Scheme and Syllabus of M.E. Mechanical Engineering 1st to 4th Semester
Applicable to batch 2019-2021

One Batch One Scheme (OBOS)

PANJAB UNIVERSITY
CHANDIGARH

Vision and Mission of Department of Mechanical Engineering

Vision

To be Fountainhead of Technological solutions for Needs of Society and Industry.

Mission

1. To impart fundamental engineering skills & knowledge for analysis of engineering problems.

2. To engage with Industry/Society for taking up stimulating problems on merits.

3. To take the project execution to "Minimum Usable Prototype (MUP)" stage/Pilot-testing and secure IP rights.

Core values

1. 100% coverage of syllabus by faculty.

2. Actual delivery of around 40 lectures for a subject.

3. Delivery of lecture for around 50 minutes by a faculty in a lecture class of one hour.

4. 100% engagement of Tutorials.

5. Presence of faculty in the lab during entire time of lab class.

6. Regular checking of practical files by faculty.

Program Educational Objectives (PEO's)

1. About 5% of our students starting-up their own start-up companies.

2. Reputation of our students as innovators.

3. Appreciable number of our students working in product-development.

4. Majority of our students working in core engineering domain.

5. Appreciation of our students for their multi-disciplinary skills.

6. Recognition of our students for solving societal problems.

7. Appreciable number of our students obtaining doctoral degrees from IITs and reputed international institutes.

8. Appreciable number of our students working in R & D.

Program Outcomes (PO's)

- An ability to apply knowledge of mathematics, science, and engineering,
- An ability to design and conduct experiments, as well as to analyze and interpret data,
- an ability to design a system, component, or process to meet the desired needs within realistic constraints, such as, economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability,
- An ability to function in multidisciplinary teams,
- An ability to identify, formulate, and solve engineering problems,
- An understanding of professional and ethical responsibility,
- An ability to communicate effectively,
- The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context,
- A recognition of the need for and an ability to engage in life-long learning,
- A knowledge of contemporary issues, and
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Summary of Scheme

Semester	Contact Hours	Credits
Semester 1	22	21
Semester 2	22	21
Semester 3	28	18
Semester 4	28	14
Total	100	74

M.E. Mechanical Engineering
First Semester

S. No.	Subject Code	Subject Name	Scheme of Teaching			Scheme of Examination					
						Marks					
			L-T-P	Contact hrs/week	Credits	Theory			Practical*		
						Internal Assessment	Univ Exam	Total	Internal Assessment	Univ Exam	Total
1.	MME-101	Advanced Engineering Mathematics	3-1-0	4	4	50	50	100	-	-	-
2.	MME-102	Design of Experiments	3-1-0	4	4	50	50	100	-	-	-
3.	MME-103	Advanced Mechanics of Materials	3-1-0	4	4	50	50	100	-	-	-
4.	MME-104	Industrial Tribology	3-1-0	4	4	50	50	100	-	-	-
5.	MME-105(a-h)	Elective-I	3-1-0	4	4	50	50	100	-	-	-
6.	MME-150	Laboratory-I	0-0-2	2	1	-	-	-	25	-	25
Total				22	21	250	250	500	25	-	25

* Practical marks include continuous and end semester evaluation

M.E. Mechanical Engineering
Second Semester

S. No.	Subject Code	Subject Name	Scheme of Teaching			Scheme of Examination					
						Marks					
						Theory			Practical*		
			L-T-P	Contact hrs/week	Credits	Internal Assessment	Univ Exam	Total	Internal Assessment	Univ Exam	Total
1.	MME-201	Continuum Mechanics	3-1-0	4	4	50	50	100	-	-	-
2.	MME-202	Advanced Manufacturing Processes	3-1-0	4	4	50	50	100	-	-	-
3.	MME-203	Advances in Engineering Materials	3-1-0	4	4	50	50	100	-	-	-
4.	MME-204	Structural Dynamics	3-1-0	4	4	50	50	100	-	-	-
5.	MME 205(a-h)	Elective-II	3-1-0	4	4	50	50	100	-	-	-
6.	MME-250	Laboratory-II	0-0-2	2	1	-	-	-	25	-	25
Total				22	21	250	250	500	25	-	25

* Practical marks include continuous and end semester evaluation

M.E. Mechanical Engineering
Third Semester

S. No.	Subject Code	Subject Name	Scheme of Teaching			Scheme of Examination					
						Marks					
			L-T-P	Contact hrs/week	Credits	Theory			Practical*		
						Internal Assessment	Univ Exam	Total	Internal Assessment	Univ Exam	Total
1	MME-301	Advanced Machine Design	3-1-0	4	4	50	50	100	-	-	-
2	MME-350	Preliminary Thesis	-	20	10	-	-	-	250	-	250
3	MME-302(a-f)	Elective-III	3-1-0	4	4	50	50	100	-	-	-
Total				28	18	200	100	300	250	-	250

*Marks will be awarded by internal institution committee

M.E. Mechanical Engineering
Fourth Semester

S. No.	Subject Code	Subject Name	Scheme of Teaching			Scheme of Examination					
						Marks					
			L-T-P	Contact hrs/week	Credits	Theory			Practical*		
						Internal Assess ment	Univ Exam	Total	Internal Assess ment	Univ Exam	Total
1	MME-450	Thesis work	-	28	14	-	-	-	175	175	350
Total				28	14	-	-	-	175	175	350

*Marks will be awarded by internal institution committee

For Internal assessment only

M.E. Thesis grade will be awarded as

S. No.	Grade	Requirement
1	A+	Publication in SCI/ SCI-E Journal/ E-SCI Journal
2	A	Publication in Scopus
3	B+	Paper presented in International conference
4	B	Paper presented in National conference

For External Evaluation
Grade as awarded by examiner

Final Grade for thesis The grade awarded in internal assessment and grade awarded in external assessment are combined and averaged and then final grade is awarded.

Elective-1 Courses in Semester 1

1. MME-105(a) Quality Control and Reliability
2. MME-105(b) Manufacturing Science
3. MME-105(c) Welding Techniques
4. MME-105(d) Tool and Cutter Design
5. MME-105(e) Condition Monitoring and Fault Diagnosis
6. MME-105(f) Advanced Heat Transfer
7. MME-105(g) Gas Dynamics
8. MME-105(h) Introduction to Modern FORTRAN
9. MME-105(j) Design of Biomedical Devices and Systems

Elective-II Courses in Semester 2

1. MME-205 (a) Fluid Dynamics
2. MME-205(b) Experimental Stress Analysis
3. MME-205(c) Mechanical Behavior of Materials
4. MME-205 (d) Composite Materials
5. MME-205 (e) Model Updating
6. MME-205 (f) Mechatronics
7. MME-205 (g) Advanced Control System
8. MME-205 (h) Imaging and Additive Manufacturing

Elective-III Courses in Semester 3

1. MME-302(a) Modeling of Manufacturing Systems
2. MME-302(b) Finite Element Method
3. MME-302(c) Computational Fluid Dynamics
4. MME-302(d) Vibration Testing
5. MME-302(e) Optimization Techniques
6. MME-302(f) Materials Design

Course Code	**MME-101**
Course Title	**Advanced Engineering Mathematics**
Type of Course	Core
L T P	3 1 0
Credits	4
Course Assessment Methods End Semester Assessment (University Exam.) Continuous Assessment (Sessional, Assignments, Quiz)	 50 50
Course Prerequisites	

SYLLABUS

Note for Examiner*- The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

SECTION-A

Series solution of differential equations, Power series methods, Legendre's polynomial, Generating functions, Recurrence relations. Frobenius method, Series solution of Bessel's differential equation, Modified Bessel's functions, Generating functions, Recurrence relations.Equations reducible to Bessel's equation. Sturm Liouville's problem, orthogonal functions, Orthogonality of eigen functions, Eigen function expansions.

SECTION-B

Numerical solutions of simultaneous and higher order differential equations: Runge-Kutta method, Picard's method. Approximate methods for B.V. problems: Finite difference method. Approximate and numerical solutions of PDE's: Finite difference approximation to derivatives. Numerical solutions of elliptic equations (Laplace and Poisson's equations), Parabolic equations and Hyperbolic equations.

RECOMMENDED BOOKS			
	NAME	**AUTHOR(S)**	**PUBLISHER**
1	Advanced Engineering Mathematics	Kreyszig, Erwin	John Wiley
2	Numerical Solution of Differential Equations	Jain, R.K.	New Age International Publishers
3	Introductory Methods of	Sastry, S.S.	Prentice Hall of

	Numerical Analysis,		India
4	Numerical Methods for Scientific and Engineering Computation	Jain, M. K., Iyengar, S. R. K., Jain, R. K.	New Age International Publishers
5	Numerical Methods for Engineers	Steven C. Chapra, Raymond P. Canale	Tata McGraw Hill
6	Elementary Differential Equations and Boundary Value Problems	William E. Boyce, Richard C. DiPrima:	John Wiley

Course Code	**MME-102**
Course Title	**Design of Experiments**
Type of Course	Core
L T P	3 1 0
Credits	4
Course Assessment Methods End Semester Assessment (University Exam.) Continuous Assessment (Sessional, Assignments, Quiz)	 50 50

SYLLABUS

Note for Examiner*- The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

SECTION-A

Introduction:
Strategy of experimentation, Some typical applications of experimental design, Basic principles, Guidelines for designing experiments, A brief history of statistical design, Using statistical design in experimentation

Simple Comparative Experiments:
Introduction, Basic statistical concepts, Sampling and sampling Distribution, Inferences about the Differences in means, randomized designs, Paired comparison Designs, Inferences about the Variances of Normal Distributions

Introduction To Factorial Design:
Basic definition and principles, Advantages of factorials, The two factor factorial design, General factorial design, Fitting response curves and Surfaces, Blocking in a factorial design
2k and 3k factorial designs Introduction, analysis of the 2k factorial design and 3k factorial design, related problems
Confounding Introduction, confounding in the 2k and 3k factorial design, partial confounding, related problems
Fractional factorial designs Introduction, fractional replication of the 2k factorial design-one-half, one-quarter and the general 2k-p fractional factorial design, design of resolution III, IV and V, related problems

SECTION-B

Regression analysis
Introduction, simple linear regression, hypothesis testing in simple linear regression, interval testing in simple linear regression, model adequacy checking-residual analysis, the lack-of-fit test, the coefficient of determination, Multiple linear regression, hypothesis testing in multiple linear regression, other linear regression models. Related problems

Taguchi Method Of Design Of Experiments:

Concept design, Parameter design, Tolerance design, Quality loss function, Signal-to- Noise ratio, Orthogonal array experiments, Analysis of Mean (ANOM), Quality characteristics, Selection and testing of noise factors, Selection of control factors, Parameter optimization experiment, Parameter design case study.

Response surface methodology
Introduction, the method of steepest ascent, analysis of quadratic models, response surface designs-designs for fitting the 1st order and 2nd order models, related problems

Analysis of Variance (ANOVA):
Introduction, Example of ANOVA process, Degrees of freedom, Error variance and pooling, Error variance and application, Error variance and utilizing empty columns, the F-test (12 Hrs)

TEXT BOOKS			
S. No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1	Introduction to Linear Regression Analysis	Montgomery D.C., Runger G.C.,	John Wiley
RECOMMENDED BOOKS			
1	Process and Product Optimization Using Designed Experiments	Myres R.H. and Montgomery D.C	John Wiley
2.	Introduction to Quality Engineering	Taguchi , G	UNIPUB,WhitePlains,New York

Course Code	**MME-103**
Course Title	**Advanced Mechanics of Materials**
Type of Course	**Core**
L T P	**3 1 0**
Credits	**4**
Course Assessment Methods **End Semester Assessment (University Exam.)** **Continuous Assessment (Sessional, Assignments, Quiz)**	 **50** **50**

SYLLABUS

Note for Examiner*- The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

SECTION-A

Stress, Strain, Stress-Strain Relations, and Introductory Elasticity
Stress, Stress Tensor,2D and 3D Stress and Mohr Circle.Strain, Equations of Compatibility, Strain Measurement.Stress-Strain Relations, Hooke's Law, Poisson's Ratio. Strain Energy, Strain Energy for Common Structural Members, Components of Strain Energy, Saint-Venant's Principle. Plastic Deformation, Simple Tension True Stress-True Strain curve and Instability, Plastic Stress-Strain Relations, Plastic Stress-Strain Increment Relations. Plane Stress Problems, Plane Stress Problems, Airy Stress Function, Solution of Elasticity Problem, Thermal Stresses, Stress due to Concentrated Load, Stress Concentration, Contact Stress.

Failure Criteria
Failure by and Criteria for Yielding and Fracture, Failure Theories: Max. Shearing Stress, Max. Distortion Energy, Octahedral Shearing Stress, Max. Principal Stress, Mohr's, Coulomb-Mohr; Fracture Mechanics, Failure Criteria for Metal Fatigue, Fatigue Life, Impact Load, Dynamic and Thermal Effects.

Torsion of Prismatic Bars
Elementary Theory, General Solution of Torsion Problem, Prandtl'sStress Function and Membrane Analogy, Torsion of Thin-walled Members: Open Cross-section, Multiply Connected, Restrained; Fluid Analogy and Stress Concentration, Curved Circular Bars, Helical Springs. Elastic-Plastic Torsion.

Beams, Plates, and Shells
Beams: Exact and Approximate Solutions, Curved Beams. Beams on Elastic Foundations: Infinite, Semi-infinite, Finite Beams, Beams Supported by equally Spaced Elastic Elements, Finite Difference Solutions. Thin Plates: Basic Assumptions and Relations, Boundary Conditions, Simply Supported Rectangular Plates, Axisymmetrically Loaded Circular Plates, Deflection by Energy Method, Finite Element Solution. Thin Shells: Basic Assumptions, Membrane Action, Shells of Revolution, Cylindrical Shells of General Shape.

(12 hours)

SECTION-B

Numerical Methods

Finite Differences and Equations, Curved Boundaries, Boundary Conditions, Finite Element Method, Properties of a Finite Element, Formulation of the Finite Element Method, Triangular Element, Use of Digital Computers.

Axisymmetrically Loaded Members

Thick-walled Cylinders, Max. Tangential Stress, Failure Theories, Compound Cylinders, Perfectly Plastic Thick-Walled Cylinders. Rotating Disks: Constant and Variable Thickness, Uniform Stress; Elastic-Plastic Stresses in Rotating Disks, Thermal Stresses in Thin Disks and Long Cylinders, Finite Element Solution.

Energy Methods

Work done in Deformation,Theorems: Reciprocity, Castigliano, Crotti-Engesser; Statically Indeterminate Systems, Principles: Virtual work, Minimum Potential Energy; Rayleigh-Ritz Method.

Elastic Stability

Critical Load, Buckling of Column, End Conditions, Critical and Allowable Stress, Initially Curved, Eccentrically Loaded and Secant Formula, Energy Methods, Finite Differences Solution.

(12 hours)

TEXT BOOKS			
S. No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1	Advanced Strength and Applied Elasticity	Ugural and Fenster	Prentice Hall, 2003
2	Advanced Mechanics of Material	Boresi and Schmidt	Wiley, 1993
3	Advanced Strength and Applied Stress Analysis	Budynas	McGrawHill, 1999

Course Code	**MME-104**
Course Title	**Industrial Tribology**
Type of Course	**Core**
L T P	**3 1 0**
Credits	**4**
Course Assessment Methods **End Semester Assessment (University Exam.)** **Continuous Assessment (Sessional, Assignments, Quiz)**	 **50** **50**

SYLLABUS

Note for Examiner*- The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

SECTION-A

Introduction

Definition and Scope of tribology, Contact of solids, nature of surfaces, surface topography, surface interactions and characterization, micro and nanotribology, surface roughness measurement techniques.

Friction

Types, laws, modern theories, dry sliding friction, temperature of sliding surface, Mechanism of rolling friction, friction instabilities, measurement of friction.

W**ear**

Classification, theories of adhesive, abrasive, surface fatigue and corrosives wear, erosive, cavitation and fretting wear, wear models, wear of miscellaneous machine components such as gears, plain bearings and rolling element bearings, ASTM standards for wear measurement, wear resistant materials, wear resistant components, Study of abrasion in grinding, lapping and honing.

(12 hours)

SECTION-B

Lubrication Theories

Lubrication regimes: hydrodynamic lubrication, hydrostatic lubrication, elastohydrodynamic lubrication, boundary lubrication, squeeze films, turbulent lubrication. Reynold's equation, Pressure distribution, load carrying capacity, friction forces in oil film and co-efficient of friction in journal bearing.

Bearing Design

Clearance in journal bearing, minimum film thickness, Sommerfeld Number. Oil grooves and flow of oil in axial and circumferential grooves, cavitation and turbulence in oil bearing. Heat generation and cooling of bearing. Design of air bearing and other gas bearings.

Applications

Application of tribology in manufacturing processes, Metal machining, Metal cutting, Tool wear, Action of lubricants, Friction welding, Extrusion process

(12 hours)

TEXT BOOKS			
S. No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1	Basic Lubrication Theory	A Comeron	Ellis Horwood
2	Friction Wear & Lubrication	Kenneth C.Ludema	CRC Press Book
3	Engineering Tribology	J.A.Williams	Cambrize
4	Fundamentals of Tribology	Basu, Sengupta&Ahuja	World Scientific
5	Engineering Tribology	Stachowiak& Bachelor	Elsevier

Course Code	MEC-150
Course Title	Laboratory-I
Type of Course	Core
L T P	0 0 2
Credits	1
Course Assessment Methods Continuous Assessment (Practical Performance, report writing and Viva voce)	50

Syllabus

The students will perform a set of experiments assembled at the discretion of the instructor(s) from the compulsory and elective courses taught during the semester.

Course Code	**MME-201**
Course Title	**Continuum Mechanics**
Type of Course	Core
L T P	3 1 0
Credits	4
Course Assessment Methods End Semester Assessment (University Exam.) Continuous Assessment (Sessional, Assignments, Quiz)	 50 50

SYLLABUS

Note for Examiner*- The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

SECTION-A

Introduction-What is Continuum Mechanics?

Tensors – Indicial notation, Tensor Algebra, Tensor Calculus, Curvilinear Coordinates

Kinematics of a Continuum - Description of motions of a continuum, Kinematic equation for rigid body motion, Infinitesimal deformation, Infinitesimal rotation tensor, rate of deformation and spin tensor, Conservation of mass, Compatibility conditions for infinitesimal strain and rate of deformation components, Deformation gradient, local rigid body motion, Finite deformation, Polar decomposition theorem, Stretch and Rotation tensors, Right Cauchy-Green, Lagrangian strain tensor, Left Cauchy-Green, Eulerian strain tensor, Change of area and volume due to deformation, Components of deformation tensors in other coordinates, Current configuration as the reference configuration

Stress – Stress Tensor, Symmetry-Principle Of Moment Of Momentum, Equations Of Motion-Principle Of Linear Momentum, Boundary Condition , Piola Kirchhoff Stress Tensors, Equations Of Motion w.r.t. Reference Configuration, Stress Power, Heat Flow, Energy Equation, Entropy Inequality, Integral Formulations of the General Principles of Mechanics.

SECTION-B

Elastic Solid – Isotropic Linear Elastic Solid, Anisotropic Linear Elastic Solid, Isotropic Solid under Large Deformation.

Newtonian Viscous Fluid – Fluids, Compressible and Incompressible Fluids, Newtonian Fluids, Interpretation of λ and μ, Incompressible Newtonian Fluid, Navier-Stokes Equations for Incompressible Fluids, Boundary Conditions, Streamline, Pathline, Steady, Unsteady, Laminar, and Turbulent Flow. Plane Couette Flow, Plane Poiseuille Flow, Hagen-Poiseuille Flow, Dissipation Functions for Newtonian Fluids, Energy Equation For A Newtonian Fluid, Vorticity Vector, Irrotational Flow, Concept Of A Boundary Layer, Compressible Newtonian Fluid, Energy Equation In Terms Of Enthalpy, Acoustic Wave.

Reynolds Transport Theorem and Applications – Green's Theorem, Divergence Theorem, Integrals Over A Control Volume And Integrals Over A Material Volume, The Reynolds Transport Theorem, The Principle Of Conservation Of Mass, The Principle Of Linear Momentum, Moving Frames, A Control Volume Fixed With Respect To A Moving Frame,The Principle Of Moment Of Momentum, The Principle Of Conservation Of Energy, The Entropy Inequality: The Second Law Of Thermodynamics.

Non-Newtonian Fluids – Linear Maxwell Fluid, Relaxation Spectra; Nonlinear Viscoelastic Fluid, Relative Deformation Tensor; Viscometric Flow, Channel Flow, Couette Flow.

TEXT BOOKS			
S. No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1	Continuum Mechanics	Lai, Rubin, and Krempl.	Elsevier, 2010
RECOMMENDED BOOKS			
1	Continuum Mechanics	Malvern	Pearson, 1966
2.	Mechanics and Thermodynamics of Continua	Gurtin, Fried, Anand	Cambridge, 2010
3.	Continuum Mechanics for Engineers	Mase and Mase	CRC, 1999
4.	Continuum Mechanics – A concise Theory	Chadwick	Dover, 1976
5.	Fundamentals of Continuum Mechanics	Bechtel	Springer, 2014

Course Code	**MME-202**
Course Title	**Advanced Manufacturing Processes**
Type of Course	Core
L T P	3 1 0
Credits	4
Course Assessment Methods End Semester Assessment (University Exam.) Continuous Assessment (Sessional, Assignments, Quiz)	 50 50

SYLLABUS

Note for Examiner- *The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

SECTION-A

Introduction:
Classification, Advantages & limitations of non conventional machining, Hybrid Machining, Ultrasonic machining (USM)-Principle of operation, process details, applications and advantages, limitations of USM.

Abrasive and Water Jet Machining:
Basic principle, mechanism of material removal, working principle of Abrasive jet machining (AJM), water jet machining (WJM), merits & demerits, application.

Chemical Machining (CM):
Working principle, process characteristics, procedures, advantages & disadvantages of chemical machining.

SECTION-B

Thermal Metal Removal Processes:
Working principles, Mechanism of material removal, process parameters, advantages & limitations, applications of processes like electric discharge machining(EDM), Electron Beam Machining (EBM), Ion beam machining (IBM), Plasma arc machining (PAM), Laser beam machining(LBM).

TEXT BOOKS

Electrochemical Processes:
Fundamentals, details of machining setup, materials and selection of tools, applications, Concept of others processes like ECG, Electrochemical deburring etc.

S. No.	NAME	AUTHOR(S)	PUBLISHER
1	Advanced Machining Processes,	V K Jain	Allied
2.	Unconventional machining	Benedict	McH

	Methods		
3	Production Technology	HMT	TMH
4	Non Convectional Machining	M. Adhithan	John Wiley
5.	Non Conventional Machining	P.K.Mishra	Narosa
6.	Modern machining process	Shan &Pandey	TMH

Course Code	**MME-203**
Course Title	**Advances In Engineering Materials**
Type of Course	Core
L T P	3 1 0
Credits	4
Course Assessment Methods End Semester Assessment (University Exam.) Continuous Assessment (Sessional, Assignments, Quiz)	 50 50

SYLLABUS

Note for Examiner*- The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

SECTION-A

Selection of materials: Service requirement, Structure-Property correlations and reappraisal of the role of crystal structure and structural defects on properties.

Material Characterization:- Stereographic Projections, X-ray diffraction, crystal structure and phase identification, residual stress measurement and other applications.

Thermal Analysis Techniques: Outline of thermal analysis, technique, description of DTA/DSC/TGA techniques and instrumentation, applications, and case studies

Optical microscopy: light optics, microscope components, possibilities, and limitations.

Scanning Electron Microscopy : Optics and performance of a SEM, Image interpretation, crystallographic information in a SEM, analytical microscopy

Scanning Tunneling Microscopy: Construction and operation, Image interpretation

Transmission Electron Microscopy: Construction and operation of a TEM, Electron Diffraction and image interpretation.

SECTION-B

Synthetic materials: Classifications and structure of polymers, class transition temperature, mechanical properties of polymers. Artificial and synthetic materials.
Nano materials: Classification, the structure, methods of their production, their properties and their sphere of applications.

Smart materials: Shape Memory Alloys, Varistors and Intelligent materials for bio-medical uses including poly-acrylates, ABS plastics, polvmatha acrylates, nylon and teflon. Applications and development of these materials.

TEXT BOOKS			
S. No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1	Callister'sMaterials Science and Engineering	William D. Callister,	Jr., Wiley India Pvt. Ltd., 2010
2.	Engineering Material Technology	5th edition, by James A. Jacobs & Thomas F. Kilduff.	Prentice Hall. Copyright 2005.
3	Foundations of Materials Science and Engineering	William F. Smith.	McGraw Hill.
4	Materials characterization techniques	Sam Zhang; L Li; Ashok Kumar	Boca Raton : CRC Press, 2009

Course Code	**MME-204**
Course Title	**Structural Dynamics**
Type of Course	Core
L T P	3 1 0
Credits	4
Course Assessment Methods End Semester Assessment (University Exam.) Continuous Assessment (Sessional, Assignments, Quiz)	 50 50

SYLLABUS

Note for Examiner*- The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

SECTION-A

The science and art of structural dynamics:
Introduction to structural dynamics; Modeling of structural components and systems; FE route of structural dynamics and its limitations; Experimental route of structural dynamics and its limitations; Understanding structural dynamics in time domain versus frequency domain.

Basic concepts:
Spring-mass model; Free vibrations of SDOF, 2-DOF and MDOF system; Dynamic matrix equation; Eigenvalues; Eigenvectors; Modeshapes; Orthogonality of normal modes; Damping ratios; Drive point and cross frequency response functions; Receptance, Mobility, Accelerance, Real modes, Complex modes.

Undamped SDOF system:
Degrees of freedom; Undamped system; Springs in parallel or in series; Newton's law of motion; Free body diagram; D' Alembert's principle; Solution of differential equation of motion; Frequency and period; Amplitude and motion.

Damped SDOF system:
Proportional versus non-proportional damping; Equation of motion; Analysis of critically damped system; Analysis of under-damped system; Analysis of over-damped system.

SECTION-B

Response of SDOF system to harmonic loading:
Harmonic excitation for undamped and damped systems; Evaluation of damping at resonance; Bandwidth method to evaluate damping; Energy dissipated by viscous damping; Equivalent viscous damping; Response to support motion; Force transmitted to foundation; Seismic instruments; Response of SDOF system to harmonic loading.

Nonlinear structural response:

Nonlinear SDOF model; Integration of the nonlinear equation of motion; Constant acceleration method; Linear acceleration step-by-step method; The Newmark beta method.

Structural dynamic analysis of beams:
Shape functions for a beam segment; System stiffness matrix; Inertial-properties lumped mass; Inertial-properties consistent mass; Damping properties; External loads; Geometric stiffness; Equation of motion; Element forces at nodal coordinates; Dynamic analysis of beams using MATLAB

Structural dynamic analysis of systems with distributed properties:
Flexural vibrations of uniform beams; Solution of equation of motion in free vibration; Natural frequencies and mode-shapes for uniform beams with both ends simply supported, both ends free, both ends fixed, one end fixed and other end free, one end fixed and other end simply supported; Orthogonality condition between normal modes.

TEXT BOOKS			
S. No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1	**Structural Dynamics Theory and Computation** by Mario Paz and William Leigh	Mario Paz and William Leigh	Kluwer Academic Publisher, 2004
2.	**Fundamentals of Structural Dynamics**	R. Craig and Andrew Kurdila	John Wiley and Sons, 2006
3	**Dynamics of Structures**	J. L. Humar	Balkema Publishers, Edition 2002
4	**Structural Dynamics for Engineers**	Hans Anton Buchholdt	Thomas Telford Publishers, 1997

Course Code	MEC-250
Course Title	Laboratory-II
Type of Course	Core
L T P	0 0 2
Credits	1
Course Assessment Methods Continuous Assessment (Practical Performance, report writing and Viva voce)	50

Syllabus

The students will perform a set of experiments assembled at the discretion of the instructor(s) from the compulsory and elective courses taught during the semester.

Course Code	**MME-301**
Course Title	**Advanced Machine Design**
Type of Course	Core
L T P	3 1 0
Credits	4
Course Assessment Methods End Semester Assessment (University Exam.) Continuous Assessment (Sessional, Assignments, Quiz)	 50 50

SYLLABUS

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SECTION-A

Introduction:
Importance of machine design in industry; Basic concepts of machine design including types of loading, stress, strain, strength, factor of safety, types of failures, computer-aided-design, stress concentration, statistical nature of mechanical properties of materials, fits, tolerances and surface finish.

Fatigue failure based design:
Stress-life approach; strain-life approach; LEFM approach, Estimated S-N diagrams; Notch sensitivity; Residual stresses; Designing for high cycle fatigue; Designing for fully reversed uni-axial stresses; designing for fluctuating uniaxial stresses, Designing for multiaxial stresses in fatigue.

Surface failure based design:
Surface geometry; mating surfaces; Effect of roughness, velocity, rolling and lubricant on friction; Adhesive wear coefficient; Abrasive wear; Corrosion wear; Surface fatigue; Spherical contact; Cylindrical contact; General contact; Dynamic contact stress, Surface fatigue failure models of dynamic contact.

Impact based design:
Energy methods, longitudinal stress waves in elastic media impact on beams, torsional impact on shafts and longitudinal impacts on helical springs

SECTION-B

Vibration based design:
Methods of dynamic design of machines; Structural dynamic modifications; Application of vibration based design to an industrial case study such as a drilling machine.

Thermal based design:
Effect of short term and long term properties of materials on design; creep and stress relaxation; Elementary analysis of thermal stresses; thermal fatigue based design.

Reliability based design:

Guarantee versus warranty; Accelerated life testing (ALT); Design of ALT plans; Exponential Modeland its application; Weibullmodel and its applications.

Optimum design:
Design vector; Design constraints; Constraint surface; Objective function surfaces; Multi-objective optimization using response surface method and its application in machine design.

TEXT BOOKS			
S. No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1	Mechanical Engineering Design	Joseph Edward Shigley& Charles R. Mischke	Mc. Graw Hill (2007)
2.	Machine Design, An Integrated Approach	Robert L. Norton	Pearson Education (2007)
3	Design of Machine Members	Vallance and Doughite	McGraw Hill, New York, 2005

ELECTIVE-I
COURSES IN **FIRST** SEMESTER

Course Code	**MME-105(a)**
Course Title	**Quality Control & Reliability**
Type of Course	Elective
L T P	3 1 0
Credits	4
Course Assessment Methods End Semester Assessment (University Exam.) Continuous Assessment (Sessional, Assignments, Quiz)	 50 50

SYLLABUS

Note for Examiner*- The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

SECTION-A

INTRODUCTION :
Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs - Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.

STATISTICAL PROCESS CONTROL (SPC): The seven tools of quality – Statistical fundamentals – Measures of central tendency and dispersion – Population and sample – Normal curve – Control charts for variables and attributes – Process capability – Concept of six sigma – New seven management tools.

TQM TOOLS: Benchmarking – Reasons to benchmark – Benchmarking process – Quality Function Deployment (QFD) – House of quality – QFD process – Benefits – Taguchi quality loss function – Total Productive Maintenance (TPM) – Concept – Improvement needs – FMEA – Stages of FMEA.

QUALITY SYSTEMS : Need for ISO 9000 and other quality systems – ISO 9000:2000 quality system – Elements – Implementation of quality system – Documentation – Quality auditing – TS 16949 – ISO 14000 – Concept – Requirements and benefits.

SECTION-B

RELIABILITY
Introduction to reliability, types of failures, definition and factors influencing system effectiveness, various parameters of system effectiveness.

RELIABILITY EVALUATION

Types of system- series, parallel, series parallel, stand by and complex; development of logic diagram, methods of reliability evaluation; cut set and tie set methods, matrix methods event trees and fault trees methods, reliability evaluation using probability distributions, Markov method, frequency and duration method.

RELIABILITY IMPROVEMENT

Techniques of reliability improvement, component redundancy, system redundancy, types of redundancies-series, parallel, series – parallel, standby redundancy.

RELIABILITY TESTING

Life testing, requirements, methods, test planning, data reporting system, data reduction and analysis.

TEXT BOOKS

S. No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1	Total Quality Management by Feigenbaum. A.V.	Feigenbaum. A.V.	Mc. Graw Hill
2.	Total Quality Management by Dale H.Besterfiled	Dale H.Bestfield	Pearson Education, Inc. 2003
3	Reliability Engineering	A.K. Govil	TATA McGraw-Hill Publishing Company
4.	Reliability Engineering	L.S.Srinath	East west press, 1991

Course Code	**MME-105(b)**
Course Title	**Manufacturing Science**
Type of Course	**Elective**

L T P	**3 1 0**
Credits	**4**
Course Assessment Methods	
End Semester Assessment (University Exam.)	**50**
Continuous Assessment (Sessional, Assignments, Quiz)	**50**

SYLLABUS

Note for Examiner*- The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

SECTION-A

Engineering Materials
Applications and Important Properties of ferrous materials-cast iron, steels and alloy steels, non-ferrous materials-Cu, Al and their alloys.New industrial materials and their properties with special emphasis to composites, Selection of materials.
(12 hours)

Metal Machining
Tool Geometry, different system of representation, mechanics of orthogonal and oblique cutting, shear angle relation in orthogonal cutting, shear angle & chip flow direction in oblique cutting, chip control methods, analysis of cutting process like turning, drilling, milling. Temp. Distribution at the tool chip interface
(12 hours)

SECTION-B

Casting Processes
Nucleation and growth in metals and alloys.constitutional super cooling. Columnar equiacquiesced and dendritic structures.Freezing of alloys centreline feeding resistance. Rate of solidification, time of solidification, mechanism of solidifications, rate of solidification, continuous casting process, Riser Design and its placement, defects in casting, inspection of casting process.
(12 hours)

Welding:
Introduction, Principle of solid state welding, Heat source, Metal Transfer in Arc Welding, Heat flow characteristics, Gas Metal Reactions, Cooling of fusion weld, weld defects and inspection, Advance welding process, Ultrasonic Welding, Electronic beam welding, Laser beam welding, Explosive Welding, Plasma welding, Development in welding Technology, Some research trends in welding, quality control of weldments.
(12 hours)

TEXT BOOKS			
S. No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**

1	Manufacturing Science	Ghosh and Malik	EWP
2	Welding Processes and Technology	R.S. Parmar	Khanna Publishers
3	Production Technology	FrnkKreith	HMT

Course Code	**MME-105(c)**
Course Title	**Welding Techniques**
Type of Course	**Elective**
L T P	**3 1 0**
Credits	**4**
Course Assessment Methods **End Semester Assessment (University Exam.)** **Continuous Assessment (Sessional, Assignments, Quiz)**	 **50** **50**

SYLLABUS

Note for Examiner*- The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

SECTION-A

Introduction

Welding– Definition, industrial importance, applications; welding vs. other fabrication processes; classification of welding and allied processes.

Welding Safety and Hazards

Hazards associated with gas and arc welding processes, protection against electric shock, arc radiations, fumes and dust, compressed gases, fire and explosions.

(12 hours)

Arc Welding & Power Sources

Arc- arc characteristics- arc physics, arc plasma, arc structure, arc stability, arc efficiency; brief introduction to bead geometry and melting rate, mode of metal transfer- short circuit, globular and spray mode of transfer, various factors and forces affecting metal transfer; welding power sources- introduction to transformers, rectifiers, transistors, thyristers, diodes, inverters; basic principle and characteristics of welding transformers, rectifiers, generators and inverters; power source characteristics- static and dynamic volt-ampere characteristics, duty cycle; arc blow- causes and its control.

Shielded Metal Arc Welding (SMAW)

Basic principle and equipment used; welding parameters and their effect on weld bead characteristics; covered electrodes- functions of electrode coating, types of coating and their characteristics, classification and coding of covered electrodes as per IS & AWS standards; advantages, limitations and applications.

(12 hours)

SECTION-B

Gas Metal Arc Welding (GMAW)

Basic principle and equipment used; welding parameters and their effect on weld bead characteristics; shielding gases- types, characteristics and applications; pulsed MIG welding; introduction to flux cored arc welding; advantages, limitations and applications.

Gas Tungsten Arc Welding (GTAW)

Basic principle and equipment used; arc initiation method and arc stability; types of tungsten electrode and their applications; shielding gases and their applications; effect of polarity on weld characteristics, difference between SAME and GTAW power sources, requirement for DC suppresser unit; pulse TIG welding; electrode contamination; advantages, limitations and applications.

Submerged Arc Welding (SAW)
Basic principle and equipment used; welding parameters and their effect on weld bead characteristics; SAW fluxes- classification and their characteristics; coding of flux wire combination as per BIS and AWS; introduction to multi-wire and multi power systems, strip cladding, narrow gap welding; advantages, limitations and applications.

Plasma Arc Welding (PAW)
Basic principle and equipment used; plasma forming and shielding gases; transferred and non-transferred arc modes; micro-plasma welding; advantages, limitations and applications.

Resistance Welding
Basic principle; Brief introduction to spot, seam, projection and flash butt welding; welding variables; heat balance; process capabilities and applications.

(12 hours)

TEXT BOOKS			
S. No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1	Modern Arc Welding Technology	S.V.Nadkarni	Oxford & IBH
2	Modern Arc Welding Technology	H.B.Cary	Prentice Hall.
3	Production Technology	FrnkKreith	HMT
4	Welding Hand book	Leonard P Connor	Volume I-III, AWS
5	Welding skills and technology	Dave Smith	McGraw Hill

Course Code	**MME-105(d)**
Course Title	**Tool and Cutter design**
Type of Course	**Elective**
L T P	**3 1 0**
Credits	**4**
Course Assessment Methods **End Semester Assessment (University Exam.)** **Continuous Assessment (Sessional, Assignments, Quiz)**	 **50** **50**

SYLLABUS

Note for Examiner*- The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

SECTION-A

Introduction

Fundamentals of cutting Tool design, Cutting tools ad their principal elements, tool Geometery, system of nomenclature and their relations, setting for the grinding of various basis cutting tool (Turning, drilling, Milling)

Tool Materials

Development of various tool materials then relative characteristics, Modern trend I tool development, Concept of tool life.

Single point cutting tools, Purpose and principal, types and their characteristics, Design procedures of single point tools, design of various high production tools, design of carbide tools.

(12 hours)

SECTION-B

Tool & Design

Form tools, purpose and types, design procedure and sharpening

Drills

Purpose and principal types ad their construction and Geometry, development I the shape of twist drills.

Milling Cutters

Purpose ad type and their construction procedure of profile sharpened and form relieved cutter, design of hobs.

Broaches

Purpose and types, design features of various broaches.

(12 hours)

TEXT BOOKS			
S. No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**

1	Tool design	Donaladson	TMH
2	Principal of machine Tools	Sen& Bhattacharya	New central Book Agency
3	Principal of metal Cutting	Shaw	Oxford

Course Code	**MME-105(e)**
Course Title	**Condition Monitoring and Fault Diagnosis**
Type of Course	**Elective**
L T P	**3 1 0**
Credits	**4**
Course Assessment Methods **End Semester Assessment (University Exam.)** **Continuous Assessment (Sessional, Assignments, Quiz)**	 **50** **50**

SYLLABUS

Note for Examiner*- The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

SECTION-A

Introduction

Introduction to maintenance techniques, maintenance Strategies, Classifications (Plant maintenance, Running maintenance, Shut Down, Emergency corrective, curative, Breakdown, preventive predictive, Reliability, Total productive Maintenance, Guidelines for selecting best strategy.

Fault Tree analysis, Methodology for tree development, Family tree definitions in symbols. Fault Tree construction, fault tree simplification, fault tree evaluation, common cause failure, Probability evaluation in fault trees, Simulation approach.

(12 hours)

SECTION-B

Analysis and Diagnosis

Wear analysis through thermograph and Ferrography

Various Techniques of condition Monitoring, condition based Maintenance, visual monitoring, performance monitoring, vibration monitoring, war debris monitoring, Decision elements in condition based maintenance detection, diagnosis, Prescription, Benefits of condition maintenance. Application of diagnostic maintenance to Industrial Machine & plants

(12 hours)

TEXT BOOKS			
S. No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1	Diagnostic maintenance & condition Monitoring	Kelly	A.Buttersworth& Co
2	Maintenance and spare parts management	Krishan G	Prentice Hall,1991
3	MaintenanceEngg. handbook	Higgins	McGraw Hill
4	Engg. Maintenance Management	Nielsel, Benjamin	Maries

Course Code	**MME-105(f)**
Course Title	**Advanced Heat Transfer**
Type of Course	Elective
L T P	3 1 0
Credits	4
Course Assessment Methods End Semester Assessment (University Exam.) Continuous Assessment (Sessional, Assignments, Quiz)	 50 50

SYLLABUS

Note for Examiner*- The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

SECTION-A

Review

Review of the basic laws of conductions, radiation and convection.

Conduction

One dimensional steady state conduction with variable thermal conductivity and with internal distributed heat source, local heat source in non-adiabatic plate. Extended surfaces-review, fins of non-uniform cross section, performance of fins (fin efficiency, thermal resistance of a fin, total surface efficiency), design consideration.

Two dimensional steady and unsteady state conduction, semi-infinite and finite flat plates; temperature field in finite cylinders and infinite semi-cylinders, numerical method, graphical method. Unsteady state conduction; sudden changes in the surface temperatures of infinite plate, cylinders and spheres; solutions using Groeber's and Heisler's charts for plates, cylinders and spheres suddenly immersed in fluids. (9 hrs)

Radiation

Introduction, properties and definitions, review ofradiation principles (Planck's law, Kirchoff's law, Stefan Boltzman law, Lambert's cosine law). Radiation through non-absorbing media; Hottel's method of successive reflections; Radiation through absorbing media; logarithmic decrement of radiation; apparent abosrptivity of simple shaped gas bodies; net heat exchange between surfaces separated by absorbing medium; radiation of luminous gas flames. (9)

Convection

Heat transfer in laminar flow; free convection between parallel plates; forced internal flow through circular tubes; fully developed flow; velocity and thermal entry lengths; solutions with constant wall temperature and with constant heat flux; forced external flow over a flat plate; the two dimensional velocity and temperature boundary layer equations; Karman Pohlhousen approximate integral method. Heat transfer in turbulent flow; eddy heat diffusivity; Reynold's analogy between skin friction and heat transfer; Von Karman integral equations, analogy between momentum and heat transfer, flow across cylinders, spheres and other bluff shapes and packed beds. (8 hrs)

Mass Transfer

Introduction, concentration, velocities and fluxes, Fick's law of diffusion, steady state diffusion in common geometries, equimolal counter-diffusion in gases, steady state diffusion in liquids, transient mass diffusion in common geometries, mass transfer coefficient, convective mass transfer (5 hrs)

TEXT BOOKS			
S. No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1	Analysis of Heat and Mass Transfer	Eckert and Drake	McGraw Hill
2.	Fundamentals of Heat Transfer	Grober, Erk and Grigul	McGraw Hill
3	Heat Transfer	Holman J.P.	McGraw Hill
4	Conduction Heat Transfer	Schneider Addison Wesley	
5	Thermal Radiation	Siegel and Howel	McGraw Hill
6.	Heat, Mass and Momentum	Rohsenhow and Choi	Prentice Hall

Course Code	**MME-105(g)**
Course Title	**Gas Dynamics**
Type of Course	**Elective**
L T P	**3 1 0**
Credits	**4**
Course Assessment Methods **End Semester Assessment (University Exam.)** **Continuous Assessment (Sessional, Assignments, Quiz)**	 **50** **50**

SYLLABUS

Note for Examiner*- The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

SECTION-A

Elementary Principles and introduction to compressible flow
Introduction, units, thermodynamics concepts for control mass analysis, flow dimensionality and average velocity, comment on entropy, pressure energy equation.The stagnation concept, stagnation pressure-energy equation, momentum equation.
Introduction, Objectives, speed of propagation of pressure front, Mach Number, sonic velocity, field due to a moving source of disturbance, Mach cone ,Mach angle, equation for a perfect gas in terms of Mach number, h. s.& t. s. diagrams .

Varying area adiabatic flow
Introduction, adiabatic flow with and without losses, the reference concept, isentropic tables, convergent & divergent nozzles, diffuser performance, frictional effects on nozzle flow problems.

Standing normal waves
Introduction, shock analysis-general fluid, working equations for perfect gas, normal-shocks tables, shocks in nozzles, supersonic wind tunnel operation, thermodynamic directions of a normal shock, rankinehugoniot relation, strength of shock, operation of nozzle.

(12 hours)

SECTION-B

Moving and oblique shocks, Prandtl-Meyer flow
Introduction, normal shocks tangential velocity superposition -oblique shocks, oblique-shocks, analysis, oblique-shock tables and charge, boundary conditions of flow direction, boundary condition of pressure equilibrium, introduction to Prandtl Meyer flow, analysis of Prandtl Meyer flow, Prandtl Meyer function.

Fanno and Rayleigh flows
Introduction, analysis for general fluid, working equations for a perfect gas, reference state and fanno tables, application, correlation with shocks, friction chocking. Analysis for a general fluid,

working equations for a perfect gas reference state and Rayleigh tables, applications, correlation with shocks, thermal choking due to heating.

Propulsion Systems

Introduction, Brayton cycle, propulsion engines, thrust power and efficiency, thrust Consideration, power consideration, and efficiency consideration, open Brayton cycle for propulsion systems, turbojet, turbo propulsion, ram jet, pulse jet.

(12 hours)

TEXT BOOKS			
S. No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1	Fundamentals of Gas Dynamics	YAHA, S.M	TMI-I, India
2	Fluid Mechanics	A.K. Mohanty	Prentice Hall of India
3	Fundamentals of Fluid Mechanics	YUAN, S.W	Prentice Hall of India.
4	Fundamentals of Gas Dynamics	Robert D. Zucker,	Met tire Publication
5	Gas Dynamics	E. Radha Krishnan	Prentice Hall of India

Course Code	**MME-105(h)**
Course Title	**Introduction to Modern Fortran**
Type of Course	**Elective**
L T P	**3 1 0**
Credits	**4**
Course Assessment Methods **End Semester Assessment (University Exam.)** **Continuous Assessment (Sessional, Assignments, Quiz)**	 **50** **50**

SYLLABUS

Note for Examiner*- The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

SECTION-A

Introduction to Computers and The Fortran Language: The Computer * Data Representation in a Computer * Computer Languages * The History of the Fortran Language * The Evolution of Fortran

Basic Elements of Fortran: The Fortran Character Set * The Structure of a Fortran Statement * The Structure of a Fortran Program * Constants and Variables * Assignment Statements and Arithmetic Calculations * Intrinsic Functions * List-Directed Input and Output Statements * Initialization of Variables * The IMPLICIT NONE Statement * Debugging Fortran Programs * Alternate KINDS of the REAL, INTEGER, and CHARACTER Data RType * COMPLEX Data Type.

Program Design and Branching Structures: Introduction to Top-Down Design Techniques * Use of Pseudocode and Flowcharts * Logical Constants, Variables, and Operators * Control Constructs: Branches.

Loops: Control Constructs: Loops.

Characters: Character Assignments and Character Manipulations * Character comparison operations * Intrinsic Character Functions * Passing Character Variables to Subroutines and Functions * Variable-Length Character Functions * Internal Files

I/O Concepts: Formats and Formatted WRITE Statements * Output Devices, Control Characters in Printer Output * Format Descriptors * Formatted READ Statements * An Introduction to Files and File Processing * Namelist I/O * Unformatted files * Direct Access Files * Stream Access Mode * Nondefault I/O for derived types (12 hours)

SECTION-B

Arrays: Declaring Arrays * Using Array Elements in Fortran Statements * Using Whole Arrays and Array Subsets in Fortran Statements * Input and Output * Multidimensional Arrays * Using

Intrinsic Functions with Arrays * Masked Array assignment : the WHERE construct * FORALL construct * Allocatable Arrays

Procedures: Subroutines * Sharing Data Using Modules * Module Procedures * Fortran Functions * Passing Procedures as Arguments to Other Procedures. * Passing Multidimensional Arrays to Subroutines and Functions * The SAVE Attribute and Statement * Allocatable Arrays in Procedures * Automatic Arrays in Procedures * Allocatable Arrays as Dummy Arguments in Procedures* Pure and Elemental Procedures * Internal Procedures * Submodules.

Derived Data Types: Derived Data Types * Working with Derived Data Types * Input and Output of Derived Data Types * Declaring Derived Data Types in Modules * Returning Derived Types from Functions * Dynamic Allocation of Derived Data Types * Parameterized Derived Data Types * Type Extension * Type-Bound Procedures * The ASSOCIATE Construct

Pointers and Dynamic Data Structures: Pointers and Targets
* Using Pointers in Assignment Statements * Using Pointers with Arrays * Dynamic Memory Allocation with Pointers *Using Pointers as Components of Derived Data Types * Arrays of Pointers *Using Pointers in Procedures * Procedure Pointers

Object-Oriented Programming in Fortran: An Introduction to Object-Oriented Programming * The Structure of a Fortran Class * The CLASS Keyword * Implementing Classes and Objects in Fortran * Categories of Methods * Controlling Access to Class Members * Finalizers * Inheritance and Polymorphism * Abstract Classes.

Coarrays and Parallel Processing: Parallel Processing in Coarray Fortran * Coarrays * Synchronization between Images *Allocatable Coarrays and Derived Data Types *Passing Coarrays to Procedures * Critical Sections * The Perils of parallel Programming. (12 hours)

TEXT BOOKS			
S. No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1	Fortran for Scientists and Engineers	Chapman	McGraw-Hill
2	Modern Fortran Explained	Metcalf	Oxford
3	Guide to Fortran Programming	Brainerd	Springer
4	Introduction to Programming with Fortran	Chivers	Springer

Course Information Sheet			
Course Code			MEC 105(j)
Course Title			**Design of biomedical devices and systems**
Type of Course	Core/Optional		Elective
LTP and Credits			3,1,0 and 4 credits
Course Assessment Methods			
Continuous Assessment			50 marks
Course Prerequisites			Machine design, solid mechanics, solid modelling, FEA
Objectives and Outcomes			
Course Objectives(CO)	1. Introduce design aspects in biomedical devices to the students 2. Educate students on clinical trials 3. Familiarize students with variants in biomedical devices based on medical specialities		
Course Outcomes	➢ Ability to design medical devices in fields of dentistry and surgery ➢ Evaluate design aspects related to manufacture implants ➢ Modelling of bone structures		

Syllabus

S.No	Topics	Lectures
PART A		
1	Principles of design in medical devices; Design Process; classification rules of devices	7
2	Implementation of design procedures; develop design and product specifications; applications of devices in dentistry; case studies	8
3	Material selection; applications of devices in surgical procedures; case studies	5
PART B		
4	Quality in Design; Design Realization; Finite Element modelling in bones and implants	8
5	Manufacturing of devices; Rapid prototyping and milling technologies	7
6	Validation and verification procedures; Various aspects involved in ethical approvals and clinical trials Labelling and instructions for use	7

Recommended books

S.NO.	NAME	AUTHOR(S)	PUBLISHER
1	Medical Device	Peter J. Ogrodnik	Academic Press

	Design		
2	Design of biomedical devices and systems	Paul H. Hing ; Richard C Fries; Arthur T Johnson	CRC Press
3	Introduction to biomedical engineering	Laurence J Street	CRC Press
4	Sample Size calculations and clinical research	Chow; Shao; Wang; Lokhnygina	CRC Press

ELECTIVE-II
COURSES IN**SECOND** SEMESTER

Course Code	**MME-205(a)**
Course Title	Fluid Dynamics
Type of Course	Elective
L T P	3 1 0
Credits	4
Course Assessment Methods End Semester Assessment (University Exam.) Continuous Assessment (Sessional, Assignments, Quiz)	 50 50

SYLLABUS

Note for Examiner*- The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

SECTION-A

Introduction & overview of Fluid Dynamics, units and basic flow concepts.Continuums, velocity fields, viscosity, classifications of fluids.Conduction Kinematics of Fluid in motion, Equations of Motion of inviscid fluid, One-dimensional inviscid incompressible flow (Bornoulli's equations and its applications). Navier-Stokes' equations. Potential flow theory and transformation. Flow around bodies, cylinders and aerofoil. Transformation of circle into aerofoil. Prediction of velocity and pressure distribution, boundary layer problems, laminar and turbulent boundary layers, separation criterion.

SECTION-B

Motion in two dimensions, sources and sinks, General theory of irrotational motion, Motion of cylinders.General differential equations of continuity, momentum and energy applied to compressible in viscid fluids, Sonic Velocity, Mach number and propagation of disturbance in a fluid flow. Isentropic flow and stagnation properties. Flow through nozzles and diffusers, Fanno, Reyleigh and isothermal flows through pipes.Dynamical Similarity, Inspection Analysis and Dimensional Analysis, Laminar flow of viscous incompressible fluids, Theory of Very Slow Motion, Boundary layer theory. Thermal Boundary Layers, Thermal Boundary Layer.

TEXT BOOKS			
S. No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1	Fluid Dynamics	M. D. Raisinghania,	S. Chand
2.	Compressible Fluid Flow	Patrick Oosthuizen	
3	Fundamental of Compressible	S.M. Yahya	

	Flow		
4	An Introduction to Fluid Dynamics,	Batchelor G K,	Cambridge (2007)

Course Code	**MME-205(b)**
Course Title	Experimental Stress Analysis
Type of Course	Elective
L T P	3 1 0
Credits	4
Course Assessment Methods End Semester Assessment (University Exam.) Continuous Assessment (Sessional, Assignments, Quiz)	 50 50

SYLLABUS

Note for Examiner*- The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

PART-A

Stress – Stress at a point, Stress Equations of Equilibrium, Stress Transformation, Principal Stresses, Maximum Shear Stress, 2D State of Stress, Special states of Stress.

Strain and Stress-Strain Relationships – Definition of Displacement and Strain, Strain Transformation, Principal Strains, Compatibility, Dilatation, Stress-Strain Relations, 2D Strain Transformation and Stress-Strain Relations.

Plane Elasticity – Field Equations, Plane Stress, Plane Strain, Airy Stress Function: Cartesian and Polar Coordinates, Problems: Circular Cylinder subject to internal and external Pressure, Thin infinite plate with circular hole under Tensile Load

Elementary Fracture Mechanics – Stress due to Elliptical hole in Uniformly Loaded Plate, Westergaard Stress Funtion, Stress Intensity Factor for select Geometries, Three modes of Loading, Crack-tip Plasticity, Equations for region adjacent to crack-tip, shaper of plastic zone, Energy approach, Criteria for Crack Instability, Fracture Control.

Introduction to Strain Measurement – Definition of strain and its relation to experimental determination, Properties of Strain-gage systems, Types of Strain-gages, Semiconductor Strain-gages, Grid Method of Strain Analysis.

Electrical-Resistance Strain–gages – Strain Sensitivity in Metallic Alloys, Gage construction, Strain-gage adhesives and mounting methods, Gage sensitivities and Gage factor, Performance characteristics of Foil Strain-gages, Environmental Effects.

Strain-gage Circuits – Potentiometer and its application to Strain Measurement, Wheatstone Bridge, Constant-current circuits, Calibrating Strain-gage circuits, Effect of lead wires, switches, and slip rings, Electrical noise, Transducer applications.

Recording Instruments – Static recording and data logging, Digital processing of Analog signals, Dynamic recording of very low/intermediate/high/very high frequencies, digital conversion rates and frequency response, telemetry systems.

Strain Analysis Methods – Three-element rectangular rosette, corrections for transverse strain effects, stress gage, torque gage, stress intensity factor gage, determine mixed mode stress intensity factors, over deterministic methods of strain analysis, residual stress determination.

PART-B

Basic Optics – Nature of Light, Wave Theory of Light, Reflection and Refraction, Image formation by Lenses and Mirrors, Optical Diffraction and Interference, Optical instruments:

Polariscope, Interferometer, Shadow Caustics.

Moiré Methods –Moiré Fringes produced by Mechanical Interference, Moiré Fringe Analysis: Geometrical, and Displacement-Field approach, Out-of-plane displacement and slope measurements, Sharpening and multiplication of Moiré Fringes, Experimental procedures and techniques, Moiré Interferometer.

Theory of Photoelasticity - Stress-optics Law, Relative retardation, Effects of stressed model in: Plane Polariscope, Circular Polariscope (Dark Field, Arbitrary Analyzer position, Tardy Compensation), Photoelastic Photography, Fringe Multiplication with Partial Mirrors.

Applied Photoelasticity 2D and 3D Stress Analysis – 2D Photoelastic Stress Analysis, Materials for 2D Photoelasticity, Properties of commonly applied Photoelastic materials, 3D Photoelasticity Stress Freezing, Materials for 3D Photoelasticity, Slicing the model and interpretation of Fringe Patterns, Effective Stresses, Shear-Difference method in 3D, Application of Frozen Stress method.

Optical Methods for Determining Fracture Parameters – Irwin's method to determine K_I from isochromatic fringe patterns, Modification of Irwin's 2-Parameter Method, Higher Parameter Methods, Determining K_I: from isopachic and Moiré fringe patterns, Methods for determining K_I in 3D bodies, Mixed mode stress intensity factors K_I and K_{II}, Birefringent coatings in fracture mechanics.

Photoelastic Coatings and Brittle Coatings – Coating Stresses, Birefringent Coatings, Stress-optic and Strain-optic relations for coatings, Coating Sensitivity, Coating Materials, Bonding the Coatings, Effect of Coating Thickness, Fringe-Order Determination of Coatings, Brittle Coatings, Test procedures for Resin-based coatings, Analysis of Brittle coating data.

Books Suggested:

Experimental Stress Analysis, 3/e	Dally and Riley, McGrawHill, 1991
Advanced Strength and Applied Elastcity	Budynas, McGrawHill, 1999

Course Code	**MME-205(c)**
Course Title	**Mechanical Behavior of Materials**
Type of Course	**Elective**
L T P	**3 1-0**
Credits	**4**
Course Assessment Methods **End Semester Assessment (University Exam.)** **Continuous Assessment (Sessional, Assignments, Quiz)**	 **50** **50**

SYLLABUS

Note for Examiner*- The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

SECTION-A

1. Overview of Mechanical Behavior: Elastic deformation, permanent deformation, Fracture.

2. Elastic Behavior: Range of elastic Moduli, Elastic properties, basis for linear elasticity, anisotropic linear elasticity, rubber elasticity, polymer elasticity and viscoelasticity, damping.

3. Plastic Behavior: ***Dislocations*** Yield strength of perfect crystal, Edge dislocation, screw and mixed dislocation, twinning, properties of dislocations, dislocation geometry and crystal structure, intersection of moving dislocations, dislocation density and macroscopic stress.***Plastic Deformation in Single and Polycrystalline Materials*** initiation of plastic flow in single crystal, stress-strain behavior of single crystals, plastic flow in polycrystals, plastic flow behavior and material class, geometrically necessary dislocations.***Strengthening of Crystalline Materials*** Strengthening, work hardening, boundary strengthening, solid-solution strengthening, particle hardening, strain gradient hardening, deformation of two phase aggregates, case studies on strength, microstructure, and processing ***High Temperature Deformation of Crystalline Materials*** Creep phenomena, Creep Mechanism, Materials aspect in Creep design, engineering aspects of creep behavior, superplasticity, hot working of metals***Deformation of Non-crystalline Materials*** Crystalline vs. non-crystalline structure, viscosity, deformation of - inorganic glasses, metallic glasses, polymeric materials

SECTION-B

4. Composite Materials: Reinforcement – basic principle, with particles, with aligned continuous and discontinuous fibers, fiber orientation effect, statistical failure of composites, strain-rate effects, microscopic effects, reinforcement of brittle matrices, modern composite materials.

5. Fracture Mechanics: Theoretical strength of a solid, crack-initiated fracture, fracture mechanics, fracture toughness and material class, impact test, fracture of brittle nonmetallic. ***Toughening***in metals, ceramics, composites, polymers,***Physics of Fracture***Types of Low-Temperature Tensile Fracture, Relation among bonding, crystal structure and fracture, Mode II and Mode III brittlefracture, ductile fracture, High Temperature Fracture, modes and mechanism, intergranular creep fracture, Design and materials considerations, failure in superplastic materials,***Fatigue Fracture***characteristics, resistance, fatigue crack growth, design against fatigue, cyclic stress-strain behavior, creep-fatigue interaction, polymeric fatigue, fatigue in composites.

6. Embrittlement: Metal embrittlement, Stress-corrosion cracking, hydrogen embrittlement, impurity-atom embrittlement, radiation damage, embrittlement of inorganic glasses and ceramics, polymer embrittlement

7. Cellular Solids: Geometries and Densities of Cellular solids, Compressive behavior of Cellular Solids, Energy absorption in Cellular solids, Sandwich panels.

Books

Title	**Author**	**Publisher**
Mechanical Behavior of Materials	Courtney	McGraw-HIll
Physical Metallurgy	George E. Dieter	McGraw-Hill
Mechanical Behavior of Materials	Norman Dowling	Pearson
Materials Science and Engineering	William D. Callister	Wiley
Advanced Mechanics of Materials	Boresi	WIley

Course Code	**MME-205(d)**
Course Title	**COMPOSITE MATERIALS**
Type of Course	**Elective**
L T P	**3 1 0**
Credits	**4**
Course Assessment Methods **End Semester Assessment (University Exam.)** **Continuous Assessment (Sessional, Assignments, Quiz)**	 **50** **50**

SYLLABUS

Note for Examiner*- The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

SECTION-A

Basics of Materials

Processing of metal, ceramic, and polymer composites, laminates; analysis of residual stresses. Advanced analysis of composite materials; anisotropic elasticity.

Fabrication Methods of Polymer Composites

Liquid resin impregnated routes, pressurized consolidation of resin pre-pegs, consolidation of resin molding compounds, injection molding of thermoplastics, hot press molding of thermoplastics, laminations, honeycomb.

Fabrication of Ceramic Composites

Powder based routes, reactive processing, layered ceramic composites, carbon/carbon composites.

(12 hours)

SECTION-B

Characterization Techniques

Visual characterization techniques-electron microscopy, atomic force microscopy, Raman, FTIR techniques

Mechanical Characterization Techniques

Micro and nano level static and dynamic mechanical properties evaluation techniques to study hardness, stress, strain, modulus etc.

Introduction to Simulation

Simulator technology, Applications, Software Packages.

(12 hours)

TEXT BOOKS			
S. No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1	Experimental Mechanics of Fiber Reinforced Composite Materials	J.M. Whitney, I.M. Daniel and R. Byron Pipes	Wiley

2	The Behavior of Structures Composed of Composite Materials	Martinus-Nijhoff	Springer
3	Mechanical Behavior of Engineering Materials	Roesler, Harders, Baeker	Springer

Course Code	MME-205(e)
Course Title	**Model Updating**
Type of Course	Elective
L T P	3 1 0
Credits	4
Course Assessment Methods End Semester Assessment (University Exam.) Continuous Assessment (Sessional, Assignments, Quiz)	 50 50

SYLLABUS

Note for Examiner*- The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

SECTION-A

Overview:Introduction and industrial relevance of model updating; Overview of applications of model updating; Introduction to direct and iterative methods of model updating; Pros and cons of direct and iterative methods of model updating; simulated experiments method.

Size Compatibility Techniques: Needs and requirements of size compatibility techniques; Guyan static reduction method; Guyan dynamic reduction method; Improved reduced system (IRS); System equivalent reduction expansion process (SEREP); Condensed versus reduced models; Expansion using mass and stiffness matrices.

Correlation Techniques: Needs and requirements of correlation techniques; Graphical comparison of eigenvalues; Overlay techniques of comparison of FRFs; Comparison of modeshapes; Modal scale factor and its limitations; Modal assurance criteria and its 3-D Plots; Normalized cross orthogonality and its 3-D Plots; Coordinate MAC and its Uses.

Direct Methods of Model Updating: Technical background of direct methods of model updating; Method of Baruch and Bar-Itzhack and its limitations; Method of Berman and its limitations; Method of Berman and Nagy and its limitations; Overall advantages and disadvantages of direct methods; Applications of direct methods of model updating.

SECTION-B

Response function method: Response function method, RFM using damping identification, RFM using complex parameters, Normal response function method; Application of each method to a cantilever beam structure.

Inverse eigen-sensitivity method: Inverseeigen-sensitivity method and its application to a cantilever beam structure. Comparison of inverse eigen-sensitivity method with the response function method.

Response surface method: Generation of experimental design matrix using central composite design method; development of response surfaces using regression analysis; model updating of a cantilever beam structure using response surface method.

Other methods of model updating: Introduction to model updating using based excitation; neural network based model updating; Genetic algorithm based model updating; simulated annealing based model updating; Particle-swarm-optimization based model updating.

TEXT BOOKS			
S. No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1	Finite Element Model Updating in Structural Dynamics	M.I. Friswell and J.E. Mottershead	Kluwer Academic Publishers, Dordrecht, The Netherlands, 1995
2	Modal Analysis	He and Fu	Butterworth Heinemann Publisher, Oxford, 2001
RECOMMENDED BOOKS			
1	Structural Dynamics Theory and Computation	Mario Paz and William Leigh	Kluwer Academic Publisher, 2004

Course Code	**MME-205(f)**
Course Title	Mechatronics
Type of Course	Elective
L T P	3 1 0
Credits	4
Course Assessment Methods End Semester Assessment (University Exam.) Continuous Assessment (Sessional, Assignments, Quiz)	 50 50

SYLLABUS

Note for Examiner*- The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

SECTION-A

MECHATRONICS, SENSORS AND TRANSDUCERS: Introduction to Mechatronics Systems – Measurement Systems – Control Systems – Microprocessor based Controllers. Sensors and Transducers – Performance Terminology – Sensors for Displacement, Position and Proximity; Velocity, Motion, Force, Fluid Pressure, Liquid Flow, Liquid Level, Temperature, Light Sensors – Selection of Sensors

ACTUATION SYSTEMS: Pneumatic and Hydraulic Systems – Directional Control Valves – Rotary Actuators. Mechanical Actuation Systems – Cams – Gear Trains – Ratchet and pawl – Belt and Chain Drives – Bearings. Electrical Actuation Systems – Mechanical Switches – Solid State Switches – Solenoids – D.C Motors – A.C Motors – Stepper Motors.

SYSTEM MODELS AND CONTROLLERS: Building blocks of Mechanical, Electrical, Fluid and Thermal Systems, Rotational – Transnational Systems, Electromechanical Systems – Hydraulic – Mechanical Systems. Continuous and discrete process Controllers – Control Mode – Two – Step mode – Proportional Mode – Derivative Mode – Integral Mode – PID Controllers – Digital Controllers – Velocity Control – Adaptive Control – Digital Logic Control – Micro Processors Control.

SECTION-B

PROGRAMMING LOGIC CONTROLLERS: Programmable Logic Controllers – Basic Structure – Input / Output Processing – Programming – Mnemonics – Timers, Internal relays and counters – Shift Registers – Master and Jump Controls – Data Handling – Analogs Input / Output – Selection of a PLC Problem.

RAPID PRTOTYPING FOR MECHATRONIC PROJECTS: Prototyping Philosophies, Solid Modeling Tools, Modeling System Dynamics, Foam core, X-Acto Knives, 2-D Rapid Prototyping: Laser Cutting/Laser CAMM, Tab and Slot Construction, 3-D Rapid Prototyping: SLA, SLS, FDM and Soft Mold Castings.

DESIGN OF MECHATRONICS SYSTEM: Stages in designing Mechatronics Systems – Traditional and Mechatronics Design - Possible Design Solutions Case Studies of Mechatronics Systems, Pick and place robot – automatic Car Park Systems – Engine Management Systems.

TEXT BOOKS			
S. No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1	Mechatronics	W. Bolton	Pearson Education, Second Edition, 1999
2	Mechatronics Integrated Technologies for Intelligent Machines	Smaili. A and Mrad. F.,	Oxford University Press, 2008
RECOMMENDED BOOKS			
1	Structural Dynamics Theory and Computation	NitaigourPremchandMahadik,	Tata McGraw-Hill Publishing Company Limited , 2003

Course Code	MME-205(g)
Course Title	Advanced Control System
Type of Course	Elective
L T P	3 1 0
Credits	4
Course Assessment Methods End Semester Assessment (University Exam.) Continuous Assessment (Sessional, Assignments, Quiz)	 50 50

SYLLABUS

Note for Examiner*- The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

SECTION-A

TRANSIENT AND STEADY STATE RESPONSE: Time domain representation –Laplace domain representation– Solution of second order differential equation with constant coefficients– System with proportional control– Proportional cum derivative control – Proportional cum integral control.

CONTROL SYSTEM ANALYSIS USING STATE VARIABLEMETHODS: State variable representation–Conversion of state variable models to transfer functions–Conversion of transfer functions to canonical state variable models–Eigenvalues and eigenvectors–Solution of state equations–Concepts of controllability and observability–Equivalence between transfer function and state variable representations–Multivariable systems.

STATE VARIABLE ANALYSIS OF DIGITAL CONTROL SYSTEMS: State descriptions of digital processors–State description of sampled continuous-time plants–State description of systems with dead-time – Solution of state difference equations – Controllability and observability.

SECTION-B

POLE-PLACEMENT DESIGN AND STATE OBSERVERS: Stability improvement by state feedback – Necessary and sufficient conditions for arbitrary pole-placement – State regulator design – Design of state observers – Compensator design by the separation principle

Linear quadratic optimal control through Lyapunov Synthesis: Concept of Lyapunov stability – Lyapunov functions for linearsystems – Parameter optimization and optimal control problems – Quadratic performance index – Optimal state regulator – Optimal digital control systems

TEXT BOOKS

S. No.	NAME	AUTHOR(S)	PUBLISHER
1	Digital control and state variable methods	M. Gopal	Tata McGraw-Hill Publishing Company
2	Theory and applications of Automatic controls	B. C. Nakra	New Age International Publishers
RECOMMENDED BOOKS			
1	Automatic control systems	Benjamin.C.Kuo	Prentice Hall of India, 7th Edition,1995
2	Linear control system analysis and design	JohnJ.D'azzo&ConstantineH.Houpis	Tata McGrow-Hill, Inc., 1995.
3	Modern Control Systems	Richard C. Dorf& Robert H. Bishop	Addidon – Wesley, 1999.
4	State Space Analysis of Control Systems	Ogata, K..	Prentice Hall
5	Digital Control of Dynamic Systems,.	G. F. Franklin, J. D. Powell and M. L. Workman	Addison Wesley, 1998, Pearson Education, Asia, 3/e, 2000
6	Computer Controlled Systems - Theory and Design	K. J. Astroms and B. Wittenmark	Prentice Hall, 3/e, 1997.

Course Code	MME-205(h)
Course Title	Imaging and additive manufacturing
Type of Course	Elective
L T P	3 1 0
Credits	4
Course Assessment Methods End Semester Assessment (University Exam.) Continuous Assessment (Sessional, Assignments, Quiz)	 50 50

SYLLABUS

Note for Examiner*- The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

SECTION-A

Introduction to Image Processing
Medical Image Processing Concepts- Analysis, Visualization, Enhancement and Segmentation
2D and 3D Transformations of geometry

SECTION-B

Design of Surfaces and Solids
Rapid Prototyping
3D Scanning and Printing

TEXT BOOKS			
S. No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1	Digital Image Processing	Gonzalez and woods	
2	Handbook of Medical Image Processing and Analysis	Isaac Bankman	
RECOMMENDED BOOKS			
1	Geometric Modeling	Michael E. Mortenson	
2	Computer Aided Engineering Design	AnupamSaxena, BirendraSahay	

ELECTIVE III COURSES IN THIRD SEMESTER

Course Code	MME-302(a)
Course Title	Modeling Of Manufacturing Systems
Type of Course	Elective
L T P	3 1 0
Credits	4
Course Assessment Methods End Semester Assessment (University Exam.) Continuous Assessment (Sessional, Assignments, Quiz)	 50 50

SYLLABUS

***Note for Examiner**- The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

SECTION-A

Introduction: Introduction and Overview, concept of system environment, element of systems, system modeling, types of models. Monte Carlo method, system simulation, Simulation-Management Laboratory, Advantages limitations of systems, Simulation of Continuous and Discrete system. (12 Hrs)

Modelling of Continuous system: Characteristics of Continuous System, comparison of Numerical integration with continuous simulation system simulation of integration formula (12 Hrs)

Modelling of Discrete System:
Time flow mechanisms, Discrete and continuous probability density function, Generation of random numbers, Testing of random numbers for randomness and for auto correction, generation of random verities for discrete distribution, generation of random varieties for continuous probability distribution-binomial, normal exponential and beta distribution, combination of discrete event and continuous models. (12 Hrs)

Modelling of queuing system: Concept of queuing theory, Characteristics of queues, stationary and time dependent queue, queue discipline, time series analysis, measure of system performance, Kendell's notation, auto covariance and auto correlation function, auto correlation effects in queuing system, simulation of single server queues, Multi server queues, queues involving complex arrivals and service times with blanking and reneging (12 Hrs)

SECTION-B

Design of simulation experiments: Length of run, elimination of initial bias. Variance reduction techniques, stratified sampling, antipathetic sampling common random numbers, time series analysis, spectral analysis, model validation, optimization procedures, search methods, single variable deterministic case search, single variable non-deterministic case search, regenerative techniques (12 Hrs)

Modelling& Simulation of PERT: Simulation of –Maintenance and replacement problems, capacity planning production system, reliability

TEXT BOOKS			
S. No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1	Simulation and Modeling	Loffick	Tata McGraw Hill
2	System Simulation with Digital Computer	DeoNarsingh	Prentice Hall of India
RECOMMENDED BOOKS			
1	System Simulation	D.S. Hira	S. Chand & Co.
2	Simulation Modeling & Analysis	David Kelton	Tata McGraw Hill
3	System Simulation	Gorden	Prentice Hall

Course Code	MME-302(b)
Course Title	Finite Element Method
Type of Course	Elective
L T P	3 1 0
Credits	4
Course Assessment Methods End Semester Assessment (University Exam.) Continuous Assessment (Sessional, Assignments, Quiz)	 50 50

Syllabus

***Note for Examiner**- The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

Section A

1 Fundamental Concepts : Historical Background, Stresses and Equilibrium, Boundary Conditions, Strain—Displacement Relations, Temperature Effects, The Rayleigh—Ritz Method, Galerkin's Method, Saint Venant's Principle, Von Mises Stress, Overview of the software used for FE methods, Advantages and disadvantages of FE methods

2.Discretization of the Domain: Types of elements, location of nodes, number of elements, simplification offered by physical configuration of body, node numbering scheme.

3. One & Two Dimensional Problems : Introduction, Coordinates and shape functions, Potential energy approach, Galerkin Approach, Assembly of the global stiffness matrix and load vector, FE equations and treatment of boundary conditions, Quadratic shape functions, ,Two dimensional problems using constant strain triangles. Quadrilateral elements.

4. Axisymmetric solids subjected to axisymmetric loadings: Axisymmetric formulation, FE modeling using triangular element, problem modelling and boundary conditions.

Section B

5. Static Analysis: Plane and three dimensional Trusses, Assembly of global matrix for the banded and skyline solutions, Beams and frames under various boundary conditions.

6. Dynamic Analysis: Formulation for solid body with distributed mass, Element mass matrices, Evaluation of eigenvalues and eigenvectors, Guyan reduction, Rigid body modes

7. Pre-processing and Post processing: Pre-processing, Mesh generation, Post processing, Deformed configuration and mode shape, Convergence requirements, Mesh refinement, Error: sources and detection

8. **FE based optimal design:** Design parameterization, Structural optimization, Topology optimization, Approximation techniques, and Design sensitivity analysis.

TEXT BOOKS			
S. No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1	FE Procedures	Bathe	Pearson, 2009
2	Introduction to FEM	Reddy	McGraw-Hill, 2017
3	Introduction to FE in Engineering	Chandupatla, Belegundu	Pearson, 2015
4	FE Method for Engineers	Huebner	Wiley, 2009
5	Fundamentals of FEA	Hutton	McGraw-Hill, 2003
6	FEA with ANSYS	Moaveni	Pearson, 2011
7	Introduction to FEM (2009)	Thompson	Wiley

Course Code	MME-302(c)
Course Title	Computational Fluid Dynamics
Type of Course	Elective
L T P	3 1 0
Credits	4
Course Assessment Methods End Semester Assessment (University Exam.) Continuous Assessment (Sessional, Assignments, Quiz)	 50 50

SYLLABUS

***Note for Examiner**- The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.*

SECTION-A

Introduction: History of CFD; Computational Fluid Dynamics: What, When, and Why?, CFD Applications, Numerical vs Analytical vs Experimental, Modeling vs Experimentation, Fundamental principles of conservation, Reynolds transport theorem, Conservation of mass, Conservation of linear momentum: Navier-Stokes equation, Conservation of Energy, General scalar transport equation (5 hrs)

Problem Formulation: The standard procedure for formulating a problem Physical and Mathematical classification of problems; Types of governing Differential equations and Boundary conditions. Mathematical classification of Partial Differential Equation, Illustrative examples of elliptic, parabolic and hyperbolic equations, Physical examples of elliptic, parabolic and hyperbolic partial differential equations (6 hrs)

Methods of Discretisation: Discretization principles: Pre-processing, Solution, Post-processing, Finite Element Method, Finite difference method, Well posed boundary value problem, Possible types of boundary conditions, Conservativeness, Boundedness, Transportiveness, Finite volume method (FVM), Illustrative examples: 1-D steady state heat conduction without and with constant source term (5 hrs)

Finite Volume Method: Some Conceptual Basics and Illustrations through 1-D Steady State Diffusion Problems: Physical consistency, Overall balance, FV Discretization of a 1-D steady state diffusion type problem, Composite material with position dependent thermal conductivity, Four basic rules for FV Discretization of 1-D steady state diffusion type problem, Source term linearization, Implementation of boundary conditions (4hrs)

SECTION-B

Numerical Solution to Heat Conduction Problems: Steady-state Problems: (i) One-dimensional Heat Con conduction Transfer through a Pin-fin (ii) Two-dimensional Conduction through a plate Unsteady-state Problem: One-dimensional Transient Heat Conduction. Explicit and Implicit Methods, Stability of numerical Methods.

(10 hrs)

Numerical Solution to Fluid Flow Problems: Types of fluid flow and their governing equations; Viscous Incompressible flows Calculation of flow field using the stream function-vorticity method; Calculation of boundary layer flow over a flat plate; Numerical algorithms for solving complete Navier- Stokes equations- MAC method; SIMPLE algorithm; Project problem.

(12hrs)

TEXT BOOKS			
S. No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1	Numerical Heat Transfer and Fluid Flow,	S. V. Patankar	Mc. Graw Hill (2007)
2	Computational Fluid Dynamics	T. J. Chung,	Cambridge University Press
RECOMMENDED BOOKS			
1			
2			

Course Code	MME-302(d)
Course Title	Vibration Testing
Type of Course	Elective
L T P	3 1 0
Credits	4
Course Assessment Methods End Semester Assessment (University Exam.) Continuous Assessment (Sessional, Assignments, Quiz)	 50 50

SYLLABUS

***Note for Examiner**- Examiner will set 7 questions of equal marks. First question will cover whole syllabus, having 10 conceptual questions of 1 mark each or 5 questions of 2 mark each and is compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each part.*

SECTION-A

Overview: Introduction and basic philosophy of modal testing; Historical development of modal testing; Practical applications of modal testing; Basic terminology and notations related to modal testing.

Methods of Vibration Testing: Impulse hammer method of modal testing; Roving accelerometer method; Roving hammer method; Shaker method of modal testing; Types of shakers and their relative merits and demerits; Comparison of hammer and shaker method of modal testing.

Basic Hardware for Vibration Testing: Working, comparison and selection criterion for different types of accelerometers, mountings of accelerometers, impulse hammers, exciters, connecting cables, charge amplifiers, filters, windows, FFT analyzers.

FRF Measurement: Preparation of test structure; Effects of double hitting; Methods of avoiding double hitting effects; Effects of mass loading; Methods of avoiding mass loading effects; Different types of windows and their use in FRF measurements; Different estimates of FRF and effects of noise; Methods of dealing with incomplete measured data; Repeatability of measured FRF data; Reciprocity of measured FRF data.

SECTION-B

Verification of Experimental Results: Visual checks; Low-frequency asymptotes; High-frequency asymptotes; Incidence of anti-resonances; Overall shape of FRF skeleton; Nyquist plot inspection; Repeated modes.

Modal Parameter Extraction Methods: Frequency domain methods; Time domain methods; SDOF methods; MDOF methods; Single-FRF methods; Multi-FRF methods; Difficulties in modal parameter extraction due to damping and model order.

Display of Modal Models: Static displays; Deflected shapes; Multiple frames; Argand diagram; Dynamic displays; Interpretation of displays of modal models.

Applications of Vibration Testing:
Practical applications of vibration testing on following real life structures:

- Cantilever beam
- Fixed-fixed beam
- Drilling machine skeleton (F-structure)
- Lathe
- I.C. Engine Structure

TEXT BOOKS			
S. No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1	Modal Testing: Theory, Practice and Application	D.J. Ewins	Second edition, Research Studies Press Limited, England, 2000
2	Theoretical and Experimental Modal Analysis	N.M.M. Maia and J.M. Silva	Research Studies Press Limited, England, 1997
RECOMMENDED BOOKS			
1	Modal Analysis	He and Fu	Butterworth Heinemann Publisher, Oxford, 2001, ISBN 0 7506 5079 6

Course Code	**MME-302(e)**
Course Title	Optimization Techniques
Type of Course	Elective
L T P	3 1 0
Credits	4
Course Assessment Methods End Semester Assessment (University Exam.) Continuous Assessment (Sessional, Assignments, Quiz)	 50 50

SYLLABUS

Note: The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

PART A

Linear programming: Modelling of linear programming problem – a few examples; Solution of linear programming problem – simplex method, two-phase method, M-method; Sensitivity analysis – graphical approach
(12 Hrs)

Non-linear programming: Convex and non-convex search space, Kuhn-Tucker conditions, Hessian matrix; Transformation of constrained optimization problems into unconstrained ones – penalty function approach; Direct search – variable elimination method, random search method
(12 Hrs)

PART B

Integer Programming: Modelling of integer programming problem – a few examples; Solution of integer programming problem – branch & bound algorithm, cutting-plane algorithm; Travelling salesman problem – formulation, solution and practical applications
(12 Hrs)

Heuristic models: Limitations of traditional optimization approaches to solve real world problems, Population based optimization techniques, Simple genetic algorithms – introduction, representation of variables, fitness function, genetic operators – reproduction, crossover, mutation; Advantages and limitations of population based optimization techniques over the point-to-point based ones (12Hrs)

Recommended Books:

Title	**Author(s)**	**Publisher**
Operations Research	Taha, H. A.	PHI
Optimization of EngineeringDesign	Deb, K.	PHI
Operations Research	D.S. Hira, P. K. Gupta	S. Chand

Course Code	**MME-302(f)**
Course Title	Materials Design
Type of Course	Elective
L T P	3 1 0
Credits	4
Course Assessment Methods End Semester Assessment (University Exam.) Continuous Assessment (Sessional, Assignments, Quiz)	 50 50
Course Prerequisites	
Course Objectives (CO)	
Course Outcome	

SYLLABUS

Note: The examiner shall set 8 questions i.e., 4 from each part and students shall be required to attempt a total of 5 questions with at least 2 questions from each part.

SECTION-A

Basic Introduction to various types of engineering, dental and bio-materials
Introduction to fabrication techniques and methodologies for different types of composite materials

SECTION-B

Simulation and Finite Element modelling techniques for characterization
Material analysis and testing techniques
Material applications for engineering, dental and surface coatings

TEXT BOOKS			
S. No.	**NAME**	**AUTHOR(S)**	**PUBLISHER**
1	Mechanical Behavior of Materials(3E)	Norman Dowling	Pearson Publishers
2	Mechanical Behavior of Materials	Bowman	John Wiley &Sons
RECOMMENDED BOOKS			
3	Mechanical Behavior of Engineering Materials	Roesler, Harders, Baeker	Springer