JECRC™
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School of Engineering

Department of Mechanical Engineering

M. Tech. (CAD/CAM)

Course Structure and Syllabi

Academic Programmes

July, 2015

M.Tech. in CAD/CAM(Total Credits: 100)

Teaching Scheme

SemesterI

Code	Subject	Contact Hours L-T-P	Credits	
MME 003A	Advanced Heat and Mass Transfer	3-1-0	4	C
MME 012A	Finite Element Method	3-1-0	4	C
MME 030A	Advanced Engineering Materials	3-1-0	4	C
MME 031A	Advance Computer Integrated Manufacturing	3-1-0	4	C
MME 005A	ThermalEngineering Laboratory	0-0-2	2	C
MME 010A	Advance CAD Lab	0-0-2	2	C
MME 038A	Seminar	0-0-2	2	F
	TOTAL	**12-4-6**	**22**	

SemesterII

Code	Subject	Contact Hours L-T-P	Credits	
MME 020A	Experimental Stress Analysis	3-1-0	4	C
MME 032A	Advanced Mechanics of Solids	3-1-0	4	C
MES001A	Research Methodology	3-0-0	3	ID
MME 033A	MEMS & NEMS	3-1-0	4	C
MME 006A	Computational Fluid Dynamics Laboratory	0-0-2	2	C
MME 025A	Mechatronics and Automation Lab	0-0-2	2	C
MME 039A	Seminar	0-0-2	2	C
	Quantitative Techniques & Computer Applications Lab	0-0-1	1	ID
	TOTAL	**12-3-7**	**22**	

SemesterIII

Code	Subject	Contact Hours L-T-P	Credits	
MME 026A	Composite Materials & Processing	3-1-0	4	C
MME 034A	Advance Metal Forming	3-1-0	4	C
MME 004A	Design of Thermal System	3-1-0	4	C
MME 035A	Precision & Micro-machining	3-1-0	4	C
MME 016A	Dissertation I	0-0-12	12	C
	TOTAL	**12-4-12**	**28**	

SemesterIV

Code	Subject	Contact Hours L-T-P	Credits	
MME 017A	Dissertation II	0-0-28	28	C
	TOTAL	**0-0-28**	**28**	

Course contents for M.Tech

L-T-P	MME001A- Advanced Internal Combustion Engineering	Credits:4
3-1-0		

Course Objectives:

- Course comprises of a breakdown explanation of all the parts that make up an Internal Combustion Engine and details the theory behind their working.
- It deal with the developments that have taken place in the last few decades in relation with the automobile industry

UNIT - I:

Introduction – Historical Review – Engine Types – Design and operating Parameters.

Cycle Analysis: Thermo-chemistry of Fuel – Air mixtures, properties – Ideal Models of Engine cycles – Real Engine cycles - differences and Factors responsible for – Computer Modeling.

UNIT - II:

GAS EXCHANGE PROCESSES: Volumetric Efficiency – Flow through ports – Supercharging and Turbo charging.

Charge Motion: Mean velocity and Turbulent characteristics – Swirl, Squish – Pre-chamber Engine flows.

UNIT - III:

ENGINE COMBUSTION IN S.I ENGINES: Combustion and Speed – Cyclic Variations – Ignition – Abnormal combustion Fuel factors, MPFI, SI engine testing.

Combustion in CI engines: Essential Features – Types off Cycle. Pr. Data – Fuel Spray Behavior – Ignition Delay – Mixing Formation and control, Common rail fuel injection system.

UNIT - IV:

POLLUTANT FORMATION AND CONTROL: Nature and extent of problems – Nitrogen Oxides, Carbon monoxide, unburnt Hydrocarbon and particulate – Emissions – Measurement – Exhaust Gas Treatment, Catalytic converter, SCR, Particulate Traps, Lean, NOx, Catalysts.

UNIT - V:

ENGINE HEAT TRANSFER: Importance of heat transfer, heat transfer and engine energy balance, Convective heat transfer , radiation heat transfer, Engine operating characteristics.

Fuel supply systems for S.I. and C.I engines to use gaseous fuels like LPG, CNG and Hydrogen.

Modern Trends in IC Engines: Lean Burning and Adiabatic concepts, Rotary Engines, Modification in I.C engines to suit Bio – fuels, HCCI and GDI concepts.

Text Books:

1. Ganesan.V – Internal combustion engines, TMH 1996.

Reference Books:

1. John Heywood – Internal Combustion engines, McGraw Hill, 1988.
2. Gill, Smith and Zurich – Fundamentals of IC engines.
3. Internal Combustion engines, Maleev.V.L, McGraw Hill.
4. R B Mathur. and R.P Sharma. – Internal Combustion engines, Dhanpat Rai and Sons, 1994.

Course Outcomes:

1. At the end of the course student will learn working of an ic engine and its application in automobile industry.

L-T-P	MME002A- Computational Method in Thermal Engineering	Credits:4
3-1-0		

Course Objectives:

- Course includes numerous uses of numerical methods in engineering. Main objectives of the course explains the application of numerical methods mathematically and practically, emphasizing programming aspects when appropriate.

Unit I

Solution of a system of linear and non-linear equations, Gauss elimination, Gauss Jordan elimination, Jacobi iteration, Gauss Seidel iteration, Convergence criteria, Newton Raphson iterations to find roots of a 1D nonlinear equation

Unit II

Difference operators (forward, backward and central difference), Stability and accuracy of solutions, Governing transport equations for mass, momentum and energy.

Unit III

Classification of first order and second order partial differential equations based on characteristics, representation of partial derivatives using finite differences, modified partial differential equation, consistency of a numerical scheme, order of accuracy, dispersion and dissipation, stability of numerical schemes, Von-Neumann stability analysis.

Unit IV

Interpolation functions: smoothness, continuity, completeness, Lagrange polynomials, Numerical quadrature: Trapezoidal rule, Simpsons rule,Gauss quadrature**,** Numerical schemes for the solution of heat equation, linear and nonlinear Burger's equation, transport equation

Unit V

Parabolic equations: algorithms - stability, consistency and convergence, Lax equivalence theorem, Hyperbolic equations: algorithms - Newmark's method,stability and accuracy,

Text Books:

1. D.A. Anderson, J.C. Tannehill and R.H. Pletcher, Computational Fluid Mechanics and Heat Transfer, II Ed., McGraw Hill, 1997

Reference Books:

2. Anderson, J. D. (Jr.), Computational Fluid Dynamics, McGraw Hill, 2010.
3. A. W. Date, Introduction to Computational Fluid Dynamics,Cambridge, 2005.
4. Hoffmann, K. A. and Chiang, S. T., Computational Fluid Dynamics for Engineers, Vol. I, II, and III, 2nd Edition, Engineering Education System, 2000.
5. Chung, T. J., Computational Fluid Dynamics, 2nd Edition, Cambridge University Press, 2010.

Course Outcomes:

- Student will be able to understand subject by approaching the cross-disciplinary topic of numerical methods with a flexible approach.

L-T-P	MME003A - Advanced Heat and Mass Transfer	Credits:4
3-1-0		

Course Objectives:

- To understand heat transfers with an emphasis on physics and real-world every day applications, while de-emphasizing the intimidating heavy mathematical aspects.
- Helps to learn Fourier Equation and Thermal Conductivity, Radiation, Heat Transfer from Extended Surfaces, Heat Exchangers, Steady State Conduction.

UNIT-I:

BRIEF INTRODUCTION TO DIFFERENT MODES OF HEAT TRANSFER: Conduction: Generalheat Conduction equation-initial and boundary conditions.

Transient heat conduction: Lumped system analysis-Heisler charts-semi infinite solid-use of shape factors in conduction-2D transient heat conduction-product solutions.

UNIT- II:

FINITE DIFFERENCE METHODS FOR CONDUCTION: ID & 2D steady state and simple transient heat conduction problems-implicit and explicit methods.

Forced Convection: Equations of fluid flow-concepts of continuity, momentum equations-derivation of energy equation-methods to determine heat transfer coefficient: Analytical methods-dimensional analysis and concept of exact solution. Approximate method-integral analysis.

UNIT-III:

EXTERNAL FLOWS: Flow over a flat plate: integral method for laminar heat transfer coefficient for different velocity and temperature profiles. Application of empirical relations to variation geometries for laminar and turbulent flows.

Internal flows: Fully developed flow: integral analysis for laminar heat transfer coefficient-types of flow-constant wall temperature and constant heat flux boundary conditions-hydrodynamic & thermal entry lengths; use of empirical correlations.

UNIT-IV:

FREE CONVECTION: Approximate analysis on laminar free convective heat transfer-boussinesque approximation-different geometries-combined free and forced convection.

Boiling and condensation: Boiling curve-correlations-Nusselts theory of film condensation on a vertical plate-assumptions & correlations of film condensation for different geometries.

UNIT-V:

RADIATION HEAT TRANSFER: Radiant heat exchange in grey, non-grey bodies, with transmitting. Reflecting and absorbing media, specular surfaces, gas radiation-radiation from flames.

Mass Transfer: Concepts of mass transfer-diffusion & convective mass transfer analogiessignificance of non-dimensional numbers.

Text Books:

1. Incropera, F. P. and De Witt, D. P., Fundamentals of Heat and Mass Transfer, 5th Edition, John Wiley & Sons, New York, 2006

Reference Books:

1. Siegel, R. and Howell, J. R., Thermal Radiation Heat Transfer, 4th Edition, Taylor & Francis, 2002.

2. Kays, W. M. and Crawford, M. E., Convective Heat and Mass Transfer, 4th Edition, Tata McGraw Hill, 2012.

Course Outcomes:

- It encourages students creative thinking and development of a deeper understanding and intuitive feel for the subject.

L-T-P	MME004A- Design of Thermal System	Credits:4
3-1-0		

Course Objectives:

- Student will learn different designing aspects of thermal systems
- To learn both process-oriented topics of thermal energy engineering and system-oriented practices

Unit I

Introduction, Life cycle design, thermal system design aspects, concept creation and assessment, computer aided thermal system design.

Unit II

Thermodynamic modeling and design analysis, basic concept and definitions, Control volume energy balance, Control volume entropy balance, Incompressible liquid model, Ideal gas model, Multi component system.

Unit III

Designing a Workable System, Economics, Equation Fitting, System Simulation, Optimization Lagrange Multipliers, Search Methods, Steady state simulation of Large Systems.

Unit IV

Dynamic Behavior of Thermal Systems, calculus Methods of Optimization, Vector Calculus of Variations and Dynamic Programming, Probabilistic Approaches to Design

Unit V

Study and Design of liquid-to-liquid, liquid-to-gas and gas-to-gas heat exchangers, Design of cooling towers; plate type heat-exchangers; run-around coil systems; heat pipes and thermal wheels; condensers and evaporators;

Text Books:

1. W F Stoecker, "Design of Thermal Systems", McGraw-Hill book company, 3rd ed, 1989

Refrence Books:

1. Goswami Y, Kreith J and Kreider M, "Principles of Sola r Engineering", Taylor and Francis, 2000
2. Eric M Smith, "Advances in Thermal Design of Heat Ex changers", John Wiley & Sons, 2005
3. Eric C Guyer, "Handbook of Applied Thermal Design", John Wiley, 2001

Course Outcomes:

2. At the end of the course students will be able to understand thermal System Design with principles involved in system design followed by the methods to implement them.

L-T-P	MME005A- Thermal Engineering Laboratory	Credits:2
0-0-2		

List of Experiments

- Conduction heat transfer
- Free Convection Heat Transfer
- Forced Convection Heat Transfer
- Radiation Heat Transfer
- Heat exchanger analysis
- Performance and emission measurements in two-and-four-stroke S.I. engines
- Performance and emission measurements in Diesel engines
- Performance test on a Centrifugal Pump
- Performance test on a Hydro-turbine
- Measurement of density and Viscosity of oils
- Performance test on air compressor
- Performance evaluation of vapour compression refrigeration
- Measurement and Analysis of combustion parameters in I.C. engines
- Performance test on centrifugal blower
- Evaluation of the Calorific value of gaseous and liquid fuels

L-T-P	MME006A- CFD laboratory	Credits:2
0-0-2		

List of Experiments

- Practice on different programming languages and software packages commonly used in engineering such as MATLAB, C++ etc.
- Programs for solving simultaneous linear equations and differential equations
- Exercises on heat conduction elasticity using commercial FEM packages
- Exercises on fluid flow using commercial FEM packages
- Exercises on fins using commercial FEM packages
- Exercises on cooling of electronic package problems using commercial FEM packages
- Modeling of flow around aero foils using commercial FEM packages
- Exercises on natural and mixed convection problems using commercial CFD solvers.
- Exercises on laminar/turbulent flows using commercial CFD solvers.
- Exercises on forced convection using commercial CFD solvers.
- Exercises on problems using commercial CFD solvers.
- Exercises on hydrodynamic using commercial CFD solvers.
- Exercises on thermal boundary layer problems using commercial CFD solvers.
- Simulation of flow in turbo machines using commercial CFD solvers

L-T-P	MME007A- Advanced Computational Fluid Dynamics	Credits:4
3-1-0		

Course Objectives:

- To learn algorithms and numerical methods to examine and solve problems pertaining to fluid flows.
- Knowledge of calculations needed to simulate the gases and liquid interactions in surfaces that are defined by the boundary conditions.

Unit I

Introduction, Philosophy of CFD, Conservation equation, mass, momentum and energy equations, convective forms of the equations and general description, Classification into various types of equation, parabolic elliptic and hyperbolic, boundary and initial conditions.

Unit II

Basics aspects of discretization, Finite Difference Technique: formulating finite difference equation, Taylor series expansion, integration over element, accuracy of finite difference method.

Unit III

Grids with appropriate transformation Finite Volume Technique: Finite volume methods, different types of finite volume grids, approximation of surface and volume integrals, central, upwind and hybrid formulations and comparison for convection-diffusion problem.

Unit IV

Methods of Solution: Solution of finite difference equations, iterative methods, matrix inversion methods, Numerical solution of quasi one dimensional nozzle flow and two dimensional supersonic flow.

Unit V

Explicit and implicit methods for incompressible coquette flow, SIMPLE type methods; fractional step methods, Turbulence modeling: Reynolds averaged, Navier-Stokes equations for supersonic flow over flat plate.

Text Book:

1. John D. Anderson, Computational Fluid Mechanics with basic applications, McGraw Hill, 2012.

Reference Books:

1. Blazek, J., Computational Fluid Dynamics: Principles and Applications, 2nd Edition, Elsevier Science & Technology, 2006.
2. Chung, T. J., Computational Fluid Dynamics, Cambridge University Press, 2003.
3. Versteeg, H. K. and Malalasekera, W., An Introduction to Computational Fluid Dynamics: The Finite Volume Method, 2nd Edition, Pearson, 2010.

Course outcomes:

- Student will be able to learn basic thoughts, equations and philosophy of computational fluid dynamics.

L-T-P	MME008A- Advanced Refrigeration and Air-Conditioning	Credits:4
3-1-0		

Course Objectives:

- To learn theoretical, principles and practical aspects of refrigeration and air conditioning systems.
- To learn the physical principles of three pillars of Refrigeration and Air Conditioning, namely thermodynamics, heat transfer, and fluid mechanics

Unit I

VAPOUR COMPRESSION REFRIGERATION: Performance of Complete vapor compression system.

Components of Vapor Compression System: The condensing unit – Evaporators – Expansion valve – Refrigerants – Properties – ODP & GWP - Load balancing of vapor compression Unit.

Compound Compression: Flash inter-cooling – flash chamber – Multi-evaporator & Multistage systems.

Unit II

PRODUCTION OF LOW TEMPERATURE: Liquefaction system ;Cascade System – Applications.– Dry ice system.

Vapor absorption system – Simple and modified aqua – ammonia system – Representation on Enthalpy –Concentration diagram. Lithium – Bromide system Three fluid system – HCOP.

Unit III

AIR REFRIGERATION: Applications – Air Craft Refrigeration -Simple, Bootstrap, Regenerative andReduced ambient systems – Problems based on different systems.

Steam Jet refrigeration system: Representation on T-s and h-s diagrams – limitations and applications.

Unconventional Refrigeration system – Thermo-electric – Vortex tube & Pulse tube – working principles.

Unit IV

AIR –CONDITIONING: Psychrometric properties and processes – Construction of Psychrometric chart. Requirements of Comfort Air –conditioning – Thermodynamics of human body – Effective temperature and Comfort chart – Parameters influencing the Effective Temperature. Summer , Winter and year round air – conditioning systems.

Cooling load Estimation: Occupants, equipments, infiltration, duet heat gain fan load, Fresh air load.

Unit V

AIR –CONDITIONING SYSTEMS: All Fresh air , Re-circulated air with and without bypass, with reheat systems – Calculation of Bypass Factor, ADP,RSHF, ESHF and GSHF for different systems.

Components: Humidification and dehumidification equipment – Systems of Air cleaning – Grills and diffusers – Fans and blowers – Measurement and control of Temperature and Humidity.

Text Book:

1. Arora, C. P., Refrigeration and Air-conditioning, TMH Edition, 2003.

Reference Books:

1. Refrigeration and Air Conditioning /Jordan& Preister /Prentice Hall
2. Roy J. Dossat, Principles of Refrigeration, 4th Edition, Prentice Hall of India (P) Ltd, 2004.

Course Outcomes:

- Students will be able to understand the fundamentals and will develop a working knowledge of the calculations involved.
- Students will be able to learn applications of refrigeration and air-conditioning, and maintenance and repair or commercial and domestic equipment.

L-T-P	MES001A- Research Methodology	Credits:4
3-1-0		

Course objectives:

- To learn progress from the beginning stage to the end of a research project with the research methodology for each step.
- To learn the quantitative and qualitative methodologies.

Unit I

Nature and Objectives of research; Methods of research: historical, descriptive and experimental. Study and formulation of research problem. Scope of research and formulation of hypotheses; Feasibility, preparation and presentation of research proposal.

Unit II

Introduction to statistical analysis: Measures of central tendency and dispersion: mean, median, mode, range, mean deviation and standard deviation. Regression and correlation analysis.

Unit III

Probability and probability distributions; Binomial, Poisson, Geometric, Negative binomial, Uniform, Exponential, Normal and Log-normal distribution. Basic ideas of testing of hypotheses; Tests of significance based on normal, t and Chi-square distributions.

Unit IV

Design of experiments: basic principles, study of completely randomized and randomized block designs. Analysis of variance technique.

Unit V

Edition and tabulation of results, presentation of results using figures, tables and text, quoting of references and preparing bibliography. Use of common softwares like SPSS, Mini Tab and/or Mat Lab. For statistical analysis.

Text Books:

1. Borth, Wayne C, et.Al., The Craft of Research: Chicago Guides to Writing Edition and Publishing.

Reference Books:

1. Meyer, P.L., Introduction to Probability & Statistical, Applications: Oxford, IBH.
2. Hogg, R.V. & Craig, A.T., Introduction to Mathematical Statistics, MacMillan.
3. Goon, A.M., Gupta, M.K. & Dasgupta, Fundamentals of Statistics, Vol.I: World Press.
4. Gupta, S.C. & Kapoor, V.K., Fundamentals of Mathematical Statistics, Sultan Chand & Sons.
5. Johnson, R.A., Probability and Statistics, PHI, New Delhi.

Course Outcomes:

- At the end of the course students will be able to understand formulation of a research problem with a research design and data collection for the research.

L-T-P	MME009A- Design of Heat Transfer Equipment	Credits:4
3-1-0		

Course Objective:

- To learn different term related to designing process and different methodology for equipment design.
- Gain knowledge of application of designing in different field of engineering.

Unit I

Introduction-Modes and mechanisms of heat transfer: Basic laws of heat transfer, General discussion about applications of heat transfer. Conduction, convection, and radiation Heat Transfer.

Unit II

Heat Exchanger Design Methodology, Basic Thermal Design Methods for Heat Exchangers, Effect of Uncertainties on the Design and Operation of Systems of Heat Exchangers Mechanical Design of Tubular Heat Exchangers fundamentals of single phase convection.

Unit III

Laminar Transport Coefficients for a Shell and Tube Geometry by the Method of Superposition, Air Cooled Heat Exchangers, Synthesis of Optimal Heat Exchanger Networks, Plate Heat Exchangers and Their Design Theory.

Unit IV

Various Methods of Classification of Heat Exchangers, LMTD and NTU Methods of Heat Exchangers, Counter flow double pipe (Hair-Pin) heat exchangers, shell and tube heat exchangers,

Unit V

Process Design of shell and tube exchanger for single phase and two phase heat transfer, boilers, condensers, cooling towers.

Text Books:

1. John J. McKetta Jr, Design of heat transfer equipment, CRC Press, 1999.

Reference Books:

1. Kern, D. Q., Process Heat Transfer, Tata McGraw Hill, New Delhi, 2001.
2. Kays, W. M. and London, A. K., Compact Heat Exchangers, 3rd Edition, Krieger Publishing Company,1998.
3. R. K. Shah, Eleswarapu Chinna Subbarao, R. A. Mashelkar
4. Incropera, F. P. and De Witt, D. P., Fundamentals of Heat and Mass Transfer, 6th Edition, Wiley India,2010.
5. Nag, P. K., Heat Transfer, 1st Edition, Tata McGraw Hill, New Delhi, 2012.

Course Outcomes:

- At the end of the course student will learn different aspects, principles and methods of designing with their practical knowledge.

L-T-P	MME010A - Advance CAD Lab	Credits:2
0-0-2		

List of Experiments

- Creation of working drawing, creating geometry, constraining the profile, extracting a part using tools
- Creating pattern of holes, translating rotating, mirroring, managing the specification tree.
- Creating sheets and views, creating text and dimensions, creating an assembly, moving components, assembling existing components,
- Creating bill of materials, creating wire frame and surface geometry using generative shape design and sweep tools.
- Generation of Ferguson's cubic surface patches
- Bezier surface patches.
- Coons patches.
- Import and export of drawing from other software.
- Linear static analysis, Automatic calculation of rigid body modes, uses specified eigen value shift, lumped and consistent mass matrices.
- Buckling analysis, Jacobi inverse iteration techniques.
- Steady state harmonic response, mode superposition method, overall structural and damping, linear dynamic analysis, non linear static analysis, non- linear dynamic analysis.
- Steady state heat transfer analysis problems. Transient heat transfer analysis. Familiarity with element library.
- Defining Boundary conditions, multipoint constraint familiarity with different types of loads.
- Solution techniques, direct and iterative solver. Results and analysis. Design optimization.

L-T-P	MME011A- Advanced Manufacturing Lab	Credits:2
0-0-2		

List of Experiments

- Hydraulic Bulge test and Erichsen test
- Mechanical properties of powder compacts
- Experiments on Rolling, Deep Drawing, Extrusion
- Uni-axial compression test to obtain true stress-strain data and to obtain the effects of lubrication
- Plane strain compression test for sheet type of specimen to obtain stress-strain behavior,
- Temperature distribution in arc welding
- Weld quality tests
- Work space analysis of manipulator.
- Experiments on TIG and MIG welding to find out the mechanical properties of metals
- Hydraulic and Pneumatic circuits
- Operation of tool and cutter grinder, twist drill grinder, Centreless grinder
- Determination of cutting forces in turning
- Inspection of parts using tool makers microscope, roughness and form tester
- PLC programming

L-T-P	MME012A-Finite Element Method	Credits:4
3-1-0		

Course Objectives:

- To learn mathematical modeling of engineering problems and approximate ways of analysis.
- Study will Helps to solve complex problems involving geometries, material properties, and loadings.

Unit I

Introduction and Direct Approach FEM: Concept of FEM, History, Packages, Range of applications, Steps in FEM, Approaches of FEM, Development of Elemental Equations for simple systems (i) Single dof problems-Spring Network, Hydraulic Network and Resistance Network (ii) Two dof problems- Plane Trusses and Frame structures; Assembly Procedure,

Unit II

Galerkin's and Rayleigh-Ritz FEM for 1-D and Radially Symmetric Scalar Field Problems:

Concept of Galerkin's and Raleigh-Ritz Mathematical Approaches, Governing Equation and Boundary Conditions for Heat Transfer-Rod and Fin, Solid Mechanics-Bar extension and Beam bending; Fluid Dynamics-parallel wall flow; Derivation of Element Matrices and Vectors, Assembly, Imposition of Boundary Conditions and Nodal Solution; Co-ordinate Transformation and Numerical Integration. Transient and Eigen Value Problems

Unit III

Galerkin's and Rayleigh-Ritz FEM for Plane (2-D) and Axisymmetric SINGLE VARIABLE Problems: Governing Equation and Boundary Conditions-Heat Transfer, Solid mechanics-Rod Torsion, Fluid Dynamics-Stream function and Velocity potential formulation, , Derivation of Element Matrices and Vectors, Assembly,

Unit IV

Galerkin's and Rayleigh-Ritz FEM for Plane (2-D) and Axisymmetric MULTI-VARIABLE Problems: Governing equation and Boundary conditions- Stress Analysis and Fluid Flow Analysis Problems: Weak Formulation and Functional, Polynomial Approximation, Derivation of Element Matrices and Vectors, Assembly, Imposition of Boundary Conditions and Nodal Solution, Post processing of solutions

Unit V

Galerkin's and Rayleigh-Ritz FEM for 3-D Problems: Governing equation and Boundary conditions-Heat Transfer and Elastic Stress Analysis Problems, Weak Formulation and Functional, Polynomial Approximation, Standard 3-D Shape Functions of C0 Continuity Elements, Derivation of Element Matrices and Vectors, Assembly, Imposition of boundary conditions and Nodal Solution; Mapping and Numerical Integration

Text Book:

1. Rao, S. S., The Finite Element Method in Engineering, 5th Edition, Elsevier 2011.

Reference Books:

1. Reddy, J. N. and Gartling D. K., The Finite Element Method in Heat Transfer and Fluid Dynamics, 3rd Edition, CRC Press, 2010.
2. Nithiarasu, P., Seetharamu, K. N. and Lewis, R. W., The Finite Element Method for Heat Transfer Analysis, John Wiley and Sons, 2004.

Course Outcomes:

- At the end of the course students will be able to learn variations and integral formulations in FEM.
- Students will gain knowledge of computer implementation of FEM like time-dependent situations, beams and frames..

L-T-P	MME013A- Incompressible and Compressible Flows	Credits:4
3-1-0		

Course Objectives:

- Students will learn explanation of the assumptions used in the analysis of compressible flows.
- To learn mathematical theory of vorticity and incompressible flow ranging from elementary introductory material to current research topics

Unit I

Introduction, motion of viscous fluid, Thermodynamic relation of perfect gas, Internal energy and enthalpy, Stagnation and sonic properties, laminar and turbulent flow, steady and unsteady flow, flow and non flow process, stream line.

Unit II

Effect of area variation on flow properties in isentropic flow, the energy equation rate equations for a control volume boundary layer theory, flow through nozzles and diffusers, impulse function.

Unit III

Flow with normal shock wave and oblique shock waves, flow in constant area ducts with friction and without friction, rarefaction wave, governing equation, change in entropy across shock, mach waves, fanno and Rayleigh flow.

Unit IV

Continuum Mechanics, Vector Calculus and Index Notation, Kinematics of Local Fluid Motion, Newtonian Fluids, Some Incompressible Flow Patterns, directions of flow, flow rate, flow visualization.

Unit V

Dimensional Analysis, Some Solutions of the Navier-Stokes Equations, Stream Functions and the Velocity Potential, Vorticity Dynamics, Flows at Moderate Reynolds Numbers

Text Books:

1. Yahya, S. M., Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion, 4th Edition, New Age Techno, 2010.

Reference Books:

1. Schlichting, H., Boundary Layer Theory, 8th Edition, Springer, 2004.
2. White, F. M., Viscous Fluid Flow, 3rd Edition, Tata Mcgraw Hill, 2011.
3. Ronald L. Panton is the J. H. Herring, Incompressible flow, Wiley India Pvt Ltd, 2011

Course Outcomes:

- Course develops in students an understanding of what causes compressible flows to differ from incompressible flows and how they can be analyzed.

L-T-P	MME014A - Jet and Rocket Propulsion	Credits:4
3-1-0		

Course Objective:

- Course will help an understanding of modern aircraft gas turbine engines, with the applicability (or lack of applicability) to military use.
- Course helps to learn different types of gas turbine and rocket propulsion for aerospace and mechanical engineers

Unit I

Jet Propulsion Introduction, Propulsion systems Types, Pulse Jet, Ram, Jet, Turbo-Jet, Efficiency And Power Of Propulsion, Flying Unit.

Unit II

Aerofoil Theory Aerofoil, Lift And Drag, Application to Axial Compressors, The Isolated Aerofoil, The Cascade Theory Cascade Nomenclature, Cascade Specification.

Unit III

Motion in Space, Rocket Principle, Nozzles, Chemical Propellants, Propulsion systems, choice of propulsion systems for missile and space launch vehicles, performance calculations, rocket propellants - performance of propellants.

Unit IV

Solid propellant, Liquid propellant, Monopropellant rockets , burning rate, erosive burning, liquid propellants, cryogenic bi-propellants, hyperbolic ignition and combustion, rocket propulsion technology - solid and liquid propellant rocket engines.

Unit V

Hybrid rockets, Combustion instability. Electrical rockets, Nuclear and advanced rockets choice of propellants, choice of chamber pressure and mixture ratio, hybrid rocket engines.

Text Books:

1. Barrere, M., Rocket Propulsion, EIsevier Pub. Co., 1990.

Reference Books:

1. Feedesiev, V. I. and Siniarev, G. B., Introduction to Rocket Technology, Academic Press, New York, 2000.
2. J. K. Jain khanna publishsers-delhi, 2003
3. Sutton, G. P. and Biblarj, O. Rocket propulsion elements, 7th Ed., New York: Wiley Intescience Pulications, 2001.
4. Ramamurthi, K., Rocket Propulsion, Macmillan (in press) 2009

Course Outcomes:

- At the end of the course students will learn basic concepts and gas dynamics; analysis of rocket propulsion systems; parametric and performance analysis of air breathing propulsion systems; and analysis and design of major gas turbine engine components.

L-T-P	MME015A - Measurements in Thermal Engineering	Credits:4
3-1-0		

Course Objectives:

1. To learn topics like Static and Dynamic Characteristics of Instruments, Sensors and Transducers, Display Devices and Recorders, Temperature Measurements, Mechatronics and Control Systems among many others.

Unit I

Introduction, Fundamental methods, Generalized measuring system, Types of input quantities, Standard and dimensional units of measurements, Types of error, Uncertainty, The chi-square distribution.

Unit II

The analog measurand, time dependent characteristics, simple and complex harmonic relations, Harmonic or Fourier analysis, Response of measuring system, Amplitude, Frequency and Phase response, Mechanical elements, Characteristics of first and second order systems.

Unit III

Signal conditioning, Voltage dividing circuits, Resistance bridges, Resonant circuit, Operational amplifiers, Digital techniques inn measurements, Fundamental digital circuit element, Binary codes, Analog to digital and digital to analog conversion.

Unit IV

Applied Measurement: Use of counters, Frequency standards, Displacement and dimensional measurement, Gage blocks, Monochromatic light, Measuring microscopes, Stress and strain measurement, Electrical and Metallic resistance strain gage, The strain gage bridge circuit.

Unit V

Measurement of - Force and torque, Pressure, Fluid flow, Temperature measurement and measurement of motion, Acoustical measurement

Text Book:

1. Holman, J. P., Experimental Methods for Engineers, Tata McGraw Hill Book Company, New Delhi, 2010.

Reference Books:

1. Thomas G. Beckwith and Lewis Buck, Mechanical Measurements, Narosa Publishing House, 2009.
2. Ernest, O. D., Measurement Systems - Applications and Design, Tata McGraw Hill Book Company, New Delhi, 2011

Course Outcomes:

- At the end of the course student will learn emphasizing precision and clarity with fundamental issues common to all areas of measurement.

L-T-P	MME018A- **Manufacturing Processes Design & Simulation**	Credits:4
3-1-0		

Course Objective:-

- To introduce different simulation techniques and processes used in manufacturing processes to the students and to relate the simulation models with the ongoing manufacturing processes.

UNIT 1: Introduction to Simulation, Systems, Models, Data Collection and Analysis, Monte Carlo Simulation, Types of system simulation, Decision making with simulation, applications.

UNIT 2: Queuing Models: Characteristics of queuing systems, queuing notions, long run measures of performance of queuing systems, steady state behavior of Markovian models (M/G/1, M/M/1, M/M/c) overview of finite capacity and finite calling population models, Network of queues. Monte Carlo simulation and its applications in Manufacturing Processes Simulation.

UNIT 3: Generation of (Pseudo) random numbers, Probability distributions and Probability densities, Sampling from probability distribution: Inverse method, Convolution method, Acceptance rejection method.

UNIT 4: Discrete Simulation, Continuous Simulation, Combined Simulation, Problem formulation, Mechanics of discrete simulation- discrete events, representation of time, generation of arrival pattern, simulation examples, simulation programming tasks, gathering statistics, measuring utilization and occupancy recording distributions and transit times, case studies.

UNIT 5: Steps to build a useful model of input data, data collection, verification of simulation models, validation process, simulation software, classification of simulation software and desirable software features, comparison of simulation packages with programming languages, general purpose simulation packages, object oriented packages, case studies.
Analysis of Simulation output, Importance of the variance of the sample mean, Procedure for estimating variance, Subinterval method, Replication Method, Regenerative method; Variance reduction techniques, Startup policies, Stopping rules, Statistical inferences, Design of experiments, Manufacturing Processes, Simulation case studies .

Text Books:

1. Law A. M., and Kelton, W. D., "Simulation Modeling and Analysis", 3rd edition, McGraw-Hill.

Reference Books:

1. Trivedi K. S., "Probability and Statistics with Reliability, Queueing, and Computer Science Applications", PHI.
2. Wadsworth G. P., and Bryan, J. G., "Introduction to Probability and Random Variables", McGraw-Hill.
3. Bernard, "Theory Of Modeling and Simulation"
4. Viswandhan N. and Narhari Y., "Performance Modeling of Automated Manufacturing Systems",
PHI India.
5. Fishwick P., "Simulation Model Design and Execution", Prentice Hall.
6. Ross, S., "Simulation", Academic Press.
7. Gordon G, "System Simulation", 2nd edition, PHI Learning.

Course Outcome :-

- Students will have an knowledge of various simulation methods and their applications and how the simulation techniques can reduce the lead time in manufacturing industries.

L-T-P 3-1-0	MME019A- Machining Processes & Analysis	Credits:4

Course Objective:-

- To impart students with the knowledge of the various aspects of the manufacturing and machining terminologies and to expose them to the mechanics of machining.

UNIT I. Introduction to Manufacturing and Machining: Identify the necessity of "manufacturing", Define with examples the concept of "manufacturing", List the main classifications of the manufacturing processes with examples , State the main purposes of "machining" , Define with examples the concept of "machining" , State with example the principles of "machining"**,** Define the concept of "machine tools".

UNIT II. Basic working principle, configuration, specification and classification of machine tools: (a) Describe the basic functional principles of machine tools (i) Illustrate the concept of Generatrix and Directrix (ii) Demonstrate Tool – work motions (iii) Give idea about machine tool drives (b) Show configuration of basic machine tools and state their uses (c) Give examples of machine tools - specification (d) Classify machine tools broadly

UNIT III. Tool Geometry: (a) learn geometry of single point turning tools (i) concept of rake and clearance angles (ii) systems of description of tool geometry (b) Study and show tool geometry (i) Machine Reference System (ASA) (ii) Tool Reference System

UNIT IV. Mechanics of Machining : (i) State the purposes of conversion of tool angles (ii) Identify the fourdifferent methods of conversion of tool angles (iii) Employ the graphical method for conversion of Rake angles, clearance angles, Cutting angles From ASA to ORS and ORS to ASA systems (iv) Convert rake angle and clearance angle from ORS to NRS (v) Demonstrate tool angle's relationship in some critical conditions.

UNIT V. Mechanism of chip formation : (i) describe with illustration the mechanism of chip formation in machining • ductile materials and brittle materials (ii) illustrate and assess geometrical characteristics of ductile chips : •chip reduction coefficient & cutting ratio , shear angle and cutting strain (iii) Identify and state the causes, characteristics and effects of built – up – edge (BUE) formation. (iv) Classify chips and identify the condition for different chip forms.

Orthogonal and oblique cutting: (i) define and distinguish, with illustrations, between orthogonal cutting and oblique cutting (ii) identify the causes of oblique cutting and chip flow deviation (iii) determine angle of chip flow deviation. (iv) illustrate and deduce effective rake angle (v) state the effects of oblique cutting

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Text Books:

1. Metal cutting theory and practice - A. Bhattacharyya

Reference Book:

1. Manufacturing Science by Amitabha Ghosh and Mallik
2. Modern machining process - PANDEY AND SHAH

Course Outcome :-

- Students will be able to understand the various terminologies of the machining tool and its mechanism and also will be able to analyse the mechanism of chip formation under different conditions

L-T-P	MME020A- Experimental Stress Analysis	Credits:4
3-1-0		

Course Objective:-

- To bring awareness on experimental method of finding the response of the structure to different types of load.

Unit-1

BASIC ELASTICITY: Laws of stress transformation, principal stresses and principal planes, Cauchy's stress quadric. Strain analysis, strain equations of transformation, Principal strain, Cauchy's strain quadric, stress-strain relationship.

TWO DIMENSIONAL PHOTO ELASTICITY: Stress optic law, optics of polariscope, plane and circular polariscope, dark and light field arrangements, fringe multiplication, fringe sharp ending, compensation techniques, commonly photo-elastic materials.

Unit-2

THREE DIMENSIONAL PHOTO ELASTICITY: Neuman's stain optic relationship, stress freezing in models, materials for three-dimensional photo-elasticity, shear-difference method of stress separation.

BI-REFRINGENT COATINGS: Sensitivity reinforcing effects and thickness of bi-refringent coatings.

Unit-3

ELECTRIC RESISTANCE STRAIN GAUGES: Gauge construction and installation, temperature compensation, gauge sensitivity, gauge factor, corrections for transverse strain effects. Factors affecting gauge relation, Rosettes, Rosettes analysis, potentiometer and wheatstone bridge circuits for strain measurements.

Unit-4

BRITTLE COATINGS: Introduction, coatings, stresses and failure theories, different types of crack patterns, crack detection, Composition of brittle coatings, coating cure, influence of atmospheric conditions, and effect of biaxial stress field.

Text Books:

1. Experimental Stress Analysis Dally & Ralley

Refrence Books:

1. Photo elasticity: Principles and Methods Jesseop & Harris
2. Theory of Plasticity J. Chakrabarty
3. Introduction to Photo Mechanics Durellil & Hiley

Course Outcome :-

- Students will be able to determine the stress analysis on different structures.

L-T-P	MME021A – MANUFACTURING SIMULATION & PRECISION ENGINEERING LABORATORY	Credits:2
0-0-2		

List of Experiments

- AGV planning
- ASRS simulation and performance evaluation
- Machines, AGVs and AS/RS integrated problems
- JIT system
- Kanban flow
- Material handling systems
- M.R.P. Problems
- Shop floor scheduling etc.
- Hydraulic and Pneumatic circuits
- Closed loop control systems
- Study of the chip formation in turning process
- Study of operation of tool and cutter grinder, twist drill grinder, Centreless grinder
- Determination of cutting forces in turning
- Experiments in unconventional manufacturing processes-AJM and study of USM, EDM, Laser Machining and Plasma spraying
- Inspection of parts using tool makers microscope, roughness and form tester
- Study of micro-controllers, programming on various CNC machine tools and also controllers
- Studies on PLC programming
- Study and programming of robots
- Condition monitoring in machining process using acoustic emission.

L-T-P	MME022A- CNC Technology & Programming	Credits:4
3-1-0		

Course Objective:-

- To introduce students with the advanced tool of manufacturing technology viz. CNC machines and to impart them the knowledge of the CNC machines and its programming.

UNIT I. **FUNDAMENTALS OF CNC MACHINES:** Introduction to Computer Numerical Control: CNC Systems – An Overview of Fundamental aspects of machine control, Different types of CNC machines – Advantages and disadvantages of CNC machines.

UNIT II. **CONSTRUCTIONAL FEATURES OF CNC MACHINES AND RETROFITTING:** Features of CNC Machines: Structure, Drive Mechanism, gearbox, Main drive, feed drive, Spindle Motors, Axes motors. Timing belts and pulleys, Spindle bearing, Slide ways, Re-circulating ball screws – Backlash measurement and compensation, linear motion guide ways. Tool magazines, ATC, APC, Chip conveyors. Retrofitting of Conventional Machine Tools

UNIT III. **CONTROL SYSTEMS, FEED BACK DEVICES AND TOOLING:** Description of a simple CNC control system. Interpolation systems. Features available in a CNC system – introduction to some widely used CNC control systems. Types of measuring systems in CNC machines – Incremental and absolute rotary encoders, linear scale – resolver – Linear induction – Magnetic Sensors for Spindle Orientation. Qualified and pre-set tooling – Principles of location – Principles of clamping – Work holding devices.

UNIT IV. **CNC PART PROGRAMMING:** Part Program Terminology-G and M Codes – Types of interpolation Methods of CNC part programming – Manual part programming – Computer Assisted part programming – APT language – CNC part programming using CAD/CAM-Introduction to Computer Automated Part Programming.

UNIT V. **ECONOMICS AND MAINTENANCE:** Factors influencing selection of CNC Machines – Cost of operation of CNC Machines – Practical aspects of introducing CNC machines in industries – Maintenance features of CNC Machines – Preventive Maintenance, Other maintenance requirements.

Text Book:

1. Computer Numerical Control Machines P. Radahkrishnan

Reference Book:

1. Automation, Production systems and Computer Integrated Manufacturing M.P. Groover
2. Computer Integrated Manufacturing Paul Ranky
3. CNC Machines M.S. Sehrawat and J.S. Narang
4. CNC Programming Handbook Smid Peter

Course Outcome :-

- Graduates will be exposed to the CNC machines and their types. Be aware of the working, construction and functioning of the CNC machines and how to build a CNC program.

L-T-P 3-1-0	MME023A- Tool Engineering	Credits:4

Course Objective:-

- Ability to understand various aspects of metal cutting, pressing and work holding devices.

Unit 1. Introduction to Tool design

Introduction –Tool Engineering – Tool Classifications– Tool Design Objectives – Tool Design in manufacturing- Challenges and requirements- Standards in tool design-Tool drawings - Surface finish – Fits and Tolerances - Tooling Materials- Ferrous and Non ferrous Tooling Materials-Carbides, Ceramics and Diamond -Non metallic tool materials-Designing with relation to heat treatment

Unit 2. Design of cutting Tools

Mechanics of Metal cutting –Oblique and orthogonal cutting- Chip formation and shear angle - Single-point cutting tools – Milling cutters – Hole making cutting tools- Broaching Tools - Design of Form relieved and profile relieved cutters-Design of gear and thread milling cutters

Unit 3. Design of Jigs and Fixtures

Introduction – Fixed Gages – Gage Tolerances –selection of material for Gages – Indicating Gages – Automatic gages – Principles of location – Locating methods and devices – Principles of clamping – Drill jigs – Chip formation in drilling – General considerations in the design of drill jigs – Drill bushings – Methods of construction –Thrust and Turning Moments in drilling - Drill jigs and modern manufacturing- Types of Fixtures – Vise Fixtures – Milling Fixtures – Boring Fixtures – Broaching Fixtures – Lathe Fixtures – Grinding Fixtures – Modular Fixtures – Cutting Force Calculations.

Unit 4. Design of Forming Tools

Types of Sheet Metal Dies –Method of Die operation–Clearance and cutting force calculations-Blanking and Piercing die design – Pilots – Strippers and pressure pads- Presswork materials – Strip layout – Short-run tooling for Piercing – Bending dies – Forming dies – Drawing dies-Design and drafting. Design of Bulk forming dies and moulds for metals and plastics.

Unit 5. Tool Design for CNC machine tools

Introduction –Tooling requirements for Numerical control systems – Fixture design for CNC machine tools- Sub plate and tombstone fixtures-Universal fixtures– Cutting tools– Tool holding methods– Automatic tool changers and tool positioners – Tool presetting– General explanation of the Brown and Sharp machine

Text Book:

1. Cyrll Donaldson, George H.LeCain, V.C. Goold, "Tool Design", Tata McGraw Hill Publishing Company Ltd., 2000.

Reference Book:

1. Prakash Hiralal Joshi, "Tooling data", Wheeler Publishing, 2000
2. Venkataraman K., "Design of Jigs, Fixtures and Presstools", TMH, 2005
3.Haslehurst M., "Manufacturing Technology", The ELBS, 1978
4. E.G.Hoffman," Jig and Fixture Design", Thomson Asia Pvt Ltd, Singapore, 2004

Course Outcome :-

- Students will be able to understand the basics of tool engineering, classify the tooling and machine tools and recognize various types of operations performed on different machine tools.

L-T-P	MME024A- Advanced Manufacturing Processes	Credits:4
3-1-0		

Course Objective:-

- To understand the basic concepts of Manufacturing and allied processes

UNIT I

Advanced Machining Processes: Classification of Advanced Machining Process. MECHANICAL ENERGY BASED PROCESSES: AJM, WJM, AWJM and USM- Working Principles, Equipment, Process parameters, Applications. ELECTRICAL ENERGY BASED PROCESSES: EDM & WEDM - Working Principles, Equipment, Process parameters, Applications.

UNIT II

CHEMICAL AND ELECTROCHEMICAL ENERGY BASED PROCESSES: CHM and ECM Working Principles, Equipment, Process parameters, Applications. THERMAL ENERGY BASED PROCESSES: LBM, PAM, EBM- Working Principles, Equipment, Process parameters, Applications.

UNIT III

Advanced Casting Processes: Metal mould casting, Continuous casting, Squeeze casting, Vacuum mould casting, Evaporative pattern casting, Ceramic shell casting.

UNIT IV

Advanced Welding Processes: Electron beam welding (EBW), laser beam welding (LBW), ultrasonic welding (USW).

UNIT V

Advanced Metal Forming Processes: Details of high energy rate forming (HERF) process, Electromagnetic forming, explosive forming, Electro-hydraulic forming, Stretch forming, Contour roll forming

Text Books:

1. "Nontraditional Manufacturing Processes", G.F. Benedict, Marcel Dekker, Inc. New York.

Reference Books

1."Materials and Processes in Manufacturing", E. P. DeGarmo, J. T Black, R. A. Kohser, Prentice Hall of India, New Delhi
3.“Modern Machining Processes” Pandey P.C. and Shan H.S. Tata McGraw-Hill, New Delhi.
6.“Advanced Machining Processes” Vijay.K. Jain, Allied Publishers Pvt. Ltd., New Delhi.
7.“Manufacturing Engineering & Technology”, Kalpakjian. S., Pearson Education Asia.

Course Outcome :-

- Students will be able to gain the knowledge of basic manufacturing processes and their applications in the practical world.

L-T-P 0-0-2	MME025A -MECHATRONICS AND AUTOMATION LAB	Credits:2

List of Experiments

- Experiments on Instrumentation Tutor Kit
- Servo Fundamentals Trainer, PLC, Mechatronics Training System
- Pneumatic Trainer and Programming on Micro-controller based autonomous Robot
- Simulation of automation systems using Automation studio
- Features and selection of CNC turning and milling centers.
- Practice in part programming and operation of CNC turning machines, subroutine techniques and use of cycles.
- Practice in part programming and operating a machining center, tool Joining and selection of sequences of operations, tool setting on machine
- Practice in APT based NC programming.
- Practice in Robot programming and its languages.
- Robotic simulation using software. Robot path control
- Preparation of various reports and route sheets
- Simulation of manufacturing system using CAM software, controller operating system commands.

L-T-P	MME026A- Composite Materials & Processing	Credits:4
3-1-0		

Course Objective:-

- To introduce students the different types of the composites compositions and their mechanical properties.

UNIT1. Introduction: Classifications of Engineering Materials, Concept of composite materials, Matrix materials, Functions of a Matrix, Desired Properties of a Matrix, Polymer Matrix (Thermosets and Thermoplastics), Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc. Types of Reinforcements/Fibers: Role and Selection or reinforcement materials, Types of fibres, Glass fibers, Carbon fibers, Aramid fibers , Metal fibers, Alumina fibers, Boron Fibers, Silicon carbide fibers, Quartz and Silica fibers, Multiphase fibers, Whiskers, Flakes etc., Mechanical properties of fibres. Material properties that can be improved by forming a composite material and its engineering potential

UNIT2. Various types of composites: Classification based on Matrix Material: Organic Matrix composites, Polymer matrix composites (PMC), Carbon matrix Composites or Carbon-Carbon Composites, Metal matrix composites (MMC), Ceramic matrix composites (CMC); Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer (FRP) Composites, Laminar Composites, Particulate Composites, Comparison with Metals, Advantages & limitations of Composites

UNIT3. Fabrication methods: Processing of Composite Materials: Overall considerations, Autoclave curing, Other Manufacturing Processes, Fiber-only performs, Combined Fiber-Matrix performs, Manufacturing Techniques: Tooling and Specialty materials, Release agents, Peel plies, release films and fabrics, Bleeder and breather plies, bagging films

UNIT4. Testing of Composites: Mechanical testing of composites, tensile testing, Compressive testing, Intralaminar shear testing, Inter-laminar shear testing, Fracture testing etc.

UNIT5. Characterisations techniques: SEM, TEM, XRD, DSC, DTA, TGA, DMA etc.

Text book:

1. Mechanical Metallurgy by G. Dieter Mc-Graw Hill

Reference book:

1. Thermal Analysis of Materials by R.F. Speyer, Marcel Decker
2. Engineering Materials: Polymers, Ceramics and Composites A.K Bhargava Prentice Hall of India
3. Materials characterisation, Vol. 10, ASM hand book

Course Outcome :-

- Students will be able to develop the basic knowledge of different types of composite materials and how they are being fabricated.
- They will be aware of various mechanical changes when composites are subjected to the mechanical testings.

L-T-P	MME027A- Manufacture of Plastic Products	Credits:4
3-1-0		

Course Objective:-

- To impart students with the knowledge of the polymer materials and how they are being manufactured.

UNIT-I

Introduction: polymeric materials, Engineering plastics, Polymer alloys, Selection of plastics.

UNIT-II

Mechanical properties, Degradation, Wear resistance, Frictional properties, Special properties, Structural features, Expanded plastics, Plastics as packaging material.

UNIT-III

Theoretical aspects; Visco-elastic behaviour, Mathematical models for visco-elastic behaviour, Deformation behaviour of plastics, Reinforced plastics.

UNIT-IV

Analysis of polymer melt flow; Newtonian and non Newtonian fluid flow, Flow in circular section, Flow in rectangular section etc.

UNIT-V

Overview and analysis of various plastics forming operations; Extrusion, Injection moulding, Thermoforming, Calendaring, Compression moulding, Blow moulding, Transfer moulding, Processing of reinforced plastics, Die design for simple components.

Text Books:

1. James F. Stenvension, Innovation in Polymer Processing Moulding, Hanser Publishers, New York, 1996.

Reference Books:

1. Friedhelm Henson, Plastics Extrusion Technology, Hanser Publishers, New York,1988.
2. Brunt Strong, Plastics: Materials and Processing, Prentice-Hall, New Jersey, 1996.
3. William J.Patton, Plastics Technology : Theory, Design and Manufacture, Prentice Hall
4. A Brent Strong, Plastics : Materials and Processings, Prentice Hall
5. Donald V. Rosato, Injection Moulding Handbook, International Thomson Publishing Company, 1985.

Course Outcome :-

- Graduates will be aware of the applications and the basic mechanical and analytical properties of the polymeric materials.
- They will be able to know the processes of manufacturing components of polymers.

L-T-P 3-1-0	MME028A- Rapid Prototyping & Tooling	Credits:4

Course Objective:-

- Conceptualization of product, impart the knowledge of the advanced manufacturing techniques for building of prototypes.

UNIT1. Introduction

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

UNIT2. Liquid based and solid based rapid prototyping systems

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

UNIT3. Powder based rapid prototyping systems:

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

UNIT4. Reverse Engineering and CAD Modeling

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

UNIT5. Rapid Tooling

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

Text Book:

1. Rapid prototyping: Principles and applications, second edition, Chua C.K., Leong K.F., and Lim C.S., World Scientific Publishers, 2003.

Reference Book:

1. Rapid prototyping, Andreas Gebhardt, Hanser Gardener Publications, 2003.
2. Rapid Prototyping and Engineering applications : A tool box for prototype development, Liou W.Liou, Frank W.Liou, CRC Press, 2007.
3. Rapid Prototyping: Theory and practice, Ali K. Kamrani, Emad Abouel Nasr, Springer, 2006
4. Rapid Tooling: Technologies and Industrial Applications, Peter D.Hilton, Hilton/Jacobs, Paul F.Jacobs, CRC press, 2000.

Course Outcome :-

- Students will be able to generate the knowledge of different prototyping systems and their application in practical world for manufacturing processes.

L-T-P	MME029A- Welding & Allied Processes	Credits:4
3-1-0		

Course Objective:-

- Introducing the concepts of welding and their different types of welding processes for joining two metals.

UNIT I .Welding Power Sources:
Types of power sources, External V-I characteristics for constant current and constant voltage power sources, Rectifiers, Solid-state Rectifiers, Inverter systems, Duty cycle.
Arc welding consumables:
Types of electrodes, AWS and Indian system of classification and coding of covered electrode for mild steel, Shielding gases and associated mixtures.

UNIT II. Metal transfer:
Short circuit/ dip transfer, Free flight, Globular type, Spray type, Forces affecting metal transfer, Weld bead geometry and shape factors, Weld dilution.

UNIT III. Arc welding processes:
Electric arc welding principle, MIG: -welding equipment and processes, shielding gas, types of metal transfer. Tungsten inert gas arc welding (GTAW): - welding equipment, electrodes, inert gases and torches. Submerged arc welding (SAW):- principle of processes, applications, fluxes and welding electrodes used. CO2 welding: - difference from MIG welding, Principle of operation, equipment, welding parameters and applications.
Solid state welding:
Introduction, main features and applications of Ultrasonic welding, Friction welding and Explosive welding.
Welding of plastics:
Difficulties in welding of Plastics, Processes for welding of Plastics.

UNIT IV. Weldability of specific Materials:
Stainless Steel, Aluminum and Cast Iron.
Surfacing and metal spraying:
Surfacing methods such as SMAW, MIG, TIG, SAW. Thermal spraying: Introduction, Procedures, Applications, Advantages and Disadvantages.
Thermal cutting of metals:
introduction, types, principle and operation of flame and plasma cutting.
Under water Welding:
Introduction, methods and applications

UNIT V. Automation in Welding:
Introduction, Semiautomatic welding, Automatic welding, Welding mechanization, Flexible Automated Welding, Robotic welding, Types of Welding Robots, Robot Selection Mechanics, Joint tracking system.

Text Book:
1. Modern welding technology:- carry H. B. (PH).
Reference Book:
1. Welding technology :- R. S. Parmar
2. AWS- welding handbook(IV – VI) Edition
3. Welding technology :- A. C. Devis
4. Welding and welding Technology :- Little (TMH)

Course Outcome :-

- Students will have the knowledge of different welding processes and their applications in real world

L-T-P	MME030A- Advanced Engineering Materials	Credits:4
3-1-0		

Course Objective:-

- Conceptualization of product, impart the knowledge of the advanced engineering materials.

UNIT I

The Structures of Materials:

Metals, Ceramics, Polymers and Composites;

Properties: Chemical, Physical, Mechanical and Dimensional Properties;

UNIT II

Ferrous Alloys:

Heat Treatments, Selective and Surface-Hardening, Specifications, Low Alloy and High Alloy Steels, Tool Steels, Stainless Steels, Cast irons;

UNIT III

Non-ferrous Alloys: Copper and its alloys, Aluminium and its alloys, Nickel, Zinc, Titanium, Magnesium and Refractory Metals; Shape Memory Phenomenon and Alloys; Ceramics, Cermets, Glass and Carbon Products; Engineering Plastics, Polymeric Coatings and Adhesives; Failure Prevention; and The Selection Process

Text Books:

1. Engineering Design; A Materials and processing approach by Dieter, G.E., McGraw Hill,1991

Books recommended:

1. Engineering Design; A Materials and processing approach by Dieter, G.E., McGraw Hill,1991
2. Materials selection in Mechanical Design by Ashby, M.F., Pergamon press, 1992
3. Plastics Technology, Theory, Design and Manufacture by Patton, W.J., Lenton Publishing Co.
4. Introduction To Engineering Materials & Manufacturing Processes by NIIT, Prentice- Hall of India.
5. Kenneth G. Budinski, Engineering Materials Properties and Selection, Prentice Hall of India
6. R.A. Higgins, Engineering Metallurgy Part 1, Edward Arnold
7. Gladius Lewis, Selection of Engineering Materials, Prentice-Hall, New Jersey, USA

Course Outcome :-

- Students will have the knowledge of different engineering materials and their applications in real world

L-T-P	MME031A- Advance Computer Integrated Manufacturing	Credits:4
3-1-0		

Course Objective:-

- Conceptualization of product, impart the knowledge of the advanced computer integrated manufacturing.

UNIT I

Introduction

The meaning and origin of CIM- the changing manufacturing and management scene – External communication - islands of automation and software-dedicated and open systems-manufacturing automation protocol - product related activities of a company- marketing engineering – production planning - plant operations - physical distribution- business and financial management.

UNIT II

Components of CIM

Building blocks of flexible manufacturing system; Manufacturing Machines and their Design Consideration e.g. CNC Turn, CNC Mill etc., Pallet, CMM, Measuring Probes, Robots, Job Loading & Unloading Arm, Work Transfer stations, Assembly Stations, Automated Storage Retrieved System (ASRS), Material Handling Systems: Automated Guided Vehicles (AGV), Conveyers, Computer Control System. Mechatronics: Sensors, Actuators, Convertors, Modular Automation.

UNIT III

Shop Floor Control & Integration of Components

Shop floor control-phases -factory data collection system -automatic identification methods- Bar code & RFID technology-automated data collection system, Integration of manufacturing & business functions.

TEXT BOOK:

1. Nanua Singh "Systems Approach to Computer Integrated Design and Manufacturing" John Wiley & Sons, Inc
2. Mikell.P.Groover "Automation, Production Systems and computer integrated manufacturing", Pearson Education 2001.

REFERENCE BOOKS:

1. Nand K. Jha "Hand-book of Flexible Manufacturing Systems" Academic Press, 1991
2. Yorem koren, "Computer Integrated Manufacturing System", McGraw-Hill, 1983.
3. Ranky, Paul G., "Computer Integrated Manufacturing", Prentice Hall International, 1986.
4. David D.Bedworth, Mark R.Hendersan, Phillip M.Wolfe "Computer Integrated Design and Manufacturing", McGrw-Hill.
5. Roger Hanman "Computer Intergrated Manufacturing", Addison – Wesley, 1997.
6. Mikell.P.Groover and Emory Zimmers Jr., "CAD/CAM", Prentice Hall of India Pvt. Ltd., New
Delhi-1, 1998.
7. Kant Vajpayee S, "Principles of Computer Integrated Manufacturing", Prentice Hall India, 2003.

Course Outcome :-

- Students will have the knowledge of different manufacturing materials and their applications in real world

L-T-P 3-1-0	MME032A- Advanced Mechanics of Solids	Credits:4

Course Objective:-

- Conceptualization of product, impart the knowledge of the advanced mechanics of solids.

UNIT I

Three dimensional stress and strain:

Principal stresses and strains, Mohr's circle representation of triaxial stresses and strains.

UNIT II

Unsymmetrical bending:

Shear centers for sections with one axis of symmetry, shear center for any unsymmetrical Section, stress and deflection of beams subjected to unsymmetrical bending.

Bending of plates:

Basic definition, stress curvature and moment relations, deferential equation of plate deflection. boundry conditions, simply supported rectangular plates, axis symmetric loaded Circular plates.

UNIT III

Contact stresses:

Point and line contact.

Buckling of columns:

Beam columns single concentrated load, number of concentrated loads, continuous lateral Load, end couple, couples at both ends triangular loads.

UNIT IV

Stress concentration:

Stress concentration in tension or compression members. Stresses in a plate with a circular hole, elliptical hole, small semi-circular grooves.

UNIT V

Beam on Elastic Foundations:

General theory, infinite, semi-infinite, finite beams classification of beams .Beam supported by equally spaced elastic elements.

Text Books:

1. Advanced strength and applied elasticity by R.C. Ugural, S.K. Fenster, Elsevier.

Refrence Books:

1. Mechanics of Solids By L.S Srinath
2. Strength of Material By G.H Ryder
3. Mechanics of Solid By Abdul Muubeen
4. Advanced mechanics of solids by Hugh ford Longmans.
5. Strength of material part-11 by S.Timoshenko affiliated East-West press pvt.Ltd, .N. Delhi

Course Outcome :-

- Students will have the knowledge of different materials and their applications in real world

L-T-P	MME033A- MEMS & NEMS	Credits:4
3-1-0		

Course Objective:-

- Conceptualization of product, impart the knowledge of the Mems & Nems

UNIT-I

Introduction, History, Development and need of Micro-Electro-Mechanical Systems. Overview of MEMS technology.

UNIT-II

Different electro-physical processes used for machining – dealing with MEMS materials; relevant nonconventional processes; IC fabrication processes used for MEMS.

UNIT-III

MEMS sensors and actuators; Mechanical process techniques and process models for micromachining;

UNIT-IV

Fabrication processes and design of the process sequences; Agile Prototyping of design and manufacturing processes in micro-machining and computer based design.

UNIT-V

Reliability and process control of micro manufacturing processes; Introduction and exposure to nanotechnology processes and systems.

Text Books

1. J. Pelesko & D. Bernstein, Modeling MEMS and NEMS

Reference Books

1. “RF MEMS and Their Applications”, Vijay Varadan, K. J. Vinoy, K. A. Jose, Wiley,2002.
2. “RF MEMS: Theory, Design, and Technology”, Gabriel M. Rebeiz, Wiley, 2003.
3. Marc Madou, Fundamentals of Microfabrication, 2nd Edition, CRC Press, 2002.
4. C. Liu, Foundations of MEMS
5. N. Maluf, An Introduction to Microelectromechanical Systems Engineering
6. J. Pelesko & D. Bernstein, Modeling MEMS and NEMS

Course Outcome :-

- Students will have the knowledge of Mems & Nems.

L-T-P 3-1-0	MME034A- Advance Metal Forming	Credits:4

Course Objective:-

- Conceptualization of product, impart the knowledge of the Advance metals

UNIT I:

Fundamentals of Metal Forming: Classification of forming processes, mechanism of metal forming,
temperature of metal working, hot working, cold working, friction and lubricants.

UNIT II:

Rolling of metals: Rolling processes, forces and geometrical relationship in rolling, simplified analysis,
rolling load, rolling variables, theories of cold and hot rolling, problems and defects in rolling, torque and power calculations.

UNIT III:

Forging: Classification of forging processes, forging of plate, forging of circular discs, open die and
closed-die forging, forging defects, and powder metallurgy forging.
Extrusion: Classification, Hot Extrusion, Analysis of Extrusion process, defects in extrusion, extrusion of tubes, production of seamless pipes.

UNIT IV:

Drawing: Drawing of tubes, rods, and wires: Wire drawing dies, tube drawing process,analysis of wire, deep drawing and tube drawing.
Sheet Metal forming: Forming methods, Bending, stretch forming, spinning and Advanced techniques of Sheet Metal Forming, Forming limit criteria, defect in formed parts. Advanced Metal forming processes: HERF, Electromagnetic forming, residual stresses, in-process heat treatment and computer applications in metal forming.

UNIT V:

Introduction to Press tool design: Design of various press tools and dies like piercing dies, blanking dies, compound dies and progressive blanking dies, design of bending, forming and drawing dies.
Analysis of Forming Process, Slab method, Upper & lower bound, FEM based simulation, slip line
theory, Use of CAE platform for Die Design & Simulation.

Text Books:

1. Mechanical Metallurgy / G.E. Dieter / Tata McGraw Hill, 1998. III Edition2. Principles of Metal Working / Sunder Kumar

References:

1. Principles of Metal Working processes / G.W. Rowe
2. ASM Metal Forming Hand book

Course Outcome :-

- Students will have the knowledge of advance metal forming.

L-T-P	MME035A- **Precision & Micro-machining**	Credits:4
3-1-0		

Course Objective:-

- Conceptualization of product, impart the knowledge of the Precision & Micro-machining

UNIT-I

INTRODUCTION: basic definition, size scales, scaling analysis, technology change, Lithographic Processes- Optical and X-ray.

UNIT-II

PRECISION ENGINEERING AND PRACTICES: Definitions, Sources of Error, Basic Concepts of Machining, Machine Tool Variables- accuracy, stiffness, spindle vibration, flatness, straightness, and smoothness of motion, 1-2 DOF systems, Feedback Variables, Cutting Tool Variables, Workpiece Variables, Environment Effects and Thermal Errors.

UNIT-III

INTRODUCTION TO MACHINING ANALYSIS: geometry of Cutting Edge, Energy Models, Comparison with Micro-scale Machining. DIAMOND MICROMACHINING: Introduction, Diamond as a Tool Material, Compatible Materials, Diamond Performance, Diamond Machining, Micro-mechanical Applications, Diamond Machining as a Micro-mechanical Process Research Method, Ductile Regime Grinding MICRO-ECM, MICRO-EDM etc.

UNIT-IV

MICROMILLING: Micro-milling Tools, Process Results and Micro-milling Applicationsmicromechanically milled X-ray masks, micro-milled mask materials, Mask Absorption Quantification, Exposure Quantification. MICRODRILLING: Micro-drilling and Macro-drilling Techniques. LASER MICROMACHINING: laser Optics, Laser Ablation, Heat Affected Zone and Laser Polymerisation. LIGA, S-LIGA

UNIT-V

Micro welding: Micro welding in similar and dissimilar materials; welding processes like ultrasonic, EB, LB; applications. Micro casting: Casting processes like vacuum, semi-solid state; applications. Processing of Integrated Circuits, Clean rooms, crystal growing and shaping of wafers, Etching, Photo and other lithography techniques, Impurity introduction, Thermal oxidation, CVD, Metallisation etc. IC packaging

Text Books:

1. Kluwer, "A new direction in manufacturing", Academic Publishers, London, 1997

Reference Books:

1. Jain V. K., "Introduction to micromachining", Narosa Publishers
2. M. Madou, "Fundamentals of microfabrication"
3. Momber A. W. and Kovacevic R., "Principles of water jet machining", Springer – Verlag
4. R. L. Murthy., "Precision engineering manufacturing", New Age International
5. G. Chryssolouris, "Laser machining – theory and practice", Springer Verlag, New York,1991
6. Kalpakjian, "Manufacturing engineering & technology", Addison – Wesley, 4nd Edition
7. Debitson A., "Hand book of precision engineering"
8. J. A. McGeough, "Advanced methods of machining", Chapman and Hall, London, 1988

Course Outcome :-

- Students will have the knowledge of Precision & Micro-machining