VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM

SCHEME OF TEACHING AND EXAMINATION FOR
M.TECH. Engineering Analysis & Design

I SEMESTER **CREDIT BASED**

Subject Code	Name of the Subject	Teaching hours/week		Duration of Exam in Hours	Marks for		Total Marks	CREDITS
		Lecture	Practical / Field Work / Assignment/ Tutorials		I.A.	Exam		
14 MDE11	Applied Mathematics	4	2	3	50	100	150	4
14 MDE12	Finite Element Method	4	2	3	50	100	150	4
14CAE13	Continuum Mechanics	4	2	3	50	100	150	4
14CAE14	Experimental Mechanics	4	2	3	50	100	150	4
	Elective – I	4	2	3	50	100	150	4
14MDE16	Design Engineering Lab I	--	3	--	25	50--	75	2
14MEA17	SEMINAR	--	3	--	25	--	25	1
	Total	**20**	**13**	**15**	**300**	**550**	**850**	**23**

ELECTIVE-I

14MDE 151	Computer Graphics	14 MDE 153	Mechatronics System Design
14MDE 152	Computer Applications in Design	14MDE 154	Design for Manufacture
14MEA155	Advanced Fluid Dynamics		

Design Engineering ;
Common to Design Engineering (MDE), Engineering Analysis & Design (MEA),Machine Design (MMD),Computer Aided Engineering(CAE)

APPLIED MATHEMATICS

(Common to MDE,MMD,MEA,CAE,MCM,MAR,IAE,MTP,MTH,MTE,MST,MTR)

Sub Code : 16MDE11	IA Marks :50
Hrs/ Week : 04	Exam Hours : 03
Total Hrs: 50	Exam Marks :100

Course Objectives:

The main objectives of the course are to enhance the knowledge of various methods in finding the roots of an algebraic, transcendental or simultaneous system of equations and also to evaluate integrals numerically and differentiation of complex functions with a greater accuracy. These concepts occur frequently in their subjects like finite element method and other design application oriented subjects.

Course Content:

1. Approximations and round off errors: Significant figures, accuracy and precision, error definitions, round off errors and truncation errors. Mathematical modeling and Engineering problem solving: Simple mathematical model, Conservation Laws ofEngineering.**06 Hours**

2. Roots of Equations: Bracketing methods-Graphical method, Bisection method, False position method, Newton- Raphson method, Secant Method. Multiple roots, Simple fixed point iteration.
   Roots of polynomial-Polynomials in Engineering and Science, Muller’s method, Bairstow’s Method Graeffe’s Roots Squaring Method.**12 Hours**

3. Numerical Differentiation and Numerical Integration: Newton –Cotes and Guass Quadrature Integration formulae, Integration of Equations, Romberg integration, Numerical Differentiation Applied to Engineering problems, High Accuracy differentiation formulae**06 Hours**

4. System of Linear Algebraic Equations And Eigen Value Problems: Introduction, Direct methods, Cramer's Rule, Gauss Elimination Method, Gauss-Jordan Elimination Method, Triangularization method, Cholesky Method, Partition method, error Analysis for direct methods, Iteration Methods.
   Eigen values and Eigen Vectors: Bounds on Eigen Values, Jacobi method for symmetric matrices, Givens method for symmetric matrices, Householder's method for symmetric matrices, Rutishauser method for arbitrary matrices, Power method, Inverse power method .**16Hours**

5. Linear Transformation: Introduction to Linear Transformation, The matrix of Linear Transformation, Linear Models in Science and Engineering
   Orthogonality and Least Squares: Inner product, length and orthogonality, orthogonal sets, Orthogonal projections, The Gram-schmidt process, Least Square problems, Inner product spaces**. 12 Hours**

Text Books:

1. S.S.Sastry, Introductory Methods of Numerical Analysis, PHI, 2005.
2. Steven C. Chapra, Raymond P.Canale, Numerical Methods for Engineers, Tata Mcgraw Hill, 4th Ed, 2002.
3. M K Jain, S.R.K Iyengar, R K. Jain, Numerical methods for Scientific and engg computation, New Age International, 2003.

Reference Books:

1. Pervez Moin, Fundamentals of Engineering Numerical Analysis, Cambridge, 2010.
2. David. C. Lay, Linear Algebra and its applications, 3rd edition, Pearson Education, 2002.

Course Outcomes:

The Student will be able to

1. Model some simple mathematical models of physical Applications.
2. Find the roots of polynomials in Science and Engineering problems.
3. Differentiate and integrate a function for a given set of tabulated data, forEngineering Applications

FINITE ELEMENT METHOD

(Common to MDE,MEA,MMD,CAE,MTR)

Sub Code : 16MDE12	IA Marks :50
Hrs/ Week : 04	Exam Hours : 03
Total Hrs: 50	Exam Marks :100

Course Objectives

1. To present the Finite element method (FEM) as a numerical method for engineering analysis of continua and structures

2. To present Finite element formulation using variational and weighted residual approaches
3. To present Finite elements for the analysis of bars & trusses, beams & frames, plane stress & plane strain problems and 3-D solids, for thermal and dynamics problems.

Course Content:

1. **Introduction to Finite Element Method:** Basic Steps in Finite Element Method to solve mechanical engineering (Solid, Fluid and Heat Transfer) problems: Functional approach and Galerkin approach, Displacement Approach: Admissible Functions, Convergence Criteria: Conforming and Non Conforming elements, C_o C_1 and C_n Continuity Elements. Basic Equations, Element Characteristic Equations, Assembly Procedure, Boundary and Constraint Conditions.

10 Hours.

2. **Solid Mechanics : One-Dimensional Finite Element Formulations and Analysis** – Bars- uniform, varying and stepped cross section- Basic(Linear) and Higher Order Elements Formulations for Axial, Torsional and Temperature Loads with problems. Beams- Basic (Linear) Element Formulation-for uniform, varying and stepped cross section- for different loading and boundary conditions with problems. Trusses, Plane Frames and Space Frame Basic(Linear) Elements Formulations for different boundary condition -Axial, Bending, Torsional, and Temperature Loads with problems.

10 Hours.

3. **Two Dimensional Finite Element Formulations for Solid Mechanics Problems:** Triangular Membrane (TRIA 3, TRIA 6, TRIA 10) Element, Four-Noded Quadrilateral Membrane (QUAD 4, QUAD 8) Element Formulations for in-plane loading with sample problems. Triangular and Quadrilateral Axi-symmetric basic and higher order Elements formulation for axi-symmetric loading only with sample problems
Three Dimensional Finite Element Formulations for Solid Mechanics Problems: Finite Element Formulation of Tetrahedral Element (TET 4, TET 10), Hexahedral Element (HEXA 8, HEXA 20), for different loading conditions. Serendipity and Lagrange family Elements

10 Hours.

4. **Finite Element Formulations for Structural Mechanics Problems:** Basics of plates and shell theories: Classical thin plate Theory, Shear deformation Theory and Thick Plate theory. Finite Element Formulations for triangular and quadrilateral Plate elements. Finite element formulation of flat, curved, cylindrical and conical Shell elements
5. **Dynamic Analysis:** Finite Element Formulation for point/lumped mass and distributed masses system, Finite Element Formulation of one dimensional dynamic analysis: bar, truss, frame and beam element. Finite Element Formulation of Two dimensional dynamic analysis: triangular membrane and axisymmetric element, quadrilatateral membrane and axisymmetric element. Evaluation of eigen values and eigen vectors applicable to bars, shaft, beams, plane and space frame.

10 Hours.

Text Books:

1. T. R. Chandrupatla and A. D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall, 3rd Ed, 2002.

2. Lakshminarayana H. V., Finite Elements Analysis– Procedures in Engineering, Universities Press, 2004.

Reference Books:

1. Rao S. S. , Finite Elements Method in Engineering- 4th Edition, Elsevier, 2006
2. P.Seshu, Textbook of Finite Element Analysis, PHI, 2004.
3. J.N.Reddy, Introduction to Finite Element Method, McGraw -Hill, 2006.
4. Bathe K. J., Finite Element Procedures, Prentice-Hall, 2006..
5. Cook R. D., Finite Element Modeling for Stress Analysis, Wiley,1995.

Course Outcome:

On completion of the course the student will be

1. Knowledgeable about the FEM as a numerical method for the solution of solid mechanics, structural mechanics and thermal problems
2. Developing skills required to use a commercial FEA software

CONTINUUM MECHANICS
(Common to MDE,MEA,MMD,CAE)

Sub Code : 16CAE13	IA Marks :50
Hrs/ Week : 04	Exam Hours : 03
Total Hrs: 50	Exam Marks :100

Course Objective:

This course aims at a comprehensive study of mechanics of solids. The topics covered are

1. Analysis of stress, strain and stress-strain relations.
2. Solution of plane elasticity problems in rectangular and polar coordinates using analytical methods including thermal loads, body forces and surface tractions
3. Formulation of 3-D boundary value problems
4. Torsion of prismatic bars

Course Content:

1. **Analysis of Stress:** Continuum concept, homogeneity, isotropy, mass density, body force, surface force Cauchy's stress principle-stress vector, State of stress at a point- stress tensor, stress tensor –stress vector relationship, Force and moment, equilibrium, stress tensor symmetry. Stress transformation laws, stress quadric of Cauchy. Principal stresses, Stress invariants, stress ellipsoid, maximum and minimum shear stress, Mohr's circle for stress, plane stress, deviator and spherical stress tensors.

   Deformation and Strain: Particles and points, continuum configuration-deformation and flow concepts. Position vector, displacement vector-Lagrangian and Eulerian description, deformation gradient, displacement gradient.Deformation tensors, finite strain tensors, small deformation theory, infinitesimal strain tensors.Relative displacement- linear, rotation tensors.Transformation properties of strain tensors.

Principal strains, strain invariants, cubical dilatation, spherical and deviator strain tensors, plane strain, Mohr's circle, and compatibility equations.

10 Hours

2. **Linear Elasticity:** Generalized Hooke's law, Strain energy function, isotropy, anisotropy, elastic symmetry. Isotropic media-elastic constants. Elastostatic and Elastodynamic problems. Theorem of superposition, uniqueness of solutions, St. Venant's principle.

10 Hours

3. **Two dimensional elasticity**- plane stress, plane strain, Airy's stress function. Two dimensional elastostatic problems in polar coordinates. Hyperelasticity, Hypoelasticity, linear thermo elasticity.

10 Hours

4. **Plasticity:** Basic concept and definitions, idealized plastic behavior. Yield condition- Tresca and Von-Mises criteria. Stress space-□-plane, yield surface. Post yield behavior-isotropic and kinematic hardening. Plastic stress-strain equations, plastic potential theory. Equivalent stress, equivalent plastic strain increment. Plastic work, strain hardening hypothesis. Total deformation theory-elastoplastic problems. Elementary slip line theory for plane plastic strain

   Viscoelasticity: Linear viscoelastic behavior. Simple viscoelastic models-generalized models, linear differential operator equation. Creep and Relaxation- creep function, relaxation function, hereditary integrals. Complex moduli and compliances. Three dimensional theory-viscoelastic stress analysis, correspondence principles

5. **Fluids:** Fluid pressure, viscous stress tensor, barotropic flow. Constitutive equations-Stokesian, Newtonian fluids. Basic equation for Newtonian fluid, Nevier-Strokes-Duhum equations. Steady flow, hydrostatic, irrotational flow. Perfect fluids- Bernoulli's equation, circulation, potential flow, plane potential flow. **Fundamental Laws of Continuum Mechanics:** Conservation of mass, continuity equation. Linear momentum principle, equation of motion, equilibrium equations. Moment of momentum principle. Conservation of energy-first law of thermodynamics energy equation. Equation of state, entropy, second law of thermodynamics. Clausius-Duhem inequality, dissipation function. Constitutive equations-thermo mechanical and mechanical continua.

10 Hours

Text Books:

1. George. E. Mase, Continuum Mechanics, CRC Press, 2000.
2. J. N. Reddy, Introduction to Continuum Mechanics with Applications, Cambridge University Press, New York, 2008.
3. W. Michael Lai, David Rubin, Erhard Krempl, Introduction to Continuum Mechanics, Butterworth-Heinemann , 4th Ed, 2010.

References:

1. Batra, R. C., Elements of Continuum Mechanics, Reston, 2006.
2. George E. Mase, Schaum's Outline of Continuum Mechanics, McGraw-Hill, 1970.
3. Dill, Ellis Harold, Continuum Mechanics: Elasticity, Plasticity, Viscoelasticity, CRC Press , 2006.
4. Fung Y. C., A First Course in Continuum Mechanics, Prentice-Hall, 2e, 1977.
5. Gurtin M. E., An Introduction to Continuum Mechanics, Academic Press, 1981.

Course Outcome: The student, upon completion of this course, will have Continuum mechanics background essential to solve engineering analysis problems by the FEM.

EXPERIMENTAL MECHANICS

(Common to MDE,MEA,MMD,CAE)

Sub Code : 16CAE16	IA Marks :50
Hrs/ Week : 04	Exam Hours : 03
Total Hrs: 50	Exam Marks :100

Course Objective:

This course aims at a comprehensive study of mechanics of solids. The topics covered are
The objective of this course is to familiarize the student with state of the art experimental techniques namely strain gauges, photo elasticity, moiré interoferometry, brittle coating, moiré fringes and holography.

Course Content:

1. **Introduction**: Definition of terms, calibration, standards, dimension and units, generalized measurement system, Basic concepts in dynamic measurements, system response, distortion, impedance matching, experiment planning.

   Analysis of Experimental Data: Cause and types of experimental errors, error analysis. Statistical analysis of experimental data- Probability distribution, gaussian, normal distribution. Chi-square test, Method of least square, correlation coefficient, multivariable regression, standard deviation of mean, graphical analysis and curve fitting, general consideration in data analysis.

   10 Hours

2. **Data Acquisition and Processing:** General data acquisition system, signal conditioning revisited, data transmission, Analog-to-Digital and Digital-to- Analog conversion, Basic components (storage and display) of data acquisition system. Computer program as a substitute for wired logic.

   Force, Torque and Strain Measurement: Mass balance measurement, Elastic Element for force measurement, torque measurement. Strain Gages -Strain sensitivity of gage metals, Gage construction, Gage sensitivity and gage factor, Performance characteristics, Environmental effects Strain, gage circuits, Potentiometer, Wheat Stone's bridges, Constant current circuits. Strain Analysis Methods-Two element and three element, rectangular and delta rosettes, Correction for transverse strains effects, stress gage - plane shear gage, Stress intensity factor gage.

   10 **Hours**

3. **Stress Analysis:** Two Dimensional Photo elasticity **-** Nature of light, - wave theory of light,- optical interference - Polariscopes stress optic law - effect of stressed model in plane and circular Polariscopes, IsoclinicsIso chromatics fringe order determination - Fringe multiplication techniques - Calibration Photoelastic model materials. Separation methods shear difference method, Analytical separation methods, Model to prototype scaling**.** **10 Hours**

4. **Three Dimensional Photo elasticity:** Stress freezing method, General slice, Effective stresses, Stresses separation, Shear deference method, Oblique incidence method Secondary principals stresses, Scattered light photo elasticity, Principals, Polari scope and stress data analyses**.**

   10 Hours

5. **Coating Methods:** a) Photoelastic Coating Method-Birefringence coating techniques Sensitivity Reinforcing and thickness effects - data reduction - Stress separation techniques Photoelastic strain gauges. b) Brittle Coatings Method:Brittle coating technique Principles data analysis - coating materials, Coating techniques. c) Moire Technique - Geometrical approach, Displacement approach- sensitivity of Moire data data reduction, In plane and out plane Moire methods, Moire photography, Moire grid production.

   Holography: Introduction, Equation for plane waves and spherical waves, Intensity, Coherence, Spherical radiator as an object (record process), Hurter, Driffeld curves, Reconstruction process, Holograpicinterferomerty, Realtime. and double exposure methods, Displacement measurement, Isopachics.

10 Hours

Text Books:

1. **Holman,**"Experimental Methods for Engineers" 7th Edition, Tata McGraw-Hill Companies, Inc, New York, 2007.
2. **R. S. Sirohi, H. C. Radha Krishna,** "Mechanical measurements" New Age International Pvt. Ltd., New Delhi, 2004
3. **Experimental Stress Analysis** - Srinath, Lingaiah, Raghavan, Gargesa, Ramachandra and Pant, Tata McGraw Hill, 1984.
4. **Instrumentation, Measurement And Analysis -**Nakra&Chaudhry, B C Nakra K KChaudhry, Tata McGraw-Hill Companies, Inc, New York, Seventh Edition, 2006.

Reference Books:

1. **Measurement Systems Application and Design** - Doeblin E. A., 4th (S.I.) Edition, McGraw Hill, New York. 1989
2. **Design and Analysis of Experiments -** Montgomery D.C., John Wiley & Sons, 1997.
3. **Experimental Stress Analysis** - Dally and Riley, McGraw Hill, 1991.
4. **Experimental Stress Analysis -** Sadhu Singh, Khanna publisher, 1990.
5. **PhotoelasticityVol I and Vol II -** M.M.Frocht,. John Wiley and sons, 1969.
6. **Strain Gauge Primer -** Perry and Lissner, McGraw Hill, 1962.

Course Outcome: It helps the students to

1. Undertake experimental investigations to verify predictions by other methods.
2. To acquire skills for experimental investigations an accompanying laboratory course is desirable.

Elective-I

COMPUTER GRAPHICS

(Common to MDE,MEA,MMD,CAE)

Sub Code : 16MDE151	IA Marks :50
Hrs/ Week : 04	Exam Hours : 03
Total Hrs: 50	Exam Marks :100

Course Objective:

This course will help the student to be knowledgeable of concepts, principles, processes and techniques essential to all areas of computer graphics

Course Content:

1. Transformations : Representation of points, Transformations: Rotation, Reflection, Scaling, Shearing, Combined Transformations, Translations and Homogeneous Coordinates, A geometric interpretation of homogeneous coordinates, Over all scaling, Points at infinity, Rotation about an arbitrary point, Reflection through an arbitrary line, Rotation about an axis parallel to coordinate axis, Rotation about an arbitrary axis in space, Reflection through an arbitrary plane.

10 Hours

2. Types and Mathematical Representation of Curves: Curve representation, Explicit, Implicit and parametric representation. Nonparametric and parametric representation of Lines, Circles, Ellipse, Parabola, Hyperbola, Conics. Parametric representation of synthetic curve, Hermite cubic splines, , Bezier curves: Blending function, Properties, generation, B-spline curves- Cox-deBoor recursive formula, Properties, Open uniform basis functions, Non-uniform basis functions, Periodic B-spline curve.

Types and Mathematical Representation of Surfaces Surface entities and parametric representation- Plane, Ruled, surface of revolution, Offset surface, Coons patch, Bezier surface, B-spline surface

10Hours

3. Types and Mathematical Representation of Solids

Solid entities: Block, Cylinder, Cone, Sphere, Wedge, Torus, Solid representation, Fundamentals of solid modeling, Set theory, Regularized set operations, Set membership classification, Half spaces, Basic elements, Building operations, Boundary representation and Constructive solid geometry, Basic elements, Building operations.

Scan Conversion and Clipping: Representation of points, lines, Drawing Algorithms: DDA algorithm, Bresenham's integer line algorithm, Bresenham's circle algorithm, Polygon filling algorithms: Scan conversion, Seed filling, Scan line algorithm. Viewing transformation, Clipping - Points, lines, Text, Polygon, Cohen-Sutherland line clipping, Sutherland-Hodgmen algorithm.

10Hours

4. Visual Realism: Introduction, Hidden line removal, Visibility of object views, Visibility techniques: Minimax test, Containment test, Surface test, Silhouttes, Homogeneity test, Sorting, Coherence, Hidden surface removal- Z-buffer algorithm, Warnock's algorithm, Hidden solid removal - ray tracing algorithm, Shading, Shading models, Diffuse reflection, Specular reflection, Ambient light, Shading of surfaces: Constant shading, Gourand shading, Phong shading, Shading enhancements, Shading Solids, Ray tracing for CSG, Z-buffer algorithm for B-rep and CSG

10 Hours

5.Applications: Colouring- RGB, CMY, HSV, HSL colour models, Data Exchange: Evolution of Data exchange, IGES, PDES, Animation: Conventional animation-key frame, Inbetweening, Line testing, Painting, Filming, Computer animation, Entertainment and Engineering Animation, Animation system hardware, Software architecture, Animation types, Frame buffer, Colour table, Zoom-pan-scroll, Cross bar, Real time play back, Animation techniques- key frame, Skelton. Path of motion and p-curves.

10 Hours

TextBooks:

1. IbrahamZeid, CAD/CAM-Theory and Practice-McGraw Hill, 2006.
2. David Rogers & Alan Adams, Mathematical Elements for Computer Graphics-Tata McGraw Hill, 2002.

ReferenceBooks:

1. Xiang Z, Plastock, R. A, Computer Graphics- Schaum's Outline, McGraw Hill, 2007.
2. Foley, van Dam, Feiner and Hughes, Computer Graphics- Principles and Practice-Addison Wesley, 1996.
3. Sinha A N., Udai A D., Computer Graphics- Tata McGraw Hill, 2008.

Course Outcome:

This course will enable students to:

1. Recognize how a visual image can be an effective means of communication
2. Acquire and develop the skills needed to creatively solve visual communication problems.
3. Understand, develop and employ visual hierarchy using images and text

COMPUTER APPLICATIONS IN DESIGN

(Common to MDE,MEA,MMD,CAE)

Sub Code : 16MDE152	IA Marks :50
Hrs/ Week : 04	Exam Hours : 03
Total Hrs: 50	Exam Marks :100

Course Objective

It helps the students to learn the principles of CAD/CAM/CAE Systems, Graphics Programming, Geometric Modeling Systems, CAD, CAM and CAE Integration, Standards for Communicating between Systems

Course Content:

1. **Introduction To CAD/CAM/CAE Systems**

   Overview, Definitions of CAD. CAM and CAE, Integrating the Design and Manufacturing Processes through a Common Database-A Scenario, Using CAD/CAM/CAE Systems for Product Development-A Practical Example.

   Components of CAD/CAM/CAE Systems: Hardware Components ,Vector-Refresh(Stroke-Refresh) Graphics Devices, Raster Graphics Devices, Hardware Configuration, Software Components, Windows-Based CAD Systems.**10 Hours**

2. **Basic Concepts of Graphics Programming**:

   Graphics Libraries, Coordinate Systems, Window and Viewport, Output Primitives - Line, Polygon, Marker Text, Graphics Input, Display List, Transformation Matrix, Translation, Rotation, Mapping, Other Transformation Matrices, Hidden-Line and Hidden-Surface Removal, Back-Face Removal Algorithm, Depth-Sorting, or Painters, Algorithm, Hidden-Line Removal Algorithm, z-Buffer Method, Rendering, Shading, Ray Tracing, Graphical User Interface, X Window System.

   Standards

   Standards for Communicating Between Systems: Exchange Methods of Product Definition Data, Initial Graphics Exchange Specification, Drawing Interchange Format, Standard for the Exchange of Product Data. Tutorials, Computational exercises involving Geometric Modeling of components and their assemblies

   10 Hours

3. **Geometric Modeling Systems**

   : Wireframe Modeling Systems, Surface Modeling Systems, Solid Modeling Systems, Modeling Functions, Data Structure, Euler Operators, Boolean Operations, Calculation of Volumetric Properties, Non manifold Modeling Systems, Assembly Modeling Capabilities, Basic Functions of Assembly Modeling, Browsing an Assembly, Features of Concurrent Design, Use of Assembly models, Simplification of Assemblies, Web-Based Modeling.

   Representation and Manipulation of Curves: Types of Curve Equations, Conic Sections, Circle or Circular Arc, Ellipse or Elliptic Arc, Hyperbola, Parabola, Hermite Curves, Bezier Curve, Differentiation of a Bezier Curve Equation, Evaluation of a Bezier Curve

10 Hours

4. B-Spline Curve, Evaluation of a B-Spline Curve, Composition of B-Spline Curves, Differentiation of a B-Spline Curve, Non uniform Rational B-Spline (NURBS) Curve, Evaluation of a NURBS Curve, Differentiation of a NURBS Curve, Interpolation Curves, Interpolation Using a Hermite Curve, Interpolation Using a B-Spline Curve, Intersection of Curves.
   Representation and Manipulation of Surfaces: Types of Surface Equations, Bilinear Surface, Coon's Patch, Bicubic Patch, Bezier Surface, Evaluation of a Bezier Surface, Differentiation of a Bezier Surface, B-Spline Surface, Evaluation of a-B-Spline Surface, Differentiation of a B-Spline Surface, NURBS Surface, Interpolation Surface, Intersection of Surfaces.

10 Hours

5. **CAD and CAM Integration**
   Overview of the Discrete Part Production Cycle, Process Planning, Manual Approach, Variant Approach, Generative Approach, Computer-Aided Process Planning Systems, CAM-I CAPP, MIPLAN and Multi CAPP, Met CAPP,ICEM-PART, Group Technology, Classification and Coding, Existing Coding Systems, Product Data Management (PDM) Systems.

10 Hours

Text Books:

1. Kunwoo Lee, “Principles of CAD/CAM/CAE systems”-Addison Wesley, 1999
2. RadhakrishnanP.,etal.,“CAD/CAM/CIM”-New Age International, 2008

Reference Books:

1. Ibrahim Zeid, “CAD/CAM – Theory & Practice”, McGraw Hill, 1998
2. Bedworth, Mark Henderson & Philip Wolfe, “Computer Integrated Design and Manufacturing” -McGraw hill inc., 1991.
3. Pro-Engineer, Part modeling Users Guide, 1998

Course Outcome:

Students develop expertise in generation of various curves, surfaces and volumes used in geometric modeling systems.

MECHATRONICS SYSTEM DESIGN

(Common to MDE,MEA,MMD,CAE)

Sub Code : 16MDE153	IA Marks :50
Hrs/ Week : 04	Exam Hours : 03
Total Hrs: 50	Exam Marks :100

Course Objective

1. To educate the student regarding integration of mechanical, electronics, electrical and computer systems in the design of CNC machine tools, Robots etc.
2. To provide students with an understanding of the Mechatronic Design Process, actuators, Sensors, transducers, Signal Conditioning, MEMS and Microsystems and also the Advanced Applications in Mechatronics.

Course Content:

1. Introduction: Definition and Introduction to Mechatronic Systems. Modeling &Simulation of Physical systems Overview of Mechatronic Products and their functioning, measurement systems. Control Systems, simple Controllers. Study of Sensors and Transducers: Pneumatic and Hydraulic Systems, Mechanical Actuation System, Electrical Actual Systems, Real time interfacing and Hardware components for Mechatronics. **10 Hours**

2. Electrical Actuation Systems: Electrical systems, Mechanical switches, Solid state switches, solenoids, DC & AC motors, Stepper motors. System Models: Mathematical models:- mechanical system building blocks, electrical system building blocks, thermal system building blocks, electromechanical systems, hydro-mechanical systems, pneumatic systems. **11 Hours**

3. Signal Conditioning: Signal conditioning, the operational amplifier, Protection, Filtering, Wheatstone Bridge, Digital signals , Multiplexers, Data Acquisition, Introduction to digital system processing, pulse-modulation.
   MEMS and Microsystems: Introduction, Working Principle, Materials for MEMS and Microsystems, Micro System fabrication process, Overview of Micro Manufacturing, Micro system Design, and Micro system Packaging. **13 Hours**

4. Data Presentation Systems: Basic System Models, System Models, Dynamic Responses of System. **8 Hours**

5. Advanced Applications in Mechatronics: Fault Finding, Design, Arrangements and Practical Case Studies, Design for manufacturing, User-friendly design. **8 Hours**

Text Books:

1. W. Bolton, “Mechatronics” - Addison Wesley Longman Publication, 1999
2. HSU “MEMS and Microsystems design and manufacture”- Tata McGraw-Hill Education, 2002

Reference Books:

1. Kamm, “Understanding Electro-Mechanical Engineering an Introduction to Mechatronics”- IEEE Press, 1 edition ,1996
2. Shetty and Kolk “Mechatronics System Design”- Cengage Learning, 2010
3. Mahalik “Mechatronics”- Tata McGraw-Hill Education, 2003
4. HMT “Mechatronics”- Tata McGraw-Hill Education, 1998
5. Michel .B. Histand& David. Alciatore, “Introduction to Mechatronics & Measurement Systems”–. Mc Grew Hill, 2002
6. “Fine Mechanics and Precision Instruments”- Pergamon Press, 1971.

Course Outcome:

This course makes the student to appreciate multi disciplinary nature of modern engineering systems. Specifically mechanical engineering students to collaborate with Electrical, Electronics, Instrumentation and Computer Engineering disciplines.

DESIGN FOR MANUFACTURE
(Common to MDE,MEA,MMD,CAE)

Sub Code : 16MDE154 IA Marks :50
Hrs/ Week : 04 Exam Hours : 03
Total Hrs: 50 Exam Marks :100

Course Objective:

To educate students a clear understanding of factors to be considered in designing parts and components with focus on manufacturability

Course Content:

1. Effect of Materials And Manufacturing Process On Design: Major phases of design. Effect of material properties on design Effect of manufacturing processes on design. Material selection process- cost per unit property, Weighted properties and limits on properties methods.

   Tolerence Analysis: Process capability, mean, varience, skewness, kurtosis, Process capability metrics, Cp, Cpk, Cost aspects, Feature tolerances, Geometries tolerances, Geometric tolerances, Surface finish, Review of relationship between attainable tolerance grades and different machining process. Cumulative effect of tolerance- Sure fit law and truncated normal law. **12 Hours**

2. Selective Assembly: Interchangeable part manufacture and selective assembly, Deciding the number of groups -Model-1 : Group tolerance of mating parts equal, Model total and group tolerances of shaft equal. Control of axial play-Introducing secondary machining operations, Laminated shims, examples.

   Datum Features : Functional datum, Datum for manufacturing, Changing the datum. Examples.**12 Hours**

3. Design Considerations: Design of components with casting consideration. Pattern,Mould, and Parting line. Cored holes and Machined holes. Identifying the possibleand probable parting line. Casting requiring special sand cores. Designing to obviatesand cores.

   Component Design: Component design with machining considerations link design for turning components-milling, Drilling and other related processes including finish- machining operations. **13 Hours**

4. True positional theory : Comparison between co-ordinate and convention method offeature location. Tolerance and true position tolerancing virtual size concept, Floating and fixed fasteners. Projected tolerance zone. Assembly with gasket, zero position tolerance. Functional gauges, Paper layout gauging. **7 Hours**

5. Design of Gauges: Design of gauges for checking components in assemble with emphasis on various types of limit gauges for both hole and shaft. **6 Hours**

Text Books:

1. Harry Peck , "Designing for Manufacturing", Pitman Publications, 1983.
2. Dieter , "Machine Design" - McGraw-Hill Higher Education, -2008
3. R.K. Jain, "Engineering Metrology", Khanna Publishers, 1986
4. Product design for manufacture and assembly - Geoffrey Boothroyd, Peter dewhurst, Winston Knight, Merceldekker. Inc. CRC Press, Third Edition
5. Material selection and Design, Vol. 20 - ASM Hand book.

Course Outcome:

Students will have added capability to include manufacturability in mechanical engineering design of parts and their assemblies.

ADVANCED FLUID DYNAMICS
(Common to MDE,MEA,MMD,CAE)

Sub Code : 16MEA155	IA Marks :50
Hrs/ Week : 04	Exam Hours : 03
Total Hrs: 50	Exam Marks :100

Course Objective:
The student will gain knowledge of dynamics of fluid flow under different conditions.

1. **Review of undergraduate Fluid Mechanics** : Differential Flow analysis- Continuity equation (3D Cartesian, Cylindrical and spherical coordinates) Navier Stokes equations (3D- Cartesian, coordinates) Elementary inviscid flows; superposition (2D).

8 Hours

2. **Integral Flow Analysis**: Reynolds transport theorem, Continuity, momentum, moment of momentum, energy equations with applications such as turbo machines, jet propulsion &propellors;

Exact solution of viscous flow equations: Steady flow: Hagen Poiseuille problem, plane Poiseuille problem, Unsteady flow: Impulsively started plate

12 Hours

3. **Low Reynolds number flows**:Lubrication theory (Reynolds equation), flow past rigid sphere, flow past cylinder

Boundary Layer Theory:Definitions, Blasius solution, Von-Karman integral, Separation,

10 Hours

4. Thermal Boundary layer and heat transfer, (Laminar & turbulent flows);
   Experiments in fluids: Wind tunnel, Pressure Probes, Anemometers and flow meters

10 Hours

5. **Special Topics**:Stability theory; Natural and forced convection; Rayleigh Benardproblem;Transition to turbulence; Introduction to turbulent flows

10 Hours

Text Books:

1. **“Foundations of fluid mechanics”** - S. W. Yuan,SI Unit edition, 1988.
2. **“Advanced Engineering Fluid Mechanics**”- K. Muralidhar& G. Biswas, Narosa Publishers, 1999.

Reference Books:

1. **"Physical Fluid Dynamics"** 2nd edition – D.J. Tritton, Oxford Science Publications, 1988.
2. **"Boundary Layer Theory"**8th edition, H. Schlichting, McGraw Hill, New York., 1999.

Course Outcome:

The student will be able to apply concepts of fluid dynamics in solving real time problems.

Design Engineering Laboratory – Lab 1
(Common to MDE,MEA,MMD,CAE,MCS)

Sub Code : 16MDE16	IA Marks :25
Hrs/ Week : 6	Exam Hours : 03
Total Hrs:84	Exam Marks :50

Note:

1) These are independent laboratory exercises
2) A student may be given one or two problems stated herein
3) Student must submit a comprehensive report on the problem solved and give a Presentation on the same for Internal Evaluation
4) Any one of the exercises done from the following list has to be asked in the Examination for evaluation.

Course Content:

Experiment #1

Numerically Calculation and MATLAB Simulation

Part A:Invariants, Principal stresses and strains with directions

Part A: Maximum shear stresses and strains and planes,Von-Mises stress

Part C: Calculate and Plot Stresses in Thick-Walled Cylinder

Experiment #2

Stress analysis in Curved beam in 2D

Part A : Experimental studies using Strain Gauge Instrumentation.

Part B : 2D Photo elastic Investigation.

Part C :Modelling and Numerical Analysis using FEM.

Experiment #3

Stress analysis of rectangular plate with circular hole under i. Uniform Tension and ii. shear

Part A: Matlab simulation for Calculation and Plot of normalized hoop Stress at hole boundary in Infinite Plate

Part B: Modelling of plate geometry under chosen load conditions and study the effect of plate geometry.

Part C: Numerical Analysis using FEA package.

Experiment #4

Single edge notched beam in four point bending.

Part A: Modellingof single edge notched beam in four point bending.
Part B: Numerical Studies using FEA.
Part C: Correlation Studies.

Experimental #5
Torsion of Prismatic bar with Rectangular cross-section.
Part A: Elastic solutions, MATLAB Simulation
Part B: Finite Element Analysis of any chosen geometry.
Part C: Correlation studies.

Experiment #6
Contact Stress Analysis of Circular Disc under diametrical compression
Part A: 3-D Modelling of Circular Discs with valid literature background, supported with experimental results on contact stress.
Part B: Numerical Analysis using any FEA package.
Part C: 2D Photo Elastic Investigation.

Experiment #7
Vibration Characteristics of a Spring Mass Damper System.
Part A: Analytical Solutions.
Part B: MATLAB Simulation.
Part C: Correlation Studies.

Experiment #8
Modelling and Simulation of Control Systems using MATLAB.