to be processed and methods of additive manufacturing with introduction to common machines used for the technology and show applications and business opportunities with future directions.

2.Ability to manufacture a 3D part by using some of the methods of additive manufacturing

Course Outcomes:

CO 1. Able to design manufacturing process chain
CO 2. To frame process design
CO 3. To frame efficient additive manufacturing process
CO 4. To identify rapid tools & software for additive manufacturing
CO 5. To understand Mini project of additive systems

Unit I

Introduction and Basic Principles of Additive Manufacturing, Development of Additive Manufacturing Technology, Generalized Additive Manufacturing Process Chain

Unit II

Vat Photopolymerization Processes / Powder Bed Fusion Processes / Extrusion-Based Systems, Material Jetting / Binder Jetting / Sheet Lamination Processes

Unit III

Directed Energy Deposition Processes / Direct Write Technologies, The Impact of Low-Cost AM Systems / Guidelines for Process Selection, Post-processing / Software Issues

Unit IV

Direct Digital Manufacturing / Design for Additive Manufacturing, Rapid Tooling

Unit V

Applications of Additive Manufacturing, Applications of Additive Manufacturing, Comparison of Additive Manufacturing Methods, Business Opportunities and Future Directions

Text Books:

Ian Gibson, David Rosen, Brent Stucker,**Additive Manufacturing Technologies,** Springer Publ. 2015.

Reference Books:

Laser Additive Manufacturing of High-Performance Materials, Dongdong Gu, Springer Publ. 2014
Understanding Additive Manufacturing, Andreas Gebhardt, Hanser Publishers, 2011

Course Outcomes - Program Outcomes - Program Specific Outcomes (CO-PO-PSO) Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	L	H		H		L			M			H	M	
CO2	M	H	L	M			M			M		L	M	H	M
CO3	M	L	M				M			M		L	M	L	L
CO4	M	L	M	H			L			M		L	L	H	
CO5	M	M	L	L			M			M		L	M	H	M