DEPARTMENT OF MECHANICAL ENGINEERING

M. Tech in Computer Aided Design Manufacture and Engineering (CADME)

I Semester

S.No	Course code	Course Title	Category	L	T	P	Credits
1	EME711	Computational Methods in Mechanical Engineering	CE	4	0	0	4
2	EME701	Advanced Mechanics of Solids	CE	4	0	0	4
3	EME702	Finite Element Analysis	CE	4	0	0	4
4	EME713	Design for Manufacturing	CE	4	0	0	4
5	EMExxx	Programme Elective – I	PE	3	0	0	3
6	Exxxxx	Interdisciplinary Elective - I	IDE	3	0	0	3
7	EME725	CAE Lab	CE	0	0	3	2
8	EME727	Finite Element Analysis Lab	CE	0	0	3	2
							26

M. Tech in Computer Aided Design and Manufacture Engineering (CADME)

II Semester

S.No	Course code	Course Title	Category	L	T	P	Credits
1	EME714	Computer Integrated Manufacturing	CE	4	0	0	4
2	EME716	Mechanical Measurements	CE	4	0	0	4
3	EME718	Theory of Vibrations	CE	4	0	0	4
4	EMExxx	Programme Elective – II	PE	3	0	0	3
5	EMExxx	Programme Elective – III	PE	3	0	0	3
6	Exxxxx	Interdisciplinary Elective – II	IDE	3	0	0	3
7	EME724	CAD/CAM Lab	CE	0	0	3	2
8	EME720	Mechanical Engineering Lab	CE	0	0	3	2
9	EME792	Technical Seminar	CE	0	0	3	2
							27

M. Tech in Computer Aided Design and Manufacture Engineering (CADME)

III Semester

1	EME891	Project Work-I	PW	8
2	EME893	Comprehensive Viva Voce	CE	2
				10

M. Tech in Computer Aided Design and Manufacture Engineering (CADME)

IV Semester

1	EME892	Project Work-II	PW	14

Programme Elective-I

S.No	Course code	Course Title
1	EME771	Mechanics of Composite Materials
2	EME751	Theory of Mechanisms
3	EME753	Virtual Manufacturing

Programme Elective-II

S.No	Course code	Course Title
1	EME752	Non Destructive Testing
2	EME754	Non Linear FEA
3	EME773	Computational Fluid Dynamics

Programme Elective-III

S.No	Course code	Course Title
1	EME756	Fatigue and Fracture
2	EME758	Acoustics and Noise Control
3	EME760	Design of Transmission Elements

Interdisciplinary Elective - I

S.No	Course code	Course Title
1	EME743	Design of Experiments
2	EME745	Reliability Engineering
3	EME762	Optimization Methods in Engineering

Interdisciplinary Elective – II

S.No	Course code	Course Title
1	EID743	Computer Graphics
2	EEI703	Virtual Instrumentation Systems
3	EME767	Mechatronics

Total Number of Credits:

Year	Semester	Proposed Credits
I	I	**26**
	II	**27**
II	III	**10**
	IV	**14**
Total		**77**

EEI703: VIRTUAL INSTRUMENTATION SYSTEMS

L	T	P	C
3	0	0	3

Module I **8 hours**

Introduction: Virtual instrumentation, definition, flexibility, block diagram and architecture of virtual instruments, virtual instruments versus traditional instruments data flow techniques- graphical programming in dataflow.

Module II **8 hours**

VI Programming Techniques: VI, sub VI, loops, structures, charts, arrays,clusters, graphs, formula node, local and global variable, strings, file I/O, execution control, instrumentdrivers.

Module III **8 hours**

Signal Conditioning in VI: Introduction, types of signal conditioning,classes of signal conditioning, plugin board signal conditioning, directconnect modular-two-wire transmitter and distributed I/O, digitaltransmitter, field wiring and signal measurement, ground loops.

Module IV **8 hours**

Data Acquisition in VI: Introduction to data acquisition, A/D, D/Aconverters, plug-in DAQ boards, analog input/output cards, digital Input/output cards, counter and timer I/O boards, real-time data acquisition.

Module V **10 hours**

Communication Networked Modules: Introduction to PC Buses, Localbus: ISA, PCI, RS232, RS422, RS485, Interface Bus, USB, PCMCIA.
Instrumentation buses: Introduction to bus protocols of MOD bus and CANbus, GPIB, networked bus, ISO/OSI references model, Ethernet, and VISA.

Text Book(s)

1. P. Sumathi, LabView based Advanced Instrumentation System, 1/e, Elsevier Publications, 2007.
2. John Park, Steve Mackay, Practical Data Acquisition for Instrumentation and Control Systems, 1/e, Elsevier Publications, 2004

References

1. Gary Johnson, LabView Graphical programming, 1/e, McGraw Hill, 1997.
2. Lisa K. Wells, Jeffrey Travis, LabView for Everyone, 1/e, Prentice Hall, 1997.

EME711 COMPUTATIONAL METHODS IN MECHANICAL ENGINEERING

L	T	P	C
4	0	0	4

ModuleI **10 hours**

Mathematical Modeling of Engineering Problems:

Approximations: Accuracy and precession, round-off and truncation errors, error problem with example problems.
Roots of Equations: Formulations of linear and nonlinear algebraic equations, solution with bisection, incremental searches, Newton-Raphson and Secant methods. Applicationto practical problems.
Algebraic Equations: Formulation of linear algebraic equations from engineering problems, solution of these problems by Gauss elimination method, pitfalls of elimination and techniques for improving the solutions, Gauss Seidel iteration for solving sparse equations by avoiding storage of zero coefficients in matrix, convergence of iteration methods. LU decomposition methods for unsymmetric (Crouts) and symmetric (Chelosky) matrices.

Module II **10 hours**

Eigen Values and Eigenvectors Problems: Formulation of equations to column, truss, spring-mass and friction problems. Solutions for the largest and smallest eigenvalues and corresponding eigenvectors.
Interpolation Methods: Polynomial interpolation, Lagrange interpolation polynomials with equi-spaced data.
Regression or curve fitting: Linear regression by least square, coefficient of correlation, multi linear regression.

Module III **10 hours**

Initial Value Problems: Ordinary differential equations, Euler and modified Euler methods, Range- Kutta method of 2^{nd} and 4^{th} order, application to vibration and heat transfer problems.
Boundary Value Problems: Linear and nonlinear ordinary differential equations, boundary value problems over semi-infinite domain, solution of nonlinear equations by finite difference method.

Module IV **10 hours**

Laplace and Poisson equations: Finite difference discretization of computational domain, different types of boundary conditions, solution to elliptic equations.
Parabolic Transient Diffusion Equations: Explicit and implicit formulation, Crank Nicolson equation.
Transform Techniques : Continuous Fourier series, frequency and time domain, Fourier integral transform, discrete Fourier transform (DFT), Fast Fourier transform (FFT), Laplace transform.

Module V **10 hours**

Numerical integration: Trapezoidal, Simpson's rule andGauss quadrature.
Optimization: one dimensional unconstrained optimization, Golden section search, Newton's method, constrained optimization.

References:

1. S.P. Venkateshan, P. Swaminathan, Computational Methods in Engineering, 1/e, Ane Publisher, 2014.
2. S.C. Chapra, R.P. Canale, Numerical Methods for Engineers, 6/e, Tata McGraw-Hill, 2012.
3. S.K. Gupta, Numerical Methods for Engineers, 1/e, New Age International, 2005

EME714 COMPUTER INTEGRATED MANUFACTURING

L	T	P	C
4	0	0	4

Module I **9 Hours**

Computer aided design: Concept of CAD as drafting and designing facility, desirable features of CAD package, drawing features in CAD – Scaling, rotation, translation, editing, dimensioning, labeling, Zoom, pan, redraw and regenerate, typical CAD command structure, wire frame modeling, surface modeling and solid modeling (concepts only) in relation to popular CAD packages.

Module II **9 Hours**

Components of CIM : CIM as a concept and a technology, CASA/Sme model of CIM, CIM II, benefits of CIM, communication matrix in CIM, fundamentals of computer communication in CIM – CIM data transmission methods – seriel, parallel, asynchronous, synchronous, modulation, demodulation, simplex and duplex. Types of communication in CIM – point to point (PTP), star and multiplexing. Computer networking in CIM – the seven layer OSI model,LAN model, MAP model, network topologies – star, ring and bus, advantages of networks in CIM

Module III **9 Hours**

Group technology and computer aided processplanning: History Of Group Technology – role of G.T in CAD/CAM Integration – part families- classification and coding – DCLASS and MCLASS and OPTIZ coding systems – facility design using G.T – benefits of G.T – cellular manufacturing.Process planning - role of process planning in CAD/CAM Integration – approaches to computer aided process planning – variant approach and generative approaches – CAPP and CMPP systems.

Module IV **9 Hours**

Shop floor control and introduction to FMS: Shop floor control – phases – factory data collection system – automatic identification methods – Bar code technology – automated data collection system.

FMS – components of FMS – types – FMS workstation – material handling and storage system –FMS layout- computer control systems – applications and benefits.

Module V **9 Hours**

Computer aided planning and control and computer monitoring: Production planning and control – cost planning and control – inventory management – material requirements planning (MRP) – shop floor control. Lean and Agile Manufacturing. Types of production monitoring systems – structure model of manufacturing – process control and strategies – direct digital control.

References:

1. Mikell P. Groover, Automation, Production Systems, and ComputerAided Manufacturing, 2/e., Prentice Hall, 2001.
2. Mikell P. Groover, and Zimmers, CAD/CAM: Principles andApplications, 3/e, Tata-McGraw hill, 2010.
3. YoremKoren, “ Computer Integrated Manufacturing”, McGraw Hill, 2005.
4. M.M.M. Sarcar, K. Mallikarjuna Rao, K. Lalit Narayan, Computer AidedDesign and Manufacturing, 2/e, Prentice Hall of India, 2008.

EME701 ADVANCED MECHANICS OF SOLIDS

L	T	P	C
4	0	0	4

MODULE-I **11 hours**

Analysis of Stress: Introduction, Body Force, Surface Force and Stress Vector, The State of Stress at a Point, Normal and Shear Stress Components, Rectangular Stress Component, Stress Components on an Arbitrary Plane, Digression on Ideal Fluid, Equality of Cross Shears, A More General Theorem, Principal Stresses, Stress Invariants, Principal Planes are Orthogonal, Cubic Equation has Three Real Roots, Particular Cases, Recapitulation, The State of Stress Referred to Principal Axes, Mohr's Circles for the Three-dimensional State of Stress, Mohr's Stress Plane, Planes of Maximum Shear, Octahedral Stresses, The State of Pure Shear, Decomposition into Hydrostatic and Pure Shear States, Cauchy's Stress Quadric, Lame's Ellipsoid, The Plane State of Stress, Differential Equations of Equilibrium, Equilibrium Equations for Plane Stress State, Boundary Conditions, Equations of Equilibrium in Cylindrical Coordinates, Axisymmetric Case and Plane Stress Case.

MODULE-II **12 hours**

Analysis of Strain: Introduction, Deformations, Deformation in the Neighborhood of a Point, Change in Length of a Linear Element, Change in Length of a Linear Element—Linear Components, Rectangular Strain Components, The State of Strain at a Point, Interpretation of γ_{xy}, γ_{yz}, γ_{xz} as Shear Strain Components, Change in Direction of a Linear Element, Cubical Dilatation, Change in the Angle between Two Line Elements, Principal Axes of Strain and Principal Strains, Plane State of Strain, The Principal Axes of Strain Remain Orthogonal after Strain, Plane Strains in Polar Coordinates, Compatibility Conditions, Strain Deviator and its Invariants.

Stress–Strain Relations for Linearly Elastic Solids: Introduction, Generalized Statement of Hooke's Law, Stress–Strain Relations for Isotropic Materials, Modulus of Rigidity, Bulk Modulus, Young's Modulus and Poisson's Ratio, Relations between the Elastic Constants, Displacement Equations of Equilibrium.

MODULE-III **12 hours**

Energy Methods: Introduction, Hooke's Law and the Principle of Superposition, Corresponding Force and Displacement or Work-absorbing Component of Displacement, Work Done by Forces and Elastic Strain Energy Stored, Reciprocal Relation, Maxwell–Betti–Rayleigh Reciprocal Theorem,Generalized Forces and Displacements, Begg'sDeformeter, First Theorem of Castigliano, Expressions for Strain Energy, Fictitious Load Method, Superposition of Elastic Energies, Statically Indeterminate Structures, Theorem of Virtual Work, Kirchhoff's Theorem, Second Theorem of Castigliano or Menabrea's Theorem, Generalization of Castigliano's Theorem or Engesser's Theorem, Maxwell–Mohr Integrals.

Bending of Beams: Introduction, Straight Beams and Asymmetrical Bending, Regarding Euler–Bernoulli Hypothesis, Shear Centre or Centre of Flexure, Shear Stresses in Thin-walled Open Sections: Shear Centre, Shear Centers for a Few Other Sections, Bending of Curved Beam (Winkler-Bach Formula), Deflections of Thick Curved Bars.

MODULE-IV **10 hours**

Torsion: Introduction, Torsion of General Prismatic Bars–Solid Sections, Alternative Approach, Torsion of Circular and Elliptical Bars, Torsion of Equilateral Triangular Bar, Torsion of Rectangular Bars, Membrane Analogy, Torsion of Thin-walled Tubes, Torsion of Thin-walled Multiple-Cell Closed Sections, Torsion of Bars with Thin Rectangular Sections, Torsion of Rolled Sections, Multiply-Connected Sections, Centre of Twist and Flexural Centre.

MODULE-V **11 hours**

Axisymmetric Problems: Introduction, Thick-walled Cylinder subjected to Internal and External Pressures-Lame's Problem, Stresses in Composite Tubes-Shrink Fits, Sphere with Purely Radial Displacements, Stresses Due to Gravitation, Rotating Disks of Uniform Thickness, Disks of Variable Thickness, Rotating Shafts and Cylinders, Summary of Results for Use in Problems.

Thermal Stresses: Introduction, Thermoelastic Stress–Strain Relations, Equations of Equilibrium, Strain-Displacement Relations, Some General Results, Thin Circular Disk: Temperature Symmetrical about Centre, Long Circular Cylinder, The Problem of a Sphere, Normal Stresses in Straight Beams due to Thermal Loading, Stresses in Curved Beams due to Thermal Loading.

Text Book:

1. L.S. Srinath, Advanced Mechanics of Solids, 2nd edition, Tata-McGraw-Hill Publishing Co. Ltd, 2003.

References:

1. Boresi, A.P. and Sidebottm, O.M., Advanced Mechanics of Materials, 5th edition, Wiley India Pvt. Ltd, 2003.
2. Fred B. Seely, Frank Erwin Richart, Advanced Mechanics of Materials, 2nd edition,Wiley India Pvt. Ltd, 2007.
3. Den Hartog., Advanced Strength of Materials, Dover Publications, 1949.
4. Timoshenko S.P., Advanced Strength of Materials, 3rd edition, D Van Nostrand Company Inc., 1956.

EME716 MECHANICAL MEASUREMENTS

L	T	P	C
4	0	0	4

Module I **8 Hours**

Introduction to measurements, errors in measurements, statistical analysis of data, regression analysis, correlation, estimation of uncertainty and presentation of data,design of experiments.

Module II **9 Hours**

Measurement of field quantities; temperature, pressure, velocity by intrusive and non-intrusive techniques under steady state and transient conditions.

Module III **9 Hours**

Condition monitoring, encoders, resolvers, Linear and angular measurements, servo control, sensors, accelerometers, dynamometers.Vibration measurement, force measurement.Controls in manufacturing.

Module IV **10 Hours**

Measurement of Strain Using Strain Gauges: Introduction to strain gauges, strain sensitivity of a strain gauge, bridge sensitivity, rosettes strain gauge alloys, carriers and adhesives performance of strain gauge system temperature compensation, two-wire and three-wire circuits strain gauge selection bonding of a strain gauge soldering, accounting for transverse sensitivity effects correction factors for special applications special gauges.

Module V **9 Hours**

Computer assisted data acquisition, measurement of impact and impulse data, Fourier analysis, data manipulation, data presentation

Text Book(s)

1. S.P. Venkateshan, Mechanical Measurements, ANE Books, 2009
2. Thomas G. Beckwith, Roy D. Marangoni, Mechanical Measurements, 6/e, Prentice hall, 2006.

References:

1. J.W. Dally and W.F. Riley, Experimental Stress Analysis, McGraw-Hill, 1991.
2. L.S. Srinath, M.R. Raghavan, K. Lingaiah, G. Gargesa, B. Pant, and K. Ramachandra, Experimental Stress Analysis, Tata Mc Graw Hill, 1984.

EME702: FINITE ELEMENT ANALYSIS

L	T	P	C
4	0	0	4

MODULE-I **10 hours**

Overview of finite element method (FEM): Basic concept, historical background, engineering applications of FEM, general description of the FEM, comparison of FEM and other methods. **Discretization of the domain:** Basic element shapes, discretization process, node numbering scheme, automatic mesh generation.

MODULE-II **12 hours**

Interpolation models: Interpolation polynomial in terms of nodal degree of freedom, selection of the order of the interpolation polynomial, interpolation polynomial for vector quantities, linear interpolation polynomials in terms of global coordinates and local coordinates. **Higher order and Isoparametric elements:** Higher order elements in terms of natural coordinates, higher order elements in terms of classical interpolation polynomials, one-dimensional elements using classical interpolation polynomials, two-dimensional (rectangular) elements using classical interpolation polynomials.

MODULE-III **12 hours**

Derivation of Element Matrices and Vectors: solution of equilibrium and Eigen value problems using variational (Rayleigh-Ritz) approach and weighted residual (Galerkin and Least squares) approach. **Assembly of Element Matrices and Vectors and Derivation of System Equations:** Coordinate Transformation, Assemblage of Element Equations, Incorporation of Boundary Conditions. Numerical Solution of Finite Element Equations of Equilibrium and Eigenvalue Problems

MODULE-IV **12 hours**

Application to Solid Mechanics Problems - Static Analysis: Basic Equations and Solution Procedure: Basic equations of solid mechanics, formulations of solid and structural mechanics, formulation of finite element equations. **Analysis of Trusses, Beams and Frames:** Space truss element, beam element, space frame element, planar frame element. **Analysis of Plates:** Triangular membrane element, numerical results with membrane element, bending behavior of plates, finite element analysis of plate bending, triangular plate bending element, numerical results with bending elements, analysis of three dimensional structures using plate elements.

MODULE-V **10 hours**

Application to Solid Mechanics Problems - Dynamic Analysis: Dynamic equations of motion, consistent and lumped mass matrices, free vibration analysis, dynamic response using finite element method. **Application to Heat Transfer Problems:** Basic equations of heat transfer, governing equation for three-dimensional bodies, statement of the problem, derivation of finite element equations, straight uniform fin analysis, tapered fin analysis, analysis of uniform fins using quadratic elements, unsteady state problems, heat transfer problems with radiation.

Text Book:

1. SS Rao, The finite element method in Engineering, 4th edition, Elsevier, Butterworth-Heinemann, Burlington, MA, 2005.

References:

1. J. N. Reddy, An introduction to the finite element method, 3rd edition, McGraw-Hill Education, 2005.
2. R.D. Cook, D. S. Malkus, M. E. Plesha, R. J. Witt, Concepts and Applications of Finite Element Analysis, 4th edition, John-Wiley & Sons, Inc., 2002.
3. L.J. Segerlind, Applied Finite Element Analysis, 2nd edition, John-Wiley & Sons, Inc., 1984.

EME718: THEORY OF VIBRATIONS

L	T	P	C
4	**0**	**0**	**4**

Module I **10 hours**

Free Vibration of Single Degree of Freedom Systems: Equation of motion,free vibration of undamped translational and torsional systems, conditions for stability, Raleigh's energy method, free vibration with viscous and coulomb damping, logarithmic decrement.

Module II **8 hours**

Harmonically Exited Vibrations: Introduction, equations of motion, response of undamped and damped systems under harmonic excitation, response of a damped system: under harmonic motion of the base, under rotating unbalance; forced vibration with coulomb damping.

Module III **7 hours**

Two Degree of Freedom Systems: Equations of motion for forced vibration, free vibration analysis of an undamped system, torsional system, coordinate coupling and principal coordinates, forced vibration analysis.

Module IV **10 hours**

Multidegree of Freedom Systems: Modeling of continuous systems as multi degree of freedom systems, derivation of equations of motion using Newton's second law, influence coefficients, free and forced vibration of undamped systems, forced vibration of viscously damped systems.
Determination of natural frequencies and mode shapes:UsingDunkerley's method and Rayleigh's method.

Module V **7 hours**

Vibration Measuring Instruments: Transducer, vibrometer, velometer, accelerometer, seismometer, frequency measuring instruments, single reed, multi reed, stroboscope-vibration exciters, experimental modal analysis. Condition monitoring techniques, diagnostic tools, signal analysis,time and frequency domain analysis.

References:

1. S.S.Rao, Mechanical Vibrations, 4/e, Pearson Education Inc., 2009.
2. L. Meirovich, Elements of Vibration Analysis, 2/e. Tata McGraw Hill, 2007.
3. J.S. Rao and K. Gupta, Introductory Course on Theory and Practice of Mechanical Vibrations, 2/e, New Age International, 1999.

EME713: DESIGN FOR MANUFACTURING

L	T	P	C
4	0	0	4

Module I **8 hours**

Introduction to DFMA, steps for applying DFMA during product design, advantages of applying DFMA during product design, factors influencing manufacture. Influence of basic design, mechanical loading and material on form design.
Influence of Manufacturing Method on Form Design: Grey iron castings, steel castings, malleable iron castings, pressure die castings and plastic mouldings.

Module II **10 hours**

Form Design of Welded Fabrications: Welding processes- gas or arc welding, weld forms, stresses, measures to combat contraction stresses.
Metal Extrusion: Process, suitable material for extrusion, design recommendation for metal extrusion.
Impact or Cold Extrusion: Process, design recommendations for backward extrusion. **Forward Extrusion:** Process, design recommendations for forward extrusion.
Form Design of Forgings: Hammer forging, drop forging.
Design for Solder and Brazed Assembly: Process, typical characteristics, suitable materials, detail design recommendations.
Design for Adhesively Bonded Assemblies: Introduction, typical characteristics, suitable materials, design recommendations for adhesive joint.

Module III **8 hours**

Designing for manufacture by machining methods, machinability, economy, clampability, existing tool equipment, to avoid redundant fits, accessibility, ease of assembly.
Design Guidelines: Guidelines for numbering system, assembly, automation, fastening, testing, repair and maintenance, repair design guidelines, maintenance.
DFM guidelines for part design: Tolerancing, standardization, criteria for combining parts, handling by automation.

Module IV **8 hours**

Design for Quality: Effect of design on quality, quality design guidelines, cumulative effects on product quality, quality strategies for products, reliability design guidelines, measurement of reliability, reliability phases, human factors in DFM, Poka-Yoke(mistake proofing), designing to minimize errors, strategy to design in quality.

Module V **8 hours**

Design for Cost Reduction: Cost reduction after product design, **c**ost measurements, overhead cost minimization strategy, minimizing cost through design.
Minimizing Cost: Minimizing overhead cost, product development expenses, engineering change order cost, cost of quality, customization and configuration cost, cost of variety, material management costs, marketing costs, sales/distribution cost, supply chain cost, life cycle cost.

References:

1. Matousek, Engineering Design- A Systematic Approach, Blackie and Son, 1974.
2. David M.Anderson, Design for Manufacturability and Concurrent Engineering, CIM Press. 2006.
3. Harry Peck, Designing for Manufacture, Pitman Publications, 1983.
4. Spotts M.F, Dimensioning and Tolerance for Quality Production, Prentice Hall, 1983.

EME725: CAE LAB

L	T	P	C
0	**0**	**3**	**2**

Module I

Introduction to CAD package software commands.
Model any three of the following machine parts:

1. Hexagonal Nut and Bolt
2. Solid Muff Coupling
3. Bushed Journal Bearing
4. Foot Step Bearing
5. Knuckle Joint
6. Socket and Spigot joint

Using assembly modeling techniques create any three of the following:

1. Plummer Block
2. Screw Jack
3. C-clamp
4. Coupling Puller
5. Pipe vice

Module II

1. Generation of a complex surface from cloud point data.
2. Generation of rational B – splines surfaces for given sample points.
3. Develop a slider crank mechanism for animated views.
4. Write a program to generate a gear wheel, given module, addendum, dedundum and base circle.
5. One exercise on optimization methods in design.
6. One exercise on product life cycle management.

EME724: CAD/CAM LAB

L	T	P	C
0	0	3	2

1. Preparation of manual part program for turning, drilling and milling
2. To generate NC program using simulation software for a turning jobusing lathe version.
3. Step turning, taper turning, drilling.
4. Thread cutting, grooving.
5. To generate NC program using simulation software for a 3-axismachining for pocket milling with island.
6. Machining of one job on CNC Lathe.
7. Machining of one job on CNC Drilling.
8. Process planning for NC job with MATLAB.
9. Cost estimation with MATLAB.
10. One exercise using Canned cycles.
11. One exercise on teach pendant programming
12. One exercise on path planning.

EME727: FINITE ELEMENT ANALYSIS LAB

L	T	P	C
0	0	3	2

1. Introduction to software package and modelling.
2. Analysis using 1-D element.
   (i) Stepped bar under axial load.
   (ii) Truss with transverse loads and thermal loads.
3. Analysis using plane stress: Stress concentration in rectangular plate with a hole
   (i) With full geometry
   (ii) Half geometry
   (iii) Symmetric boundary condition with 16, 64, 256 elements and study of Convergence.
4. Axi-symmetric element
   Thick cylinder subjected to internal pressure.
5. Beams:
   (a) Cantilever with concentrated loads and UDL with 16, 64,256 elements
   (i) Cantilever with concentrated load at free end.
   (ii) Cantilever with roller support, uniformly distributed load.
   (iii)Propped Cantilever with uniformly distributed load.
   (b)Simply supported beam
   (i) Concentrated load at the centre, uniformly distributed load with16, 64,256 elements
   (ii)Simply supported beam with overhang inverted L (Γ) at the centre concentrated load at the tip of inverted Γ.
6. 3-D Elements:
   (i) Problems in (5) with 3-D elements and compare results.
7. Mesh generation using software.
8. Contact stress in a sphere resting over a plate(Consider as 2D problem)
9. Natural frequency in a string fixed at both the ends.

EME720 MECHANICAL ENGINEERING LAB

L	T	P	C
0	0	3	2

1. Determination of natural frequencies of free un-damped and damped vibrations.
2. Determination of the amplitude of forced un-damped and damped vibrations.
3. Determination of the natural frequency of un-damped torsional vibrations.
4. Determination of the natural frequency of damped torsional vibrations.
5. Determination of stresses using simple strain gauges.
6. Determination of Principal stresses 1 and 2 in magnitude and direction using strain gauge rosettes.
7. Determination of pressure using strain gauges.
8. Measurement of wear using a pin-on-disc apparatus.
9. Determination of coefficient of friction.
10. Calibration of a thermocouple.
11. Calibration of a thermistor.
12. Determination of flow rate.

EME771 MECHANICS OF COMPOSITE MATERIALS(Elective)

L	T	P	C
3	0	0	3

MODULE-I **10 hours**

Introduction to composite materials: Classification and characteristics of composite materials, Mechanical behavior of composites, Basic terminology of laminated fiber reinforced composite materials, Advantages, Applications, Different types of fibers and matrix materials, Manufacture of laminated fiber reinforced composite materials - Hand layup, bag molding, Resin transfer molding, filament winding and pultrusion.

MODULE-II **12 hours**

Macromechanical behavior of a lamina: Introduction, Stress-strain relations for anisotropic materials - generalized hooks law, Stiffnesses, compliances and engineering constants for orthotropic materials, Restrictions on engineering constants, Stress-strain relations for plane stress in orthotropic materials, Stress-strain relations for a lamina of arbitrary orientation, Invariant properties of an orthotropic lamina, strengths of an orthotropic lamina, Biaxial criteria for an orthotropic lamina.

MODULE-III **12 hours**

Micromechanical behavior of lamina: Introduction, Mechanics of materials approach to stiffness, Elasticity approach to stiffness, comparison of approaches to stiffness, Mechanics of materials approach to strength.

MODULE-IV **10 hours**

Macro mechanical behavior of laminate: Introduction, Classical lamination theory, Special cases of laminate stiffnesses, Theoritical versus measured laminate stiffnesses, Strength of laminates, Inter laminar stresses. **Bending of laminated plates**: Introduction, Governing equation for bending of laminated plates, Deflection of simply supported laminated plates under distributed transverse load.

MODULE-V **12 hours**

Introduction to design of composite structures: Introduction, Structural design, Materials selection, Laminate joints, Design requirements and design failure criteria, Optimization concepts, Design analysis philosophy for composite structures.

Text Book:

1. R. M. Jones, Mechanics of composite materials, 2nd edition, Taylor and Francis, 1999.

References:

1. B. D. Agarwal, L. J. Broutman and K. Chandrasekhara, Analysis and performances of Fiber composites, 3rd edition, John Wiley & Sons, Inc., 2006.
2. J. C. Halpin, Primer on composite materials, revised edition, Technomic Publishing Company, Inc., 1984.

EME751: THEORY OF MECHANISMS (Elective)

L	T	P	C
4	0	0	4

Module I **6 hours**

Kinematics: Review of velocity and acceleration in mechanisms, analytical and graphical methods,use of auxiliary points and special methods for velocity and acceleration determination, pole, polode, polode curvature, path curvature, inflection circle, Euler-Savaryequation, Bobiller theorem,collineation axis, Hartman’s construction.

Module II **8 hours**

Synthesis of Mechanisms: Two position and three position synthesis of four bar linkage and slider crank mechanism, relative poles of four bar linkages and slider crank mechanisms, geometric methods of synthesis with three accuracy points, design of a function generators using Chebychev spacing, overlay method for conditioned crank mechanisms transmission angle, angle design for optimum transmission, coupler curves, Robert's Law, cognate mechanisms.

Module III **8 hours**

Analysis of Cams: Basic curves, pressure angle, determination of cam size, cam profile (analytical and graphical), advanced curves, combination of curve, Polydyne cams.
Cam dynamics: Cam force analysis, dynamics of high speed cam system, source of vibration, follower response, phase plane method, Johnson's numerical analysis, position error, jump and cross-over shock, spring surge and wind up.

Module IV **10 hours**

Static and Dynamic Force Analysis: Forces, couples, conditions of equilibrium, free body diagram, analysis of 4-bar linkage, slider crank mechanisms, spur gears, cams, helical gears, force analysis using Coulomb friction and pin joint friction. Dynamic force analysis of spatial mechanism, linear impulse and momentum, moment of momentum, components of moment of momentum, motion of a rigid body, moments and products of inertia, translation of axes, rotation of axes, measuring moment of inertia, Euler's equation of motion.

Module V **10 hours**

Spatial Mechanisms: Introduction to spatial linkages, special mechanisms, the position problem, position analysis of RGGR mechanism, velocity and acceleration analysis of RGGR linkage, the Eulerian angles, a theorem on angular velocities and accelerations, the Hooke universal joint.

References

1. Shigley, J.E, John J. Uicker, Theory of Machines and Mechanisms, Oxford University press, 2004.
2. Allen S. Hall, Jr., Kinematics and Linkage Design, Prentice Hall, 2007.
3. Holowenko, A.R, Dynamics of Machinery, Wiley, 2007.
4. Hartenberg and Denavit, Kinematic Synthesis of Linkages, McGraw Hill, 1964.
5. Arthur G. Erdman and George N. Sandor, Mechanisms Design Analysis and Synthesis - Vol.I and II, Prentice Hall of India.
6. Rothbart H.A., Cams, Wiley, 1956.

EME753: VIRTUAL MANUFACTURING (Elective)

L	T	P	C
3	0	0	3

Module I 8 hours

Review of Computer Graphics: Review of computer graphics, 2D graphics.2D primitives and transformations. Algorithm to digitize the graphic entities, rasterization, 3D graphics.3D primitives and transformations, projections and viewing, algorithms for hidden line removals, lighting.Shading and ray tracing.

Module II 9 hours

VR Devices: Input devices-track balls, 3D Mouse, data gloves, Virtual hand and trackers, output devices graph terminal, stereo glasses, head mounting devices, vision dome, caves.

Module III 8 hours

Applications: Virtual prototyping, behavior simulation, digital mockup, walk through/flythrough. Virtual training/simulation, micro electro mechanical systems and nanotechnology.

Module IV 9 hours

Virtual Modeling language: History, Concepts, syntax, basic nodes-group, transform switch, LOD etc, geometry nodes-indexed face set, indexed line set, coordinate, coordindwx, textures etc. sensor nodes-time sensor touch sensor, sphere sensor, cylinder sensor and proximity sensor, scriping- VRML Script and JAVA Script.

Module V 8 hours

Tutorials and samples: VRML authoring tools-3D studio MAX, cosmo World, VRML Pad (editor) VRML Viewing tools-cosmo player, auto Vue, SGI's open inventor, virtual collaborative tools-V collab.

Text Book(s):

1. Computer Graphics-Principles and practice - Janes D,Foley et al., - 2/e. in C, Addision -Wesley 1997.
2. The VRML- 2.0 Hand book - Jed Hartman and Josie wernecke - Addision-Wesley - 1997.
3. The Annocated VRML 2.0 hand book Addision - R Carey and G Bell -Wesley 1997.

References

Virtual Manufacturing by Prashant Banerjee (Author), Dan Zetu (Author) - John Wiley & Sons 2001

EME752: NON DESTRUCTIVE TESTING (Elective)

L	T	P	C
3	0	0	3

Module I **8 hours**

Introduction to NDT: Introduction, non-destructive versus destructive tests, conditions for effective non-destructive testing, personnel consideration, certification summary, discontinuities. Origins and Classification: Primary production of metals, castings, cracks, welding discontinuities, discontinuities from plastic deformation, corrosion – induced discontinuities, operationally induced discontinuities, fatigue cracking, creep, brittle fracture, geometric discontinuities.

Module II **9 hours**

Penetrant Testing and Magnetic Particle Testing: Penetrant testing: Introduction, theory and principles, penetrant equipment and materials, penetrant procedures, penetrant procedures, techniques and variables, evaluation and disposition, penetrant testing applications. Magnetic Particle Testing: Introduction, theory and principles, equipment and accessories, techniques, variables, evaluation of test results and reporting, applications.

Module III **9 hours**

Radiography Testing and Radiation Safety: Introduction, theory and principles, geometric exposure principles, shadow formation, shadow sharpness, radiographic equipment and accessories, variables, techniques and procedures, radiographic evaluation, applications, compendium of radiographs.
Radiation Safety: Special and SI units of radiation, principles of radiation detectors – ionization chamber, proportional counter, G.M. counters, scintillation counters, solid state detectors, biological effect of ionizing radiation, operational limits of exposures, radiation hazards evaluation and control, design of radiography installation and shielding calculations.

Module IV **8 hours**

Ultrasonic Testing: Introduction, theory and principles, equipment for ultrasonic applications, techniques, variables, evaluation of test results, applications, basic instrument calibration, calibration blocks (IIW block, ASTM blocks, distance amplitude block, area amplitude block), cables, connectors, test specimens. Reference reflectors for calibration (side drilled holes, notches, etc.,), inspection calibration, comparison with reference blocks, reference for planned tests (straight beams, angle beam), transmission factors – factors affecting the performance of ultrasonic test.

Module V **8 hours**

Other NDT Techniques: Eddy current testing; Introduction, theory and principles, alternating current principles, eddy current, test equipment, eddy current applications and signal display, advantages and limitations
Thermal Infrared Testing: Introduction, theory and principles, equipment and accessories, techniques, variables, data storage, applications, advantages and limitations, thermal chalks
Acoustic Emission Testing: Introduction, principles of acoustic emission testing, advantages and limitations of acoustic emission testing.

Text Books:

1. J. Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, 2/e, Tata McGraw Hill, 2011.

References:

1. C. Hellier, Handbook of Non-Destructive Evaluation, 1/e, McGraw Hill Professional, 2001.
2. B. Raj, T. Jayakumar and M. Thavasimuthu, Practical Non Destructive Testing, 3/e, Alpha Science International, 2002.

3. Non-Destructive Examination and Quality Control, 9/e, ASM International, Vol.17, 1989.

EME756: FATIGUE AND FRACTURE (Elective)

L	T	P	C
3	0	0	3

Module I **9 Hours**

Introduction: Kinds of failure, brittle and ductile fracture, modes of fracture failure.
Energy Release Rate: Griffith's criterion, energy release rate - definition and analysis, energy release rate of DCB specimen, inelastic deformation at crack-tip, crack resistance, stable and unstable crack growth, R-curve for brittle cracks and critical energy release rate.

Module II **9 Hours**

Stress Intensity Factor: Introduction, LEFM, stress and displacement fields in isotropic elastic materials, stress intensity factor, mathematical analysis, Westergaard's approach and its applications, application of principle of superposition, crack in a plate of finite dimensions, edge cracks, the relation between G_1 and K_1 and critical stress intensity factor.

Module III

9 Hours

Anelastic Deformation at the Crack Tip: Approximate shape and size of the plastic zone, effective crack length – approximate approach, Irwin correction and Dugdale approach; Effect of plate thickness.
J-Integral: Relevance and Scope, definition, path independence, stress-strain relation, J-integral from a designer's point of view, experiments to determine critical J- integral, predicting safety or failure and applications to engineering problems.

Module IV **10 Hours**

Fatigue of Metals: Introduction, Fatigue damage mechanisms, fatigue life at different stress levels, material macro- and meso-scales, material response at different stress levels.
Stress-Based Fatigue Design- Definitions and material data for stress-based fatigue analysis and stresses in material.
Strain-Based Fatigue Design- Material models for low-cycle fatigue analysis, monotonic loading, cyclic loading and design with respect to fatigue life

Module V **9 Hours**

MultiaxialFatigue: Multiaxial loading, strain cycle identification, high cycle fatigue analysis, fatigue in a multiaxial state of stress, normal stress measures, shear stress measures, mid value of the shear stress and safety factors.

Text Books:

1. T Dahleberg, A Ekberg, Failure Fracture Fatigue an Introduction, 1/e, Overseas Press India, 2006.
2. Prashant Kumar, Elements of Fracture Mechanics, Tata McGraw Hill, 2009.

References:

1. TribikramKundu, Fundamentals of Fracture Mechanics, CRC Press, 2008

EME758: ACOUSTICS AND NOISE CONTROL (Elective)

L	T	P	C
3	0	0	3

Module I **8 hours**

Basics of Acoustics: Velocity of sound, wavelength, frequency and wave number, acoustic pressure and particle velocity, acoustic intensity and acoustic energy density, spherical waves, directivity factor and directivity index, levels and the decibel, combination of sound sources, octave bands and weighted sound levels.

Acoustic Measurements: Sound level meters, intensity level meters, octave band filters, acoustic analyzers, dosimeter, measurement of sound power, noise measurement procedures.

Module II **8 hours**

Transmission of sound: Sound transmission indoors and outdoors. The wave equation, complex number notation, wave equation solution, solution for spherical waves, changes in media with normal incidence, changes in media with oblique incidence, sound transmission through a wall, transmission loss for walls, approximate method for estimating the transmission loss and transmission loss for composite walls. Sound transmission class, absorption coefficient.
Noise Sources: Noise and sources; Fan, electric motor, pump, gas compressor, transformer, cooling tower, gas vents, appliance and equipment, valves, air distribution systems, traffic and train.
Noise Control: Noise control at source, in the transmission path and at the receiver.

Module III **8 hours**

Acoustic Criteria: The human ear, hearing loss, industrial noise criteria, speech interference level, noise criteria for interior spaces, community reaction to environmental noise, the day-night level, HUD criteria, aircraft noise criteria.
Room Acoustics: Surface absorption coefficients, steady state sound level in a room, reverberation time, effect of energy absorption in the air, noise from adjacent room, acoustic enclosures, acoustic barriers.

Module IV **10 hours**

Silencer Design: Silencer design requirements, lumped parameter analysis, the Helmholtz resonator, side branch mufflers, expansion chamber mufflers, dissipative mufflers, evaluation of attenuation coefficient, commercial silencers, plenum chambers.
Vibration Isolation for Noise Control: Undamped single-degree-of-freedom system, damped single-degree-of-freedom system, damping factors, forced vibration, mechanical impedance and mobility, transmissibility, rotating unbalance, displacement excitation, dynamic vibration isolator, vibration isolation matrix, effects of vibration on humans.

Module V **8 hours**

Case Studies in Noise Control: Introduction, noise of folding carton packing station, metal cut-off saw, paper machine wet end, air scrap handling duct, air operated hoist motor, blanking press and noise in a small meeting room.

Text Book(s):

1. Randall F. Barron, Industrial noise control and acoustics, CRC press, 2002.

References:

1. R. J. Peters, Acoustics and noise control, 3/e, Routledge, 2011.

EME760: DESIGN OF TRANSMISSION ELEMENTS (Elective)

L	T	P	C
3	0	0	3

Module I **8 hours**

Chain and Belt Drives: Analysis, design and selection of chain drives and belt drives, tensioning belt, timer belts, sprocket design, chordal action in chains, chain velocity and drive ratio, length of chain and center distance, failure of the chain drives and belt drives, friction drives: classification, theory and operation of friction drives, design considerations, including thermal aspects.

Module II **8 hours**

Spur Gear and Straight Helical Gear: Speed ratios and number of teeth, force analysis - tooth stresses , dynamic effects, fatigue strength, factor of safety, gear materials, design of straight tooth spur & helical gears based on strength and wear considerations, pressure angle in the normal and transverse plane, equivalent number of teeth-forces for helical gears.

Module III **10 hours**

Straight Bevel Gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears.
Worm Gear: Merits and demerits- terminology, thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair.
Cross Helical Gear: Terminology-helix angle, estimating the size of the pair of cross helical gears.

Module IV **6 hours**

Design of Gear Box: Standardization of spindle speeds, ray diagrams, design of housings, lubrication considerations, heat generation and cooling considerations, stepless regulation of speed, selection of servo and stepper motors, timing belts.

Module V **10 hours**

Cam Design: Types; pressure angle and under cutting base circle determination, forces and surface stresses.
Clutches: Friction clutches, centrifugal clutches;Analysis, dynamics and thermal aspects of clutches.Design of automobile clutch: single plate, multi plate, cone clutch, overrunning clutches.
Brakes: Disc brakes; Design and analysis of self-actuating brakes, fixed link and sliding anchor drum brakes, dynamics and thermal aspects of vehicle braking, design of brakes for applications such as modern automobiles, cranes, railway coaches, aircrafts and machine tools.

Text Book(s)
1. Nieman, Design of Machine Elements – Vol. II, Springer Verlag.

References
1. Newcom and Spurr, Braking of Road Vehicles, Chapman and Hall, 1967.
2. Reshetov, Design of Machine Elements, Mir Publication, 1978.
3. Dobrovolksy, Design of Machine Elements, Mir Publishers, 1977.
4. Wong, Theory of Ground Vehicles, Wiley, 2001.

EME754: NON LINEAR FEA (Elective)

L	T	P	C
3	0	0	3

Module I **8 Hours**

Preliminary Concepts andLinear Finite Elements- Introduction, Vector and tensor calculus, Stress and strain, Mechanics of continuous bodies and Finite element method.

Module II **8 Hours**

Nonlinear Finite Element Analysis Procedures– Introduction to nonlinear systems in solid mechanics, types of nonlinearity, solution procedures for nonlinear algebraic equations, and steps in the solution of nonlinear FEA.

Module III **8 Hours**

FEA for Nonlinear Elastic Problems - Stress and Strain Measures in Large Deformation, Nonlinear Elastic Analysis, Critical Load Analysis, Hyperelastic Materials, Finite Element Formulation for Nonlinear Elasticity.

Module IV **8 Hours**

FEA for Elastoplastic Problems - 1D Elastoplasticity, Multi-dimensional Elastoplasticity, Finite Rotation with Objective Integration, Finite Deformation Elastoplasticity with Hyperelastcity and Mathematical Formulation from Finite Elasticity.

Module V **10 Hours**

Finite Element Analysis for Contact Problems – Introduction, simple one point contact problems, general formulation for contact problems, finite element formulation of contact problems, Three-dimensional contact analysis and contact analysis procedure and modelling issues.
Usage of softwares for solving nonlinear FEA problems.

Text book:

1. Nam-Ho Kim, Introduction to Nonlinear Finite Element Analysis, Springer, 2014.

EME773: COMPUTATIONAL FLUID DYNAMICS (Elective)

L	T	P	C
3	0	0	3

MODULE-I **10 hours**

Finite difference methods: Taylor’s series – FDE formulation for 1D and 2D steady state heat transfer problems – Cartesian, cylindrical and spherical co -ordinate systems– boundary conditions – Unsteady state heat conduction – errors associated with FDE - Explicit Method – Stability criteria – Implicit Method – Crank Nickolson method – 2-D FDE formulation – ADI – ADE

MODULE-II **12 hours**

Finite Volume Method: Formation of Basic rules for control volume approach using1D steady heat conduction equation – Interface Thermal Conductivity - Extension of General Nodal Equation to 2D and 3D Steady heat conduction and unsteady heatconduction

MODULE-III **12 hours**

Incompressible Fluid Flow: Governing Equations, Stream Function - Vorticity method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and Spalding, Computation of Boundary layer flow, Finite difference approach

MODULE-IV **12 hours**

Convection Heat Transfer: Solution of one dimensional and two dimensional steady/unsteady convection – Diffusion, Discretization Schemes and their assessment Treatment of Boundary Conditions - Diffusion problems, Convection problems, Convection-diffusion problems.

MODULE-V **12 hours**

Turbulence Models: Algebraic Models – Turbulence models - Zero-Equation, One-Equation, Two-Equation & Stress-Equation Turbulent Models- K - ε Models, Standard and High and Low Reynolds number models.

Text Books:

1. Anderson, D. A, Tannehill, J. C., and R. H. Pletcher, R. H., Computational Fluid Mechanics and Heat Transfer, 2nd edition, Taylor & Francis, 1995.
2. Versteeg, H. K. and W. Malalasekera, W., An Introduction to Computational FluidDynamics: The Finite Volume Method, 2nd edition, Addison Wesley – Longman, 1995.

References:

1. Chow, C.Y, Introduction to Computational Fluid Dynamics, 2nd edition, John Wiley, 1979.
2. Muralidhar, K., and Sundararajan T., Computational Fluid Flow and Heat Transfer, 2nd edition, Narosa Publishing House, New Delhi, 1995.
3. Hirsch, A.A., Introduction to Computational Fluid Dynamics, McGraw Hill, 1989.
4. Patankar, S.V., Numerical heat transfer and fluid flow, Hemispher Publishing Corporation, 1992
5. Bose, T.K., Computational Fluid Dynamics, Wiley, 1988.

EID743: COMPUTER GRAPHICS (Elective)

L T P C

3 0 0 3

Module I **8 Hours**

Introduction to computer graphics- Introduction, Non interactive/interactive Graphics, Uses of computer graphics, classification of Applications, Programming Language, Graphics and Operating software, Graphic systems Configuration.

Graphic Systems-Introduction, Cathode Ray Tube(CRT)basics, Refresh Display, Direct View Storage Tube(DVST), Raster Display, Input devices, Output devices, Computer Graphic Software, Integration of Graphics Standard, Interactive Graphic Techniques, Graphical User Interface.

Output Primitives- Introduction, Representing Image, Straight Line, Line drawing algorithms, Differential Digital Analyser(DDA)algorithm, Bresenham"s Line Algorithm, Circle generating Algorithm, Bresenham"s circle Algorithm, Midpoint circle Algorithm, Polygon filling Algorithms, Character or Text Generation, Aliasing and Antialising

Module II **10 Hours**

Two Dimensional Transformations-Introduction, Representation of points, Matrix Algebra and Transformation, Transformation of points, Transformation of straight line, Midpoint Transformation, Transformation of Parallel Lines, Transformation of Intersecting Lines, Rotation, Reflection and Scaling of Straight Line or Polygons, Combined Transformation, Translation and Homogeneous Coordinates, Rotation about an Arbitrary point, Reflection about an Arbitrary Line.

Three Dimensional Transformations- Introduction, 3D Transformations, Rotation about an axis Parallel to a Coordinate Axis, Rotation about an Arbitrary Axis in Space, Reflection through an Arbitrary Plane, 3D Modelling Schemes.

Window Clipping- Introduction, Viewing Transformation, Clipping, Point Clipping, Line Clipping, Cohen-Sutherland Line clipping, Polygon Clipping, Sutherland-Hodgman Algorithm, Curve Clipping, Text Clipping .

Module III **8 Hours**

Curves – Curve representation, non-parametric and parametric curves, parametric representation of conic sections, 2D and 3D representation of Bezier and spline curves.

Surfaces – Bezier surfaces, Spline surfaces, Blended surfaces. Influence of knot spacing. B-spline basis function, B-spline with multiple knots, rotational B-spline surfaces.

Module IV **8 Hours**

Mesh generation – Choice of grid – Simple and complex geometries, mesh generation – structured and unstructured meshes, mesh refinement. Exposure to commercial softwares on mesh generation.

Module V **8 Hours**

Solid modelling methods - Constructive Solid Geometry (CSG) methods and Boundary Representation (Brep) methods.

Reverse engineering – Methodology, Advantages and Applications.
Transformation of geometric details from solid model to manufacturing systems.

Textbooks:

1. Amarendra N Sinha, Arun D Udai , Computer Graphics, TataMcGrawHill, 2008
2. Ibrahim Zeid, CAD/CAM Theory and Practice, McGraw-Hill, 1991

References

1. Donald Hearn, M. Pauline Baker ,Computer Graphics, 2/e, Prentice Hall, 1997

EME792: TECHNICAL SEMINAR

L	T	P	C
0	0	3	2

Student has to select a topic of his/her interest in consultation with the faculty incharge of seminar. He/She can collect information from the books, journals, internet and prepare a report. Prepare for a power point presentation on the topics and present to a committee to evaluate the seminar.

Seminar is separate for each student.

EME891: PROJECT WORK

L	T	P	C
0	0	0	8

A graduate is expected to contribute to the industry in design, development, testing, maintenance of equipment and managing the employees as soon as joining the industry. Hence it is essential to have training in any of the above areas by taking up a project work. The project work can be an extension of mini project or can be an independent.

The project work is individual.

EME892: PROJECT WORK

L	T	P	C
0	0	0	16

The project chosen in EME891 is to be continued.

EME767 MECHATRONICS (Elective)

L	T	P	C
3	0	0	3

Module I **10 hours**

Mechatronics system design: Introduction to Mechatronics: What ismechatronics, integrated design issues in mechatronics, Mechatronics keyelements, the mechatronics design process, Advanced approaches in mechatronics.

Module II **12 hours**
Modeling and simulation of physical systems: Simulation and block diagrams,Analogies and impedance diagrams, Electrical systems, Mechanical translationalsystems, Mechanical rotational systems, Electro mechanical coupling, Fluidsystems.

Module III **12 hours**

Sensors and transducers: An introduction to sensors and transducers, Sensorsfor motion and position measurement, Force, torque and tactile sensors, Flowsensors, Temperature-sensing devices.Actuating devices: Direct current motor, permanent magnet stepper motor, fluidpower actuation.

Module IV **12 hours**

Signals, systems and controls: Introduction to signals, systems and controls,System representation, Linearization of nonlinear systems, Time delays.Real time interfacing: Introduction, Elements of a data acquisition and controlsystem, Overview of the I/O process, Installation of the I/O card and software.

Module V **10 hours**

Advanced applications in mechatronics: Sensors for condition monitoring,Mechatronic control in automated manufacturing, Artificial intelligence inmechatronics, Microsensors in mechatronics.

Text Book(s)
1. Devdas Shetty and Richard A. Kolk, Mechatronics System Design, 5thedition, P.W.S. Publishing Company.

Reference
1. W. Bolton, Mechatronics, 3rdedition, Pearson Education.

EME762: OPTIMIZATION METHODS IN ENGINEERING(Elective)

L	T	P	C
3	0	0	3

Module I **12 hours**

Geometric programming (G.P): Unconstrained minimization problem, Solutionof an unconstrained geometric programming, differential calculus method andarithmetic method, Primal dual relationship and sufficiency conditions. Solutionof a constrained geometric programming problem (G.P.P), ComplementaryGeometric Programming, constrained minimization.

Module II **10 hours**

Dynamic programming (D.P): Multistage decision processes, Concepts of suboptimization, computational procedure in dynamic programming calculus methodand tabular methods.Linear programming as a case of D.P and Continuous D.P.

Module III **12 hours**

Integer programming (I.P): Integer linear programming, Graphicalrepresentation, Gomory's cutting plane method, Bala's algorithm for zero-oneprogramming problem, Integer non linear programming, Branch-and-boundmethod, sequential linear discrete programming, generalized penalty functionmethod

Module IV **10 hours**

Stochastic Programming (S.P): Basic concepts of Probability Theory,Stochastic linear programming, stochastic non-linear programming.

Module V **12 hours**

Unconventional optimization techniques: Multi-objective optimization -Lexicographic method, Goal programming method, Genetic algorithms, SimulatedAnnealing, Neural Networks based Optimization.

Text Book(s)

1. Rao S.S., Engineering Optimization - Theory and Practice, 3rd edition, NewAge International (P) Ltd. Publishers, 1996.

References

1. Ravindran, Phillips and Solberg, Operations Research- Principles and Practice,2nd edition, JohnWiely, 2007.
2. Hiller and Lieberman, Introduction to Operations Research, 7th edition,McGraw Hill, 2002.
3. James P. Ignizio, Goal Programming and Extensions, 2nd edition, LexigtonBooks, 1976.
4. David E. Goldberg, Genetic Algorithms - In Search, Optimization and MachineLearning, 1st edition, Addison-Wesley Longman (Singapore) Pvt. Ltd., 1989.

EME743: DESIGN OF EXPERIMENTS (Elective)

L	T	P	C
3	0	0	3

Module I **12 hours**

Introduction: The scientific method, The role of statistics in the advancement of science, The phases of an experiment, Specifying the problem and the hypotheses, Experimental designs, Analyses of experiments, Statistical inference, Estimation-Properties of estimators, Confidence intervals, Hypothesis testing, The Z-test, the T-test, the X2-test, and the F-test. Sample size.

Module II **12 hours**

Completely Randomized Design: The one-factor experiments in a CRD, Linear model, Partitioning of the total sum of squares, the analysis of variance table, Orthogonal contrasts, Multiple range tests, Scheffe's test, Confidence intervals on means, Fixed and random models, Estimation of variance components, Randomized Complete Block Design-The model and assumptions, The ANOVA table, Tests after ANOVA.

Module III **10 hours**

Latin Square and Related Designs: Latin squares and two-way restrictions on randomization, the linear model and assumptions for a one-factor experiment fitted in a Latin square design, ANOVA table.

Module IV **12 hours**

Factorial Experiments: Complete factorial experiments in CRD's, Main effects and interactions, one observation per treatment combination, linear model and analysis, the error term and pooling, the meaning of a significant interaction, the case of n observations per treatment combination. Complete 2f factorial experiments in CRD's, Special notation, average effect of main effects and interaction, orthogonal contrasts and sum of squares, Yates's algorithm.

Module V **10 hours**

Fixed, Random And Mixed Models: Single and two factor models, EMS rules, Pseudo-F test.
Nested and Nested – Factorial Experiments: Nested experiments, Nested factorial experiments, Repeated-measures design and nested-factorial experiments, Factorial experiment in a randomized block design.

Text Book(s)

1. Hicks and Turner, Fundamental Concepts in the Design of Experiments,5/e, Oxford University Press, 1999.
2. Douglas C. Montgomery, Design and Analysis of Experiments, 8/e, JohnWiley and Sons Inc., 2012.

EME745: RELIABILITY ENGINEERING (Elective)

L	T	P	C
3	0	0	3

Module I **12 hours**

Reliability: Definition; Probability Concept; Addition of Probabilities; Complimentary Events; Kolmogorov Axioms. Failure Data Analysis: Introduction, Mean Failure Rate, Mean Time to Failure (MTTF), Mean Time between Failures (MTBF), Graphical Plots, MTTF in terms of Failure Density, MTTF in Integral Form.

Module II **12 hours**

Hazard Models: Introduction, Constant Hazard; Linearly Increasing Hazard, the Weibull Model, Density Function and Distribution Function, Reliability Analysis, Important Distributions and their Choice, Standard Deviation and Variance. Conditional Probability: Introduction, Multiplication Rule, Independent Events, Vernn Diagram, Hazard Rate as conditional probability, Bayes Theorem.

Module III **12 hours**

System Reliability: Series. Parallel and Mixed Configurations, Complex Systems, Logic Diagrams, Markov Models. Reliability Improvement & Repairable Systems: Redundancy, Element, Unit and standby

Module IV **10 hours**

Redundancy, Optimization; Reliability – cost trade- off, Introduction to Repairable Systems, Instantaneous Repair Rate, MTTR, Reliability and Availability Functions, Important Applications.

Module V **10 hours**

Fault-Tree Analysis and Other Techniques: Fault-tree Construction, Calculation of Reliability, Tie- set and Minimal Tie-set. Unit Maintain ability and Availability: Introduction, Maintenance Planning, Reliability and Maintain ability trade – off.

Text Book(s)

1. L.S. Srinath, Reliability Engineering, 4/e, Affiliated East-West Press, NewDelhi, 2005.

References

1. D.J. Smith, K.C. Kapur and L.R. Lamberson, Reliability in Engineering Design,Wiley Publications, 2009.
2. A.K.Govil, Reliability Engineering, Tata Mc-Graw Hill, New Delhi, 1983.