Effective from Session 2015-16
Babu Banarasi Das University, Lucknow

Department of Mechanical Engineering
School of Engineering
Master of Technology [Full Time] (Design Engg.)
Evaluation Scheme

Semester I										
Course Category	**Course Code**	**Code Title**	**Contact Hours**			**Evaluation Scheme**			**Credits**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
C	**MAS2104**	Advanced Mathematics	**3**	**1**	**0**	**40**	**60**	**100**	**4**
C	**MME2101**	Design of Experiments	**3**	**1**	**0**	**40**	**60**	**100**	**4**
C	**MME2102**	Experimental Stress Analysis	**3**	**1**	**0**	**40**	**60**	**100**	**4**
C	**MME2103**	Computer Aided Design	**3**	**1**	**0**	**40**	**60**	**100**	**4**
GE		Generic Elective - I	**3**	**1**	**0**	**40**	**60**	**100**	**4**
C	**MME2198**	Seminar	**0**	**0**	**2**	**100**	**0**	**100**	**1**
C	**MME2102P**	Experimental Stress Analysis Lab	**0**	**0**	**2**	**100**	**0**	**100**	**1**
C	**MME2103P**	CAD Lab	**0**	**0**	**2**	**100**	**0**	**100**	**1**
Total			**15**	**5**	**6**	**500**	**300**	**800**	**23**

Legends:

L	Number of Lecture Hours per week
T	Number of Tutorial Hours per week
P	Number of Practical Hours per week
CIA	Continuous Internal Assessment
ESE	End Semester Examination

Category of Courses:

F	Foundation Course
C	Core Course
GE	Generic Elective
OE	Open Elective

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Semester II										
Course Category	**Course Code**	**Code Title**	**Contact Hours**			**Evaluation Scheme**			**Credits**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
C	**MME2201**	Theory of elasticity	**3**	**1**	**0**	**40**	**60**	**100**	**4**
C	**MME2202**	Simulation, Modeling and Analysis	**3**	**1**	**0**	**40**	**60**	**100**	**4**
C	**MME2203**	Finite Element Method	**3**	**1**	**0**	**40**	**60**	**100**	**4**
GE		Generic Elective - II	**3**	**1**	**0**	**40**	**60**	**100**	**4**
GE		Generic Elective - III	**3**	**1**	**0**	**40**	**60**	**100**	**4**
C	**MME2298**	Seminar	**0**	**0**	**2**	**100**	**0**	**100**	**1**
C	**MME2299**	Industrial Training	**0**	**0**	**2**	**100**	**0**	**100**	**1**
C	**MME2202P**	Simulation, Modeling and Analysis Lab	**0**	**0**	**2**	**100**	**0**	**100**	**1**
Total			**15**	**5**	**6**	**500**	**300**	**800**	**23**

Legends:

L	Number of Lecture Hours per week
T	Number of Tutorial Hours per week
P	Number of Practical Hours per week
CIA	Continuous Internal Assessment
ESE	End Semester Examination

Category of Courses:

F	Foundation Course
C	Core Course
GE	Generic Elective
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Semester III									
Course Category	**Course Code**	**Code Title**	**Contact Hours**			**Evaluation Scheme**			**Credits**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
C	**MME2351**	State – of-the-art Seminar #	-	-	-	**200**	-	**200**	**4**
C	**MME2352**	Thesis I*	-	-	-	**400**	-	**400**	**16**
Total			-	-	-	**600**	-	**600**	**20**

Student need to perform a literature survey and will give a State-of the- art presentation and will submit a synopsis clearly mentioning the problem statement. The Presentation and synopsis will be evaluated internally within 2 months of the start of the semester and the result will be intimated to the students so as to proceed for Thesis.

*Student will develop the workable model for the problem they have supposed in synopsis.

Semester IV									
Course Category	**Course Code**	**Code Title**	**Contact Hours**			**Evaluation Scheme**			**Credits**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
C	**MME2451**	Thesis II**	-	-	-	**200**	**800**	**1000**	**28**
Total			-	-	-	**200**	**800**	**1000**	**28**

** (a) This is in continuation with Thesis-I.

(b) The require Experimental/Mathematical Verification of the proposed model will be done in this Semester.

Legends:

L Number of Lecture Hours per week
T Number of Tutorial Hours per week
P Number of Practical Hours per week
CIA Continuous Internal Assessment

ESE	End Semester Examination

Category of Courses:

F	Foundation Course
C	Core Course
GE	Generic Elective
OE	Open Elective

Babu Banarasi Das University, Lucknow

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Evaluation Scheme

Credit Summary Chart

Course Category	Semester				Total Credits	%age
	I	II	III	IV		
F						
C	19	15	20	28	82	87.23%
GE	4	8			12	12.77%
OE						
GP						
Total	23	23	20	28	94	100.00%

Discipline wise Credit Summary Chart

Course Category	Semester				Total Credits	%age
	I	II	III	IV		
Basic Sciences						
Humanities & Social Sciences						
Engineering Sciences						
Professional Subject - Core	18	14			32	34%
Professional Subject – Generic Elective	4	8			12	13%
Professional Subject – Open Elective						
Thesis Work, Seminar and/or Internship in Industry or elsewhere	1	1	20	28	50	53%
Total	23	23	20	28	94	100%

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Semester I										
Course Category	**Course Code**	**Code Title**	**Contact Hours**			**Evaluation Scheme**			**Credits**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
C	**MAS2104**	Advanced Mathematics	**3**	**1**	**0**	**40**	**60**	**100**	**4**
C	**MME2101**	Design of Experiments	**3**	**1**	**0**	**40**	**60**	**100**	**4**
GE		Generic Elective - I	**3**	**1**	**0**	**40**	**60**	**100**	**4**
Total			**9**	**3**	**0**	**120**	**180**	**300**	**12**

Semester II									
Course Category	**Course Code**	**Code Title**	**Contact Hours**			**Evaluation Scheme**			**Credits**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
C	**MME2201**	Theory of elasticity	**3**	**1**	**0**	**40**	**60**	**100**	**4**
C	**MME2103**	Finite Element Method	**3**	**1**	**0**	**40**	**60**	**100**	**4**
GE		Generic Elective - II	**3**	**1**	**0**	**40**	**60**	**100**	**4**
Total			**9**	**3**	**0**	**120**	**180**	**300**	**12**

Legends:

L	Number of Lecture Hours per week
T	Number of Tutorial Hours per week
P	Number of Practical Hours per week
CIA	Continuous Internal Assessment
ESE	End Semester Examination

Category of Courses:

F	Foundation Course

C	Core Course
GE	Generic Elective
OE	Open Elective

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Evaluation Scheme

Semester III

Course Category	Course Code	Code Title	Contact Hours			Evaluation Scheme			Credits
			L	T	P	CIA	ESE	Course Total	
C	MME2102	Experimental Stress Analysis	3	1	0	40	60	100	4
C	MME2103	Computer Aided Design	3	1	0	40	60	100	4
C	MME2198	Seminar	0	0	2	100	0	100	1
C	MME2102P	Experimental Stress Analysis Lab	0	0	2	100	0	100	1
C	MME2103P	CAD Lab	0	0	2	100	0	100	1
Total			6	2	6	380	120	500	11

Semester IV

Course Category	Course Code	Code Title	Contact Hours			Evaluation Scheme			Credits
			L	T	P	CIA	ESE	Course Total	
C	MME2202	Simulation, Modeling and Analysis	3	1	0	40	60	100	4
GE		Generic Elective - III	3	1	0	40	60	100	4
C	MME2298	Seminar	0	0	2	100	0	100	1
C	MME2299	Industrial Training	0	0	2	100	0	100	1
C	MME2202P	Simulation, Modeling and Analysis Lab	0	0	2	100	0	100	1
Total			6	2	6	380	120	500	11

Legends:

L	Number of Lecture Hours per week
T	Number of Tutorial Hours per week
P	Number of Practical Hours per week
CIA	Continuous Internal Assessment
ESE	End Semester Examination

Category of Courses:

F	Foundation Course
C	Core Course
GE	Generic Elective
OE	Open Elective

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Semester V

Course Category	Course Code	Code Title	Contact Hours			Evaluation Scheme			Credits
			L	T	P	CIA	ESE	Course Total	
C	MME2351	State – of-the-art Seminar #	-	-	-	200	-	200	4
C	MME2352	Thesis I*	-	-	-	400	-	400	16
Total			-	-	-	600	-	600	20

Student need to perform a literature survey and will give a State-of the- art presentation and will submit a synopsis clearly mentioning the problem statement. The Presentation and synopsis will be evaluated internally within 2 months of the start of the semester and the result will be intimated to the students so as to proceed for Thesis.

*Student will develop the workable model for the problem they have supposed in synopsis.

Semester VI

Course Category	Course Code	Code Title	Contact Hours			Evaluation Scheme			Credits
			L	T	P	CIA	ESE	Course Total	
C	MME2451	Thesis II**	-	-	-	200	800	1000	28
Total			-	-	-	200	800	1000	28

** (a) This is in continuation with Thesis-I.

(b) The require Experimental/Mathematical Verification of the proposed model will be done in this Semester.

Legends:

L Number of Lecture Hours per week
T Number of Tutorial Hours per week
P Number of Practical Hours per week

CIA	Continuous Internal Assessment
ESE	End Semester Examination

Category of Courses:

F	Foundation Course
C	Core Course
GE	Generic Elective
OE	Open Elective

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Department of Mechanical Engineering

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Evaluation Scheme

Credit Summary Chart								
Course Category	Semester						Total Credits	%age
	I	II	III	IV	V	VI		
F								
C	8	8	11	7	20	28	82	87%
GE	4	4		4			12	13%
OE								
GP								
Total	12	12	11	11	20	28	94	100%

Discipline wise Credit Summary Chart								
Course Category	Semester						Total Credits	%age
	I	II	III	IV	V	VI		
Basic Sciences								
Humanities & Social Sciences								
Engineering Sciences								
Professional Subject - Core	8	8	10	6			32	34%
Professional Subject – Generic Elective	4	4		4			12	13%
Professional Subject – Open Elective								
Project Work, Seminar and/or Internship in Industry or elsewhere			1	1	20	28	50	53%
Total	12	12	11	11	20	28	94	100%

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Evaluation Scheme
List of Generic Electives

Course Code	Generic Elective-I
MME2051	Micro Electro- Mechanical Systems
MME2052	Flexible Manufacturing Systems
MME2053	Computer Aided Process Planning
MME2054	Quality Engineering
MME2055	Advance Welding Technology
MME2056	Engineering Design
MME2057	Optimization for Engineering Design
MME2058	Theory of Vibration
Course Code	**Generic Elective-II**
MME2061	Advanced Manufacturing Processes
MME2062	Research and AI in Mfg. Systems
MME2063	Computer Graphics & Product Modeling
MME2064	System Simulation
MME2065	Numerical methods for manufacturing Processes
MME2066	Product Development
MME2067	Robotics & Automation
MME2068	Computer Integrated Manufacturing
Course Code	**Generic Elective-III**
MME2071	Mechatronics
MME2072	Tribology
MME2073	Design of pressure Vessels
MME2074	Nonlinear Vibration
MME2075	Advanced Composite Material
MME2076	Theory of Plate & Vessels
MME2077	Theory of Elasticity
MME2078	Theory of Mechanism

DESIGN OF EXPERIMENTS (MME2101)

Course Objective:

1. To learn the need of designed approach in sampling and modeling.
2. To learn the factor based design and analysis approach.
3. To learn importance of variance in design and its implication.
4. To learn nested design and quality loss function for designed quality.

Learning Outcome:

At the end of the course student should be able to:

1. To understand the fundamentals of optimized design.
2. To understand the effect of error and variance on quality and delivery.
3. To understand different methods of response surface design.
4. To understand and interpret the graphical results.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Fundamentals of experimental design, Selection of an appropriate design, Criteria for evaluation, Factors and levels, Reviews of statistical inference, Importance of optimized design, Functional design, Parametric design.	30	1
II	Single Factor Experiments, Completely randomized design, Analysis of variance (ANOVA), Effect of total sum of Squares, Randomized block design, Randomized incomplete block design, Latin square design.	30	1
III	Factorial Experiments, Two way analysis of variance, Fixed Random and Mixed models, Expected mean square rules, Nested and nested factorial designs, Effect of confounding, Fractional factorial design, Response Surface Methodology – Central composite designs, method of steepest ascent response surface designs.	30	1
IV	Steps in designing performance in to a product, Taguchi’s definition of quality Loss functions and manufacturing tolerances, Additivity, Orthogonal arrays vs. classical statistical experiments, Graphic evaluations of main effects, Selecting factors for Taguchi in Experiments. Concepts of S/N Ratios—its significance in robust design, Case studies of S/N.	30	1

Reference Books:

1. Douglus C. Montgomery - Statistical Quality Control, John Wiley and sons.
2. Charles R. Hicks, - Fundamental Concepts in design of experiments, 1984. Holt, Rinehort and Winston.
3. Tapan P. Bagchi, - Methods Explained: Practical steps to Robust Design, Prentice Hall.
4. Cochran, W. G., and G. M. Cox. 1957. Experimental Designs Asia Publishing House.
5. Phadke M.S. Quality Engineering Using Robust Design, Prentice-Hill.

EXPERIMENTAL STRESS ANALYSIS (MME2102)

Course Objective:

1. To develop the relationship between the loads applied to a non-rigid body and the internal stresses and deformations induced in the body.
2. To study the general state of stresses and strains in a given loaded member and the magnitude and direction of the principal stresses.
3. To study stress, crack and failure pattern and strain rate sensitivity.
4. To learn the impact and implication of principal direction, plane and stresses.

Learning Outcome:

At the end of the course student should be able to:

1. To understand the different techniques and method to calculate and assess the stresses experienced by a component.
2. To understand the failure initiation, occurrence and avoidance.
3. To learn different theories and models of stress strain modeling.
4. To appreciate and design complex real structures.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Stress and Stress Equations of Equilibrium Laws of Stress Transformations and principal Stresses, Two-Dimensional State of Stress, Stresses Relative to Principal Coordinate System, Strain: Introduction, Displacement and Strain, Strain transformation equation and principal strains, compatibility, Strain Transformation Equations and Stress Strain Relations for Two-Dimensional State of Stress.	30	1
II	Brittle Coating Method: Coating Stresses, Failure Theories, Brittle Coating Crack Patterns, Resin and Ceramic Based Brittle Coating, Test Procedure, and Analysis of Brittle Coating Data. Strain Gage Adhesives, Gage Sensitivity and Gage Factor. Strain Gage Circuit: Potentiometer and its Application, Wheat-Stone Bridge, Bridge Sensitivity, Null Balance Bridges. Analysis of Strain Gage Data.	30	1
III	Stress Optic Law, Relative Retardation, Stressed Model in Plane Polariscope, Effect of Principal Directions, Effect of Principal Stress Difference, and Stressed Model in Circular Polariscope, Light and Dark Field arrangements, Tardy Compensation, Fringe Sharpening and Multiplication by Partial Mirrors.	30	1

IV	Two Dimensional Photo-elasticity: Isochromatic Fringe Patterns, Isoclinic Fringe Patterns, Compensation Techniques, Calibration Methods, Separation Methods, Electrical Analogy Method, Oblique Incidence Method.	**30**	**1**

Reference Books:

1. Experiment Stress Analysis by- James W. Dally and William F. Riley, International Student Edition, McGraw-Hill Book Company.
2. Experiment Stress Analysis by- Dr. Sadhu Singh, Khanna Publishers.

COMPUTER AIDED DESIGN (MME2103)

Course Objective:

1. To learn advance concepts of CAD and computer graphics.
2. To learn about the geometric issues concerned solid modeling.
3. To learn the latest advances in the CAD design and drafting.
4. To learn the in depth concepts of curves, surfaces and solid modeling.

Learning Outcome:

At the end of the course student should be able to:

1. To understand the importance of CAD in the Product design.
2. To develop simple part model in CAD.
3. To analyze the importance of CAD modeling and numeric production methods.
4. To understand the application of CAD in various part update and change management.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Introduction, Historical Development, Explicit and Implicit Equations, Intrinsic Equations Parametric Equations Coordinate Systems, Curves: Fundamental of Curve Design Parametric Space of a Curve, Reparametrization, Space Curves: Spline Curves, Bezier Curves, B-Spline Curve, Rational Polynomials, Rational curves, NURBS.	30	1
II	Surfaces: Fundamental of Surface Design, Parametric Space of a Surface, Reparametrization of a Surface patch, Sixteen point form, Four Curve Form, Plane, Cylindrical and Ruled Surfaces, Surfaces of Revolutions, Bezier Surface, B Spline Surface.	30	1
III	Solids: Fundamental of Solid Design, Parametric Space of a Solids; Continuity and composite Solids Surface and Curves in a Solid ,Solid Modeling: Topology and Geometry, Set theory, Euler Operators, Regularized Boolean Operators, Construction Criteria, Graph Based Models.	30	1
IV	Instances and Parameterized Shapes, Cell-decomposition and Spatial Occupancy Enumeration, Sweep representation, CGS, B-Rep, Wireframe Analytical properties, Relational properties and Intersection. Applications in Mechanical Engineering Design.	30	1

Reference Books:

1. Mathematical Elements of Computer Graphics, Rogers and Adams, McGraw Hill. 1994.
2. CAD CAM Theory and Practice: I. Zeid, Tata-McGraw Hill, 2006.
3. Computer-Aided Design, R K Srivastava, Umesh Publications, Delhi, 2007, 3rd edition.
4. Geometric Modeling: Michael E. Mortenson, John Wiley, 1992.
5. Computer-Aided Engineering Design, B Sahay and A. Saxena, 2004.
6. Kathryn A. Ingle, “Reverse Engineering”, McGraw-Hill, 2004.

THEORY OF ELASTICITY (MME2201)

Course Objective:

1. To learn various mathematical and physical aspects of deformation.
2. To learn stress strain relationship in two dimensional Cartesian coordinates.
3. To learn the formulation of elasticity equations and stress function variants.
4. To learn the usage of different mathematical technique to solve complex problem formulations.

Learning Outcome:

At the end of the course student should be able to:

1. To understand the stress stiffness and generalized failure models.
2. To understand the mathematical techniques to solve engineering equations.
3. To identify and appreciate the different analogies in two dimensional stress problems.
4. To understand different type of stresses in various cylinders.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Definition and Notation for forces and stresses, Components of stresses, equations of Equilibrium Specification of stress at a point, Principal stresses and Mohr's diagram in three dimensions Boundary conditions, Stress components on an arbitrary plane Stress invariants, Octahedral stresses Decomposition of state of stress, Stress transformation.	30	1
II	Deformation, Strain Displacement relations, Strain components The state of strain at a point, Principal strain, Strain transformation, Compatibility equations Cubical dilatation. Stress -Strain Relations and the General Equations of Elasticity Generalized Hooke's; law in terms of engineering constants Formulation of elasticity Problems.	30	1
III	Saint-Venant's principle of super position and reciprocal, Two Dimensional Problems in Cartesian Co-Ordinates, Airy's stress function, investigation for simple beam problems, Use of Fourier series to solve two dimensional problems.	30	1
	Two Dimensional Problems in Polar Co-Ordinates, General equations, stress distribution symmetrical about a force on semi-infinite plane, Stress	30	1

IV	concentration around a circular hole in an infinite plate, Thermal Stresses: Introduction, Thermo-elastic stress-strain relations, Thin circular disc, Long circular cylinder, Torsion of Prismatic Bars: Torsion of Circular and elliptical cross section bars, Soap film analogy, Membrane analogy, Torsion of thin walled open and closed tubes, Elastic Stability: Axial compression of prismatic bars.		

Reference Books:

1. Timoshenko and Goodier, "Theory of Elasticity ",'McGraw Hill Book Company.
2. Dym C. L and Shames. I. H, Solid Mechanics: A variation Approach, McGraw Hill New York- 1973.
3. Sitharam T.G. “Applied Elasticity" Interline publishing.
4. Srinath L.S. “Advanced Mechanics of Solids ", Tata McGraw Hill Company.
5. Sadhu Singh," Theory of Elasticity", Khanna publisher.

SIMULATION MODELING AND ANALYSIS (MME2202)

Course Objective:

1. To introduce modeling, simulation and optimization as it applies to the study and analysis of manufacturing systems for decision support.
2. To expose with a wide range of applications for simulation methods and models and to integrate them with their introduction to operations management.
3. To learn the differentiation between the continuous and discrete systems in accordance with simulation modeling.
4. To understand static and dynamic models and fundamentals of model evaluations.

Learning Outcome:

At the end of the course student should be able to:

1. To understand the practical skills necessary to design, implement and analyze discrete-event simulation systems.
2. To understand the basic theory underlying discrete-event simulation methodologies in order to enable a critical understanding of simulation output in managerial environments.
3. To build the foundations necessary to quickly adapt for future advances in simulation technology.
4. To appreciate the modeling best practices and implementations of it.

Course Contents:

Module	**Course Topics**	**Total Hours**	**Credits**
I	Introduction: A Review of Basic Probability and Statistics, Random Variables and Their Properties, Estimation of Means Variances and Correlation.	**30**	**1**
II	Physical Modeling: Concept of System and Environment, Continuous and Discrete Systems, Linear and Non-Linear Systems, Stochastic Activities, Static and Dynamic Models, Principles of Modeling, Basic Simulation Modeling, Role of Simulation In Model Evaluation and Studies, Advantages of Simulation.	**30**	**1**
III	System Simulation: Techniques of Simulation, Monte Carlo Method, Experimental Nature of Simulation, Numerical Computation Techniques, Continuous System Models, Analog and Hybrid Simulation, Feedback Systems, Computers In Simulation Studies, Simulation Software Packages.	**30**	**1**

IV	Simulation of Mechanical Systems, Building of Simulation Models, Simulation of Translational and Rotational Mechanical Systems, Simulation of Hydraulic Systems, Simulation of Manufacturing Systems, Simulation of Waiting Line Systems, Job Shop with Material Handling and Flexible Manufacturing Systems, Simulation Software For Manufacturing, Case Studies.	**30**	**1**

Reference Books:

1. System Simulation by Geoffrey Gordon, Prentice Hall.

2. System Simulation: The Art and Science Robert E. Shannon Prentice Hall.

3. System Modeling and Control J. Schwarzenbach and K.F. Gill Edward Arnold.

4. Modelling and Analysis of Dynamic Systems Charles M Close and Dean K. Frederick Houghton Mifflin.

5. Simulation of manufacturing Allan Carrie John Wiley & Sons.

FINITE ELEMENT METHOD (MME2203)

Course Objective:

1. To enable the students understand the mathematical and physical principles underlying the Finite Element Method (FEM) as applied to solid mechanics.
2. To understand the characteristics of various finite elements.
3. To develop finite element equations for simple and complex systems.
4. To learn 2D and 3 D problem formulation and usage of FEM packages.

Learning Outcome:

At the end of the course student should be able to:

1. To apply the knowledge of mathematics and engineering to solve problems in structural engineering by approximate and numerical methods.
2. To design a new component or improve the existing components using FEA.
3. To solve the problems in solid mechanics and heat transfer using FEM.
4. To use commercial FEA packages like ANSYS and modern CAD/CAE tools for solving real life-problems.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Approaches of FEM- Discrete, Variation and Weighted Residual, Direct Problems-Spring, Hydraulic Network, Resistance Network and Truss Systems.	**30**	**1**
II	1-D Field and Beam Bending Problems-Formulation using Galerkin and Raleigh-Ritz approaches, Derivation of elemental equations and their assembly, Solution and its post processing.	**30**	**1**
III	2-D and Axisymmetric Field and Stress Problems-Formulation using Galerkin and Raleigh-Ritz approaches, Derivation of elemental equations and their assembly, Solution and its post processing.	**30**	**1**
IV	3-D Field and Stress Problems-Formulation using Galerkin and Raleigh-Ritz approaches, Derivation of elemental equations and their assembly, Solution and its post processing, Eigen value and time dependent problems, Discussion about preprocessors, postprocessors and finite element packages.	**30**	**1**

Reference Books:

1. The Finite Element Method, O.C. Zienkiewicz and R.L. Taylor, McGraw Hill.
2. An Introduction to Finite Element Method, J. N. Reddy, McGraw Hill.
3. Finite Element Procedure in Engineering Analysis, K.J. Bathe, McGraw Hill.
4. Finite Element Analysis, C.S. Krishnamoorthy, Tata McGraw Hill.
5. Concepts and Application of Finite Element Analysis, R.D. Cook, D.S. Malcus and M.E. Plesha, John Wiley.
6. Introduction to Finite Elements in Engineering, T.R Chandragupta and A.D. Belegundu, Prentice Hall India.
7. Finite Element and Approximation, O.C. Zenkiewicy& Morgan.
8. Numerical Methods, E Balagurusamy, Tata McGraw Hill.

EXPERIMENTAL STRESS ANALYSIS LAB (MME2102P)

1. Casting of Photoelastic Sheet.
2. Preparation of Circular Disk or any model from photo-elastic sheet.
3. Determination of fringe constant using circular disk.
4. Determination of stresses using at least three photo-elastic models.
5. Separation of Principle Stresses using any method of stress separation.
6. Stress freezing of photoelatic model.
7. Fixing of strain gages to the specimen.
8. Stress and strain measurement in cantilever beam using strain gages.
9. Study and demonstration of Reflection Polariscope.
10. Study and demonstration of Fringe sharpener and multiplier.

COMPUTER AIDED DESIGN LAB (MME2103P)

List of Experiments:

1. Creating a Simple Object (Part 1) (About 3D axes, datum planes, orientation in space, rotation etc. in Pro-E)
2. Creating a Simple Object (Part 2) (Create features like holes, chamfers etc.)
3. Revolved Protrusions, Revolved Copies and Model Analysis
4. Modeling Utilities (Parent-child relations, redefining sketches, and rerouting or changing references.)
5. Datum and sketcher tools
6. Patterns and Copies
7. Sweep and Blends
8. Engineering Drawings
9. Assembly Fundamentals
10. Assembly Operations

COMPUTERS AIDED MANUFACTURING LAB (MME2204P)

List of Experiments:

1. Milling simulation using CAPSMILL software.
2. Turing simulation using CAPSTURN software.
3. Turing simulation using CAPSTURN software.
4. Turning exercise in Production lathe using single tool.
5. Milling exercise in Trainer Milling machine.
6. Programming experiment for turning operation on CNC machine.
7. Experiment on Transfer line/Material handling.
8. Experiment on Mechatronics and controls.
9. Multi-axial Machining in CNC Machining Center–EDM– EDM Wire Cut– Rapid Prototyping.

MICRO ELECTRO- MECHANICAL SYSTEMS (MME2051)

Course Objective:

1. To understand the basic concepts of MEMS.
2. To enhance the knowledge of sensors and actuators.
3. To familiarize with the properties and applications and explore the MEMS/ NEMS devices and their applications.
4. To learn the processes and fundamentals of etching and micromachining processes.

Learning Outcome:

At the end of the course student should be able to:

1. Use Nanomaterials and polymers for various industrial applications.
2. To design MEMS devices for various applications.
3. To demonstrate the knowledge of devices used in MEMS/NEMS.
4. To understand the concepts and application of micromachining.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Introduction: Intrinsic Characteristics of MEMS Introduction To Micro Fabrication Silicon Based Mems Processes – New Materials Review of Electrical and Mechanical Concepts In Mems Semiconductor Devices– Stress and Strain Analysis – Flexural Beam Bending- Torsional Deflection. Polymer and Optical MEMS: Polymers In MEMS, Polimide - Su-8 - Liquid Crystal Polymer (Lcp) – Pdms – Pmma – Parylene – Fluorocarbon Application To Acceleration, Pressure, Flow and Tactile Sensors Optical Mems – Lenses and Mirrors.	30	1
II	Sensors and Actuators-I: Electrostatic Sensors Parallel Plate Capacitors Applications – Interdigitated Finger Capacitor Comb Drive Devices Thermal Expansion, Thermal Couples, Thermal Resistors – Applications – Magnetic Actuator, Micro-Magnetic Components, Case Studies of Mems In Magnetic Actuators.	30	1
III	Sensors and Actuators Piezoresistive Sensors – Piezoresistive Sensor Materials Stress Analysis of Mechanical Elements Applications To Inertia, Pressure, Tactile and Flow Sensors Piezoelectric Sensors and Actuators Piezoelectric Effects – Piezoelectric Materials, Applications To Inertia,	30	1

	Acoustic, Tactile and Flow Sensors.		
IV	Micromachining: Silicon Anisotropic Etching Anisotropic Wet Etching, Dry Etching of Silicon Plasma Etching Deep Reaction Ion Etching (Drie) Isotropic Wet Etching Gas Phase Etchants Case Studies - Basic Surface Micromachining Processes Structural and Sacrificial Materials – Acceleration of Sacrificial Etch – Striction and Antistriction Methods – Assembly of 3d MEMS – Foundry Process.	**30**	**1**

Reference Books:

1. Chang Liu, ‘Foundations of MEMS’, Pearson Education Inc., 2006.
2. James J. Allen, micro electro mechanical system design, CRC Press published in 2005.
3. Nadim Maluf, “An introduction to Micro electro mechanical system design”, Artech House, 2000.

FLEXIBLE MANUFACTURING SYSTEMS (MME2052)

Course Objective:

1. To learn principles and application of FMS, CNC and DNC.
2. To learn hardware and software implication in design and implementation of FMS.
3. To learn part programming and robot programming as applicable in industrial setting.
4. To lean the use of AGV and Supervisory systems.

Learning Outcome:

At the end of the course student should be able to:

1. To understand the importance and application of FMS and Numeric Controls in industrial setting.
2. To understand the concept and application of scheduling, planning and control.
3. To appreciate the importance and usage of supervisory systems in manufacturing.
4. To design and develop material handling systems.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Introduction, Purpose and Definition Architecture of FMS, CNC and DNC.	30	1
II	Hardware and of Software's Auxiliary Devices In FMS MS Operation Control Production Scheduling In FMS, FMS Scheduling Rules FMS Capacity Planning and Control.	30	1
III	Part Programming Computer Assisted Part Programming Methods, Robotics, Introduction, Classification Hardware Details of Robot Elements Principles of Robot Programming.	30	1
IV	Automated Guided Vehicles Classification and Elements Supervisory Systems Application On Welding Assembly, Material Handling, Economics of FMS Technology.	30	1

Reference Books:

1. Flexible Manufacturing System by H K Shivanand, New Age International.
2. Flexible Manufacturing Systems by Thomas J Drozda, Judy D Stranahan, Gloria Farr, Society of Manufacturing.

3. Flexible Manufacturing Systems: Recent Developments by A Raouf, M Ben Daya, Raouf, Elsevier Science & Technology.

COMPUTER AIDED PROCESS PLANNING (MME2053)

Course Objective:

1. To understand the process planning in production environment.
2. To understand the CAPP and GT concepts and applications.
3. To appreciate the need and demand of computer aided process planning and its constituents.
4. To understand the various concept of dimensioning and tolerances in part and assembly design.

Learning Outcome:

At the end of the course student should be able to:

1. To learn design and implementation of decision tree and appreciate the decision support system.
2. To appreciate the capacity building and the usage and application of capacity planning.
3. To learn the usage and advantage of computer application in manufacturing design and process planning.
4. To appreciate the various concept of decision and process planning.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Introduction: The Place of Process Planning In The Manufacturing Cycle Process Planning and Production Planning-Process Planning and Concurrent Engineering, CAPP, Totally Integrated Process Planning Systems Modulus Structure-Data Structure-Operation Report Generation, Expert Process Planning.	30	1
II	Part Design Representation Design Drafting Dimensioning, Conventional Tolerance Geometric Tolerance Cad-Input/Output Devices Topology – Geometric Transformation Perspective Transformation Data Structure-Geometric Modeling For Process Planning.	30	1
III	Process Engineering and Process Planning Experience Based Planning, Decision Table and Decision Trees Process Capability Analysis, Process Planning Variant Process Planning Generative Approach-Forward and Backward Planning, Input Format, AI.	30	1

IV	Computer Aided Process Planning Systems Logical Design of Process Planning Implementation Considerations Manufacturing System Components Production Volume, No. of Production Families CAM-I.	**30**	**1**

Reference Books:

1. Gideon Halevi and Roland D. Weill, "Principle of process planning- A Logical Approach", Chapman & Hall, 1995.
2. Chang T. C. & Richard A. Wysk, "An Introduction to automated process planning systems", Prentice Hall 1985.
3. Chang, T.C., "An Expert Process Planning System", Prentice Hall,1985.
4. Nanua Singh, "Systems Approach to Computer Integrated Design and Manufacturing", John Wiley &Sons,1996.

QUALITY ENGINEERING (MME2054)

Course Objective:

1. To enable the students understand the principles of Quality Engineering.
2. To provide students details of quality planning and TQM techniques.
3. To learn the application and usage of control charts and in production environment.
4. To appreciate the inbuilt quality and designed quality.

Learning Outcome:

At the end of the course student should be able to:

1. To learn to implement TQM tools and techniques in contemporary industries.
2. To apply the holistic approach of quality engineering.
3. To understand the concept and value of quality by design.
4. To understand the design and implementation of FMEA.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	The Meaning and Origin of CIM The Changing Manufacturing and Modern Quality Philosophies Statistics Fundamentals For Quality Engineering.	**30**	**1**
II	X-Bar, R and S Control Charts Process Capability Case Study of Variables Quality Problem Quality Problem Diagnosis Robust Design Case Study Tolerance Overview of Quality Planning, Improvement and Control.	**30**	**1**
III	Individuals Control Chart Exponentially Weighted Moving Average Chart Attribute Control Charts Two Case Studies Employing Attribute Control Charts.	**30**	**1**
IV	Robust Design Introduction Two Level Factorial Designs, Model Building With Two Level Designs Two Level Fractional Factorial Designs.	**30**	**1**

Reference Books:

1. Richard Devor, Tsong-how Chang and John Sutherland (1992), Statistical Quality Designand Control, Macmillan.
2. Pignatiello, Joseph J. Jr. and John S. Ramberg (1995), Process Capability Studies andIndices: Fundamental Issues.
3. Montgomery, D.C. Statistical Quality Control, Wiley.
4. Joiner, Brian L. (1994), Fourth Generation Management: The New Business Consciousness, McGraw Hill.
5. Gitlow, Oppenheim and Oppenheim (1994), Quality Management: Tools and Methods forImprovement, Irwin.
6. Juran, J. M. and Gryna, F. (1993), Quality Planning and Analysis, 3rd ed., McGraw-Hill.
7. Juran, J. M. (1989), Quality Control Handbook, McGraw-Hill.
8. Selected Papers, Journal of Quality Management, Quality Engineering, Journal of Quality Technology, Quality Progress, Quality Digest and other journals.

ADVANCE WELDING TECHNOLOGY (MME2055)

Course Objective:

1. To acquire basic knowledge about the behavior and properties of engineering joining processes.
2. To acquire knowledge about various methods of welding, cold and hot working and forming.
3. To understand different welding techniques of plasma, arc and gas welding processes.
4. To understand the modern and non-conventional welding processes.

Learning Outcome:

At the end of the course student should be able to:

1. To learn the need and application of different welding processes.
2. To appreciate the need and suitability of particular welding method.
3. To learn the different types of defects and the quality of welds.
4. To learn various testing and inspection methods for welds in engineering application.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	A Review of Various Metal Joining Techniques Welding, Brazing, Soldering and Adhesive Bonding Welding Compared With Other Processes of Fabrication.	**30**	**1**
II	Classification of Welding Processes Application of Welding Processes, Fusion Welding: Mechanism of Arc Initiation and Maintenance, Temperature Distribution. Techniques Scope and Limitations of Manual Metal Arc. TIG, MIG, Submerged Arc.	**30**	**1**
III	Electroslag Welding. Plasma Arc and Electro Gas Welding, Various Gas Welding Processes E.G. Oxyacetylene Oxy-Hydrogen Welding Processes Resistance Welding Modern Welding Processes Viz. Electron Beam, Ultrasonic Explosive, Laser Beam Processes and Their Applications.	**30**	**1**
IV	Solid State Welding Processes Viz. Friction, Diffusion Cold Pressure Process and Their Applications Oxygen Cutting Plasma Arc Cutting, Laser Cutting Processes Scope and Application Welding Defect and Remedies Weld Cracking and Prevention Testing and Inspection	**30**	**1**

	of Welds		

Reference Books:

1. Welding Hand Book

ENGINEERING DESIGN (MME2056)

Course Objective:

1. To introduce integrated approach to the design of complex engineering systems.
2. To understand the different design methods and models.
3. To understand the impact and implication of material selection and design for manufacturing and assembly.
4. To understand the various statistical approach to assess and design the quality of product.

Learning Outcome:

At the end of the course student should be able to:

1. To learn the product life cycle stages and human factor involvement.
2. To learn the different computer and design techniques for structural and shape optimization.
3. To learn value analysis and pitfalls in implementing value engineering.
4. To learn the concept of designed quality in product planning and designing.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	The design process: Morphology of Design. Design drawings - Computer Aided Engineering Designing of standards and Concurrent Engineering Technological Forecasting - Market Identification Competition Bench marking Systems Engineering - Life Cycle Engineering Human Factors in Design -Industrial Design.	**30**	**1**
II	Design Method: Creativity and Problem Solving, Product Design Specifications & Conceptual design Decision theory -Embodiment Design - Detail Design Mathematical Modeling – Simulation Geometric Modeling, Finite Element Modeling – Optimization Search Methods - Geometric Programming Structural and Shape Optimization.	**30**	**1**
III	Material Selection Processing and Design Material selection Process - Economics - Cost Vs Performance –Weighted property Index - Value Analysis Role of Processing and Design Classification of Manufacturing Process Design for Manufacture and Design for Assembly Design for castings, Forging, Metal Forming, Machining and Welding Residual	**30**	**1**

	stresses - Fatigue, Fracture and Failure.		
IV	Engineering Statistics and Reliability Probability - Distributions - Test of Hypothesis Design of Experiments and Reliability Theory Design of Reliability - Reliability centered Maintenance. Quality Engineering: Total Quality Concept Quality Assurance and Statistics Process Control, Taguchi Methods - Robust Design Failure Model Effect Analysis.	**30**	**1**

Reference Books:

1. Dieter George E., engineering Design –"A Materials and Processing Approach", McGraw.
2. Hill, International Edition Mechanical Engg., Series ,1991.

THEORY OF MECHANISM (MME2078)

Course Objective:

1. To familiarize students with types of mechanisms, joints and degrees of freedom to perform position, velocity and acceleration analysis using graphical and analytical methods.
2. To provide students an understanding of different types of linkage, four- six bar mechanism and balancing of linkages.
3. To teach the basics of synthesis of simple mechanisms, path generation and CAM mechanisms.
4. To teach students the dynamics of mechanism and dimensional synthesis.

Learning Outcome:

At the end of the course student should be able to:

1. To demonstrate an understanding of the concepts of various mechanisms and pairs.
2. To conduct forward and inverse kinematics of robotic mechanism.
3. To design and develop the path of fixed and moving centroid.
4. To synthesize simple mechanisms for function, path generation and body guidance.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Review of Fundamentals of Kinematics Mobility Analysis Formation of One D.O.F. Multi-Loop Kinematics Chains, Network Formula, Gross Motion Concepts.	**30**	**1**
II	Kinematic Analysis, Position Analysis Vector Loop Equations For Four Bar, Slider Crank, Inverted Slider Crank - Geared Five Bar and Six Bar Linkages. Analytical Method For Velocity and Acceleration Analysis, Four Bar Linkage Jerk Analysis - Plane Complex Mechanism. Path Curvature Theory: Fixed and Moving Centroids', Inflection Points and Inflection Circle. Euler Savary Equation, Graphical Constructions, Cubic of Stationary Curvature.	**30**	**1**
III	Synthesis of Mechanisms: Type Synthesis, Number Synthesis - Associated Linkage Concept. Dimensional Synthesis - Function Generation, Path Generation, Motion Generation. Graphical Methods, Cognate	**30**	**1**

	Linkage -Coupler Curve Synthesis, Design of Six Bar Mechanisms Algebraic Methods. Application of Instant Centre in Linkage Design.CAM Mechanism - Determination of Optimum Size of Cams.		
IV	Dynamic of Mechanisms: Static Force Analysis With Friction, Inertia Force Analysis - Combined Static and Inertia Force Analysis. Shaking Force, Kinetostactic Analysis. Introduction to Force and Moment, Balancing of Linkages. Spatial Mechanism and Robotics, Kinematic Analysis of Spatial RSSR Mechanism - Denavit - Hartenberg Parameters. Forward and Inverse Kinematics of Robotic Manipulators.	**30**	**1**

Reference Books:

1. Sandor G.N. and Erdman A.G., "Advanced Mechanism Design Analysis and Synthesis", Prentice Hall, 1984.
2. Shigley, J.E., and Uicker, J.J., "Theory of Machines and Mechanisms", McGraw Hill, 1995.
3. Amitabha Ghosh and Ashok Kumar Mallik, "Theory of Mechanism and Machines", EWLP, Delhi, 1999.
4. Nortron R.L., "Design of Machinery", McGraw Hill, 1999.

OPTIMIZATION FOR ENGINEERING DESIGN (MME2057)

Course Objective:

1. To provide students the knowledge of optimization techniques and various approaches.
2. To enable the students apply mathematical and computational skills needed for the practical utility of Optimization techniques.
3. To introduce students to research methods and current trends in engineering optimization.
4. Application of optimization techniques in design of various mechanical members.

Learning Outcome:

At the end of the course student should be able to:

1. To apply various techniques in industrial optimization problems.
2. To solve simple optimization problem for commonly used mechanical members.
3. To illustrate the use of OT tools in a wide range of applications in industries.
4. To explain current topics and advanced techniques of optimization for industrial solutions.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Introduction: General Characteristics of Mechanical Elements, Adequate and Optimum Design, Principles of Optimization, Formulation of Objective Function, Design Constraints Classification of Optimization Problem.	30	1
II	Optimization Techniques: Single Variable and Multivariable Optimization, Techniques of Un-Constrained Minimization, Golden Section, Random Pattern and Gradient Search Methods - Interpolation Methods; Optimization With Equality and Inequality Constraints Direct Methods-Indirect Methods Using Penalty Functions.	30	1
III	Lagrange’s Multipliers, Geometric Programming and Stochastic Programming, Multi Objective Optimization, Genetic Algorithms and Simulated Annealing Techniques.	30	1
IV	Engineering Applications: Structural Applications Design of Simple Truss Members. Design Applications-Design of Simple Axial, Transverse Loaded Members For Minimum Cost, Maximum	30	1

	Weight, Design of Shafts and Torsionally Loaded Members Design of Springs, Dynamic Applications-Optimum Design of Single, Two Degree of Freedom Systems, Vibration Absorbers. Application In Mechanisms-Optimum Design of Simple Linkage Mechanisms.		

Reference Books:

1. Johnson Ray, C., "Optimum Design of mechanical elements", Wiley, John& Sons, 1990.
2. Goldberg, D.E.., "Genetic algorithms ion search, Optimization and machine", Barnen, Addison-Wesley, New York, 1989.
3. Kalyanamoy Deb, "Optimization for Engineering Design algorithms and Examples”,Prentice Hall of India Pvt.

THEORY OF VIBRATION (MME2058)

Course Objective:

1. To understand the concepts of harmonics and natural frequency and equivalent system.
2. To understand the free and forced vibrations with transmissibility.
3. To understand the single degree and multi degree of freedom, damped and undamped systems.
4. To understand the concept of numerical analysis and different methods.

Learning Outcome:

At the end of the course student should be able to:

1. To analyze free and forced vibrations of machines, engines and structures.
2. To calculate the torsional vibration of circular shafts.
3. To understand the concept of designing the shafts and critical speed.
4. To understand the utility and application of dampers.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Introduction: Periodic Motion, Harmonic Motion, Superposition of Simple Harmonic Motions, Beats, Fourier Analysis. Single Degree Freedom System, Free Vibration, Natural Frequency, Equivalent Systems, Energy Method For Determining Natural Frequency, Response to Initial Disturbance, Torsional Vibrations, Damped Vibrations, Vibrations of Systems with Viscous Damping, Logarithmic Decrement.	30	1
II	Single Degree Freedom, Forced Vibration, Harmonic Excitation With Viscous Damping, Steady State Vibrations, Forced Vibrations With Rotating and Reciprocating Unbalance, Support Excitation, Vibration Isolation, Transmissibility, and Vibration Measuring Instruments, Displacement, Velocity and Acceleration Measuring Instruments.	30	1
III	Two Degree Freedom Systems, Principal Modes, Double Pendulum, Torsional System With Damping, Coupled System, Undamped Dynamic Vibration Absorbers, Centrifugal Pendulum Absorbers, Dry Friction Damper. Multi Degree Freedom System: Exact Analysis, Undamped Free and Forced Vibrations of Multi-Degree Freedom Systems & Influence Number, Reciprocal Theorem, Vibration of	30	1

	Gear System, Principal Coordinates, Continuous Systems- Longitudinal Vibrations of Bars, Torsional Vibrations of Circular Shafts.		
IV	Multi Degree Freedom System: Numerical Analysis, Rayleigh's, Dunkerely's, Holzer's Ad Stodola Methods, Rayleigh-Ritz Method, Critical Speed of Shafts: Shaft With One Disc With and Without Damping, Multi-Disc Shafts, Secondary Critical Speed.	**30**	**1**

Reference Books:

1. Mechanical Vibrations by P. Srinivasan, TMH.
2. Mechanical Vibrations by G. K. Groover, Jain Brothers, Roorkee.
3. Mechanical Vibrations by W. T. Thomson.
4. Mechanical Vibrations by J.S. Rao and K Gupta, New Age.

ADVANCED MANUFACTURING PROCESSES (MME2061)

Course Objective:

1. To acquire basic knowledge about the behavior and properties of aspect of manufacturing and concepts of CAD modeling.
2. To acquire knowledge about various methods of advance manufacturing welding, cold and hot working and forming.
3. To understand forging, molding and powder metallurgy processes in detail and application of these in manufacture of a product.

Learning Outcome:

At the end of the course student should be able to:

1. To use the principles of foundry and casting.
2. To choose materials in a manufacturing process based on their properties.
3. To conduct experiments on various manufacturing processes.
4. To demonstrate an ability to solve engineering problems in welding and powder metallurgy processes.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	CAD: Co-Ordinate Transformations Three Dimensional Curve and Surface Geometry, Types and Mathematical Representation of Curves and Surfaces, Parametric Description of Analytic and Synthetic Curves, Curve and Surface Design, Composite Curves and Spines, Composite Surfaces, Types and Mathematical Representation of Solids: Half Spaces, Boundary Representation (B-Rep), Constructive Solid Modeling (CSG), Sweep Representation, Solid Modeling Based Application.	**30**	**1**
II	CAM: Stock Boundary Definition and Generation of Machining Paths From CAD Database. Cutter Paths For Numerical Control. CAD- CAM Interface.	**30**	**1**
III	Flexible Manufacturing System: Management Decisions, Distributed Processing In FMS, Interfacing Computer, M/C Tool Controllers and Industrial Robots. Quantitative Analysis of FMS, Social Issues. A Brief Overview of Non-Traditional Machining Processes.	**30**	**1**

IV	Analysis of Mechanical, Thermal and Electrochemical Type Nontraditional Machining Processes. Analysis of Micro-Machining Process. Tool Design For Selected Non-Traditional Machining Process, A Comparative Study of Various Processes. Application of CNC Concepts To Non-Traditional Machining Process Machines. Computer Aided Process Planning of Nontraditional Processes. Precision Machining and High Speed Machining.	**30**	**1**

Reference Books:

1. Automation, Production System, & CIM by Grover, Prentice Hall
2. CAD CAM by C. McMahon and J. Browne: published by Addison-Wesley.
3. Computer Aided Manufacturing by Chang. Wysk, Wang: Prentice Hall.

RESEARCH AND AI IN MFG. SYSTEMS (MME2062)

Course Objective:

1. To learn the concept of artificial intelligence and its application.
2. To learn various knowledge base expert systems.
3. To learn implementation and implication of various expert systems.
4. To learn the process and failure diagnosis of various systems and relevant case studies.

Learning Outcome:

At the end of the course student should be able to:

1. To understand the utility of expert systems.
2. To understand designing, selection and application of various systems.
3. To appreciate the usage of various knowledge base system in manufacturing and production.
4. To understand the real life production scenarios by means of case studies.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Artificial Intelligence: Definition and Scope Application Areas; Knowledge Based System (Expert System)Definition – Justification – Structure - Characterization	**30**	**1**
II	Knowledge Sources, Expert Knowledge Acquisition Knowledge Representation, Knowledge Base, Interference Strategies – Forward and Backward Chaining.	**30**	**1**
III	Expert System Languages, ES Building Tools or Shells, Typical examples of Shells. Expert System software for manufacturing application in CAD, CAPP, MRP Adaptive Control. Robotics, Process control	**30**	**1**
IV	Fault diagnosis, Failure Analysis Process Selection, GT, Linking expert systems to other software such as DBMS. MIS. MDS, Process control and office automation. Case studies of typical application in tool selection. Process Selection, Part classification. Inventory control, Process Planning etc.	**30**	**1**

Reference Books:

1. Artificial Intelligent Hand book. Jhon & Andrew Kusiak
2. Artificial Intelligent. T. Barnold.
3. Introduction to Artificial Manufacturing Expert System. Dan. W. Patter

COMPUTER GRAPHICS AND PRODUCT MODELLING (MME2063)

Course Objective:

1. To learn the basics of computer graphics and hardware software requirement.
2. To learn various modeling techniques.
3. To learn various type of surfaces and curve and their representation.
4. To learn visualization, transformation and mathematical methods.

Learning Outcome:

At the end of the course student should be able to:

1. To understand the need the applicability of computer graphics.
2. To understand the mathematics behind the surface and curve generation.
3. To understand operations and technique required for surface modeling.
4. To understand the visualization and editing of geometric models.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Definition of Computer Graphics. Graphics Hardware, Types of System, Input/ Output Devices. Graphics Standards, Data Structure and Data Base, Modes of Graphics Operation, Modeling and Viewing.	**30**	**1**
II	Geometric Modeling: Types and Mathematical Representation of Curves, Parametric Representation of Analytic and Synthetic Curves, Types and Mathematical Representation of Surfaces, Parametric Representation of Analytic and Synthetic Surface	**30**	**1**
III	Plane, Surface, Ruled Surface, Surface of Revolution, Hermite Bi-Cubic Surface, Beizer Surface, B-Spline Surface, Sculptured Surface, Surface Manipulation, Displaying Evaluating Points and Curves, Segmentation, Trimming, Integration, Projection and Transformations Engineering Application.	**30**	**1**
IV	Types and Mathematical Representation of Solids-Half Spaces, Boundary Representation (B-Rep), Constructive Solid Modelling (CSG), Sweep Representation, Solid Modeling Based Application. Two and Three Dimensional Graphics Transformations of Geometric Models – Translation, Calling, Reflection, Rotation, Homogeneous, Representation and Mappings; Projection of Geometric Models – Orthographic and Perspective	**30**	**1**

	Projection, Engineering Applications. Visualization, Hidden Line and Hidden Surface and Solid Removal, Visibility of Objects, Shading and Color Models, Editing.		

Reference Books:

1. Schaum's Outline of Theory and Problems of Computer Graphics by Roy A. Plastoc & Gordon Kelley, McGrawhill.
2. Hill Computer Graphics using open GL Pearson Education.
3. Foley, Computer Graphics, Person Education.

SYSTEM SIMULATION (MME2064)

Course Objective:

1. To learn the need and use of different simulation method.
2. To learn different simulation models and concepts.
3. To learn simulation of mechanical and hydraulic systems.
4. To expose to the different simulation packages and case studies.

Learning Outcome:

At the end of the course student should be able to:

1. To understand the application and utility of simulations.
2. To understand design and application of different simulation models.
3. To understand the simulation scenarios and their correlation.
4. To understand the real world problems with case studies.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	System Simulation Monte Carlo method, Experimental nature of simulation, Numerical computation techniques, Continuous system models, Analog mand Hybrid simulation, Feedback systems.	**30**	**1**
II	System Dynamics: Growth and Decay models, Logistic curves, System dynamics diagrams, Probability Concepts in Simulation: Stochastic variables discrete and continuous probability functions, Random numbers, Generation of Random numbers, Variance reduction techniques, Determination of length of simulation runs.	**30**	**1**
III	Simulation of Mechanical System: Building of Simulation models Simulation of translational and rotational mechanical systems, Simulation of Hydraulic systems. Computers in simulation studies, Simulation software packages	**30**	**1**
IV	Simulation of Manufacturing Systems Simulation of waiting line systems, Job shop with material handling Flexible manufacturing systems. Simulation software for manufacturing, Case studies.	**30**	**1**

Reference Books:

1. Schaum's Outline of Theory and Problems of Computer Graphics by Roy A. Plastoc& Gordon Kelley,
2. System Simulation Geoffrey Gordon Prentice Hall.
3. System simulation: The Art and Science Robert E. Shannon Prentice Hall.
4. System Modeling and Control J. Schwarzenbach and K.F. Gill Edward Arnold.
5. Modeling and Analysis of Dynamic System Charles M Close and Dean K. Frederickoughton Mifflin
6. Simulation of manufacturing Allan Carrie John Wiley & Sons.

NUMERICALS METHODS FOR MANUFACTURING PROCESSES (MME2065)

Course Objective:

1. To learn different simulation and numerical methods used for manufacturing processes.
2. To learn the different issues faced in manufacturing settings and their implications.
3. To learn digital implementation in product life cycle.
4. To learn automated and integrated manufacturing concepts and methods.

Learning Outcome:

At the end of the course student should be able to:

1. To understand different simulation and numerical technique to optimize manufacturing processes.
2. To understand the challenges and numerical solutions to mitigate such challenges.
3. To understand processes and issues in computer integration of manufacturing facility.
4. To understand the communication and information system in manufacturing environment.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	System Simulation Techniques of Simulation, Monte Carlo Method, Basic Concept of Manufacturing, Manufacturing Problems, System Approach To Manufacturing Problems, Principle of Modeling In Mathematical and Physical Form, Types of Models.	**30**	**1**
II	Simulation In Modeling. Sources of System Error, Stability of Linear and Non- Linear System, Adaptive Control, System Optimization Techniques	**30**	**1**
III	Product Design and Part Configuration Project Scheduling By PERT, GERT, Flow Graph, Productive Maintenance, Automation of Production, Computer Aided Design, Computerized Layout Planning, Automated Process Planning, Automated Operation Planning.	**30**	**1**
IV	Automatic and Computer Integrated Manufacturing, Automated Assembly and Testing Information Systems For Manufacturing. Fundamentals of Information Systems, Production Information and	**30**	**1**

	Management Systems.		

Reference Books:

1. Manufacturing Process & system Ostwald Wiley India Pvt. Ltd.
2. Materials & Process in Manufacturing E. Paul Degarmo, JT Black RA Kosher Prentice Hall of India.
3. Manufacturing Systems Design and Analysis Wu B Kluwer Aca
4. Queuing Theory in Manufacturing Systems Analysis and Design Papadopulos H T Chapman.
5. Performance Analysis of manufacturing Systems AltiokTayfor Springer-V.

PRODUCT DEVLOPMENT (MME2066)

Course Objective:

1. To acquire skills to design and develop products in a structured way.
2. To get aware with general design principles for manufacturability.
3. To understand the product economics in product design.
4. To learn the broad processes involved from ideation to prototyping of a product.

Learning Outcome:

At the end of the course student should be able to:

1. To understand product development process and review design of existing product considering reliability.
2. To be able to design a product according to requirement of market.
3. To be able to appreciate the value of aesthetics into the product design.
4. To use value engineering for product development.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Challenges of Product Development; Successfully Product Development; Quality Aspect of Product Design; Market Research; Survey Identify Customer Needs Product Planning Processes.	**30**	**1**
II	Product Architecture Implication of Architecture Establishing The Architecture, Related System Level Design Issue.	**30**	**1**
III	Industrial Design Overview Design For Manufacturing and Assembly, Tolerancing, Design of Gauges: Design For Environment Robust Design, Prototyping Engineering Materials.	**30**	**1**
IV	Concurrent Engineering Product Costing, Value Engineering Aesthetic Concepts: Visual Effect of Form and ColourProduct Data Management. Innovation and Creativity In Product Design, Case Studies.	**30**	**1**

Reference Books:

1. Product Design and Development by Karl T. Ulrich and Steven G. Eppinger ; Irwin MeGrawHill.
2. Product Design and Manufacturing, A C Chitale and R C Gupta ;PHI.
3. New Product Development :Tim Jones, Jim Butterworth,Heinman,Oxford,1997.
4. Product Design for Manufacture and Assembly ;GeoffreyBoothroyd, Peter Dewhurst and Winston knight.
5. Product Design:Ouo and Wood; Pearson education.
6. Industrial Design for Engineers: Mayall W.H. Landon ,Hiffee books Ltd,1998.
7. Applied Ergonomics, Hand Book: Brien Shakel(Edited)Butterworth Scientitic, Landon 1998.
8. Introduction of ergonomics-R.C Bridger, MeGrawHill Pub.
9. Human Factor Engineering –Sanders &MeCormick, MeGrawHill Publication.

ADVANCE COMPOSITE MATERIAL (MME2075)

Course Objective:

1. To learn the need and use of composites.
2. To learn different types of composites and types of reinforcements.
3. To learn ceramic matrix composites and constituents interactions.
4. To learn mechanics, properties and failure of composites.

Learning Outcome:

At the end of the course student should be able to:

1. To understand the usefulness and applicability of different composites.
2. To understand the structure and composition of composites used in various domains.
3. To understand the impact and implication of orientation in composite strength
4. To appreciate the cause and effect of composite fracture.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Composites: Definition and Classification, Matrices and Their Properties. Importance of Glass, Ceramic and Carbon Fibres, Polyster, Epoxies, Thermosetting and Thermoplastic Materials. Fabrication, Structure. Properties and Application: Common Ceramic Matrix Composite Material and Their Properties,Interfaces In Composites, Interaction At The Interface.	30	1
II	Types of Reinforcement Continuous Fiber, Short Fiber, Whisker, Glass Fiber, Carbon/Graphite Fiber, Natural Fiber, Boron Carbide Silicon Carbide Fiber.Quality and Testing; Material Testing, Mechanical Testing, Thermal and Environmental Testing, Flamibility Testing, Non-Destructive Testing.	30	1
III	Ceramic Matrix Composites: Fabrication, Properties, and Uses, Interface Reaction, Toughness; Specific Examples - Alumina Silicon Carbide, Mullitezirconia, Polymer-PZT Composites, Processing and Application.	30	1
IV	Mechanics of Properties of Composites: Density, Mechanical Properties, Mechanism of Load Transfer From Matrix To Fiber, Variation of Lamina Properties With Orientation, Tensile and Compressive Strength of Unidirectional Fiber Composite, Fracture In Composites, Debonding, Fiber Pull Out,	30	1

	Delamination Fracture.		

Reference Books:

1. S.Timoshenko and W.Krieger.Theory of plate and shells. MC Graw Hill.
2. Ansel C. Ugual. Stresses in plates and shells, MC Graw Hill.
3. G. S. Ramaswami, Design and Construction of Concrete Shells and Roofs, CDS Publication.
4. Chandrashekhara K. Analysis of Concrete Shells, New Age International Edition.
5. Chandrashekhara K., Analysis of Plates, New Age International Edition.

THEORY OF PLATES AND VESSELS (MME2076)

Course Objective:

1. To acquire skills to design plate parts and vessels.
2. To get aware with general design principles and mathematical relationship between load and deformation.
3. To learn the stress behavior encountered in vessel design.
4. To learn the issues involved in support modeling of pipes and pressure vessels.

Learning Outcome:

At the end of the course student should be able to:

1. To appreciate the challenges involved in plate and vessel design.
2. To understand the various concepts and theories for design of pressure vessel.
3. To be able to appreciate the value of support structure and design implications.
4. To understand the cause and remedy of failure due to variety of loads.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Introduction: Thin and Thick Plates, Small and Large Deflection Theory of Thin Plates: Moment Curvature Relations. Stress Resultants. Governing Differential Equation In Cartesian Co-Ordinates, Various Boundary Conditions.	30	1
II	Analysis of Rectangular Plates: Navier Solution For Plates With All Edges Simply Supported. Distributed Loads. Point Loads and Rectangular Patch Load. Levey`S Method: Distributed Load and Line Load. Plates Under Distributed Edge Moments. Raleigh-Ritz Approach For Simple Case In Rectangular Plates. Introduction To Shear Deformation Theories.	30	1
III	Circular Plates: Analysis of Circular Plates Under Axi-Symmetric Loading. Moment Curvature Relations. Governing Differential Equation In Polar Co-Ordinates. Simply Support and Fixed Edges. Distributed Load, Ring Load, A Plate With A Central Hole.	30	1
IV	Circular Cylindrical Shells: Membrane Theory: Equilibrium Equation, Strain Displacement Relations, Boundary Conditions.Bending Theory: Equilibrium Equation, Strain Displacement, Relation, Governing	30	1

	Differential Equation,Solution For A Simply Supported Cylindrical Shell, Various Boundary Conditions. Application To Pipes and Pressure Vessels.		

Reference Books:

1. S. Timoshenko and W.Krieger, Theory of Plates and shells, McGraw Hill.
2. Ansel C. Ugaral, Stresses in plates and shells ,McGraw Hill.
3. G. S. Ramaswamy, Design and Construction of Concrete shell Roofs, CBS Publications.
4. Chandrashekhara K. Analysis of Concrete shells. New age International Edition.
5. Chandrashekhara K. Analysis of Plates. New Age International.

ROBOTICS AND AUTOMATION (MME2067)

Course Objective:

1. To learn the fundamentals of Automated Manufacturing and CNC.
2. To design and develop automation strategies
3. To get acquainted with constructional features and other basic information on robotics.
4. To know about the sensors used in robotics.

Learning Outcome:

At the end of the course student should be able to:

1. To know the basics of robotics and automation.
2. To do robot programming and learning of manipulators and kinematics.
3. To be able to understand the use of industrial robots and prospects of automation.
4. To optimize the production capacity by means of manufacturing automation.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Introduction of Robot Technology: Robot Physical Configuration, Basic Robot Motions, Types of Manipulators Constructional Features.	30	1
II	Actuators and Transmission System Pneumatic, Hydraulic and Electrical Actuators and Their Characteristics and Control System, Advantages and Disadvantages of Various Kinematic Structures, Servo and Non Servo Manipulators.	30	1
III	Artificial Intelligence: Logging Locomotion,Expert System, Concept of Spatial Description and Transformation,Manipulator Kinematics: Inverse Manipulator, Kinematics Jacobeans: Velocities and Static Forces: Manipulator Dynamics, Position Control of Manipulators, Force Control of Manipulators, Robot Programming Languages and Systems. Concept of Automation In Industry, Mechanization and Automation, Automatic Classification of Automation System.	30	1
IV	Basics of Automated Work Piece Handling: Working Principles and Techniques, Job Orienting and Feeding Devices. Transfer Mechanism Automated Feed Out The Components, Performance Analysis. Assembly, Automation, Automatic Packaging and Automatic	30	1

	Inspection.		

Reference Books:

1. CAD/CAM by Groover and Elimmers (Jr.)
2. CAD/CAM HandBook, Bed ford Massachusetts.
3. Automation Production Systems and Computer Aided Manufacturing.
4. Robotics and Engineers by Royan MIT Press.
5. Robot Manipulators by Paul MIT Press.
6. Robotics by Hall & Hall.
7. Robot Motion by Brady MIT Press.
8. Numerical Controlled Computer Aided manufacturing by Press man and elements. John Wiley& Sons. New York.

COMPUTER INTEGRATED MANUFACTURING (MME2068)

Course Objective:

1. To provide overall view of modern computer aided manufacturing.
2. To study group technology manufacturing principles and its benefits.
3. To know about value of planning in manufacturing and its impact.
4. To learn the differentiation between conventional and modern production planning and control.

Learning Outcome:

At the end of the course student should be able to:

1. Identify value of planning in all phases of product life cycle.
2. Use of process mapping and Group Technology in the industry.
3. Enhance the productivity through applications of modern management techniques.
4. Understand the implementation of computer aided techniques.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Analysis of Manufacturing Systems Classification of Manufacturing System, Analysis of Manufacturing Operation, Linking Manufacturing Strategy and System. Material Handling System. Computer Control System.	**30**	**1**
II	Technology For CIM System Trend In Information Technology, Telecommunication, Software, Information System Department, International Standards and OSI, Local Area Networks (Lans), Software Integration, Decision Support System.	**30**	**1**
III	Group Technology Concept of Group Technology and Its Application,Classification and Coding Techniques, Benefits of Group Technology.	**30**	**1**
IV	Production Planning and Management In CIM System System Evolution, Material Control Within CIM, Traditional Production Planning and Control, CIM Based Production Management System, Cost Planning and Control. Master Production Schedule (MPS). Material Requirement Planning (MRP). Capacity Requirement Panning (CRP). Manufacturing Resource Planning (MRPII).	**30**	**1**

Reference Books:

1. Mikell P. Groover “Automation. Production Systems and computer integrated manufacturing”. Pearson Education 2001
2. YoremKoren “Computer Integrated Manufacturing System” McGraw-Hill, 1983.
3. Ranky. Paul G. “Computer Integrated Manufacturing” prentice Hall International. 1986.
4. Roger Hanman “Computer Integrated Manufacturing”, Addision – Wesley, 1997.
5. Mikell. P. Groover and Emory Zimmers Jr. “CAD/CAM”, Prentice Hall of India Pvt. Ltd.
6. Kant Vajpayee S, “Principles of Computer Integrated Manufacturing”, Prentice Hall of India.
7. Radhakrishnan P. Subramanyam S. and Raju V., “CAD/CAM/CIM”, 2nd Edition New Age International Ltd. New Delhi.

MECHATRONICS (MME2071)

Course Objective:

1. To learn about the amalgamation about mechanical and electronics subsystem for larger performance perspective.

2. To learn about the concept of measurement and different methods of measurement.

3. To learn principle and application of different type of sensors

4. To learn about various method of data acquisition and filtering.

Learning Outcome:

At the end of the course student should be able to:

1. To understand the working of mechanical and electronics systems in tandem.

2. To understand the measurement processes and variety of errors occurring during measurement.

3. To understand the various sensors and their applicability in day today life.

4. To understand digital data acquisition and conversion.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	General Concept of Measurement Basic Block Diagram Stages of Generalised Measurement System State Characteristics; Accuracy Precision Resolution Reproductability Sensitivity Zero Drift Linearity, Dynamic Characteristics Zero Order Instrument First Order Instrument Time Delay	**30**	**1**
II	Sensors and Principles: Resistive Sensors Potentiometer and Strain Gauges Inductive Sensors Self Inductance Type, Mutual Inductance Type, LVDT Capacitive Sensors- Piezoelectric Sensors Thermocouples Thermistors Radiation Pyrometry – Fibre Optic Temperature Sensor Photo Electric Sensors Pressure and Flow Sensors.	**30**	**1**
III	Signal Conditioning Amplification Filtering Level Conversion Linearisation Buffering Sample and Hold Circuit Quantisation Multiplexer/ Demultiplexer Analog To Digital Converters Digital To Analog Converters.	**30**	**1**
IV	Data Acquisition and Conversion General Configuration Single Channel and Multichannel Data Acquisition System Digital Filtering Data Logging Data Conversion Introduction To Digital Transmission Systems PC Based Data Acquisition System.	**30**	**1**

Reference Books:

1. RANGAM C.S., SARMA, G.R. MANI, V.S.V.,"Instrumentation -devices and Systems", Tata Mcgraw Hill publishing Company Ltd., 1997.
2. SAWHNEY, A.K.," A Course in Electrical and Electronic Measurements and istrumentation," DhanpatRai& Sons, 1995.
3. DOEBLIN, E.O. Measurement Systems, McGraw Hill, 1995.

TRIBOLOGY (MME2072)

Course Objective:

1. To learn about the scope and application of tribology.
2. To learn about different type of friction and governing laws.
3. To learn about the surface quality and various pattern of wear.
4. To lean about lubrication and governing principles and mathematical equations.

Learning Outcome:

At the end of the course student should be able to:

1. To understand the importance of contact surface design.
2. To appreciate the friction and design for friction methods
3. To understand the surface quality and impact on performance.
4. To understand the lubrication mechanism.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Introduction: Definition and Scope of Tribology, Contact of Solids, Surface Topology, Surface Interaction.	**30**	**1**
II	Friction: Definitions, Types, Friction Laws, Modern Theory of Dry Solid Friction, Mechanism of Rolling Friction, Friction of Elastomers.	**30**	**1**
III	Surface Roughness: Standardization, Measurement, Statistical Analysis of Surface. Wear: Definition, Classification, Theories of Adhesives, Abrasives Surface Fatigue and Corrosive Wear Miscellaneous Wear Theory Such As Erosive, Cavitations and Fretting Wear.	**30**	**1**
IV	Lubrication: Lubrication of Bearing, Lubricant, Mineral Oil, Grease, Solid Lubricant, Lubrication Regime, Viscous Flow, Reynolds Equation and Its Limitations, Hydrodynamic Lubrication, Hydrostatic Lubrication, Elasto-Hydrodynamic Lubrication, Boundary Lubrication, Squeeze Films.	**30**	**1**

Reference Books:

1. Engineering Tribology, P Sahoo Prentice Hall of India
2. Principles and Applications of Tribology D.F. Moore Pergamon Press
3. Fundamentals of Tribology Basu, Sengupta&Ahuja Prentice Hall of India

DESIGN OF PRESSURE VESSELS (MME2073)

Course Objective:

1. To acquire skills to design and develop pressure vessels in a structured way.
2. To get aware with general design principles for manufacturability of industrial vessels.
3. To learn the stress behavior encountered in vessel design.
4. To learn the broad processes and issues involved in support modeling.

Learning Outcome:

At the end of the course student should be able to:

1. To understand pressure vessel design and manufacturing process.
2. To understand the various types of stresses commonly experienced by a pressure vessel.
3. To be able to appreciate the value of support structure and design implications.
4. To understand the cause and remedy of failure of pressure vessel.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Membrane theory of thin shells stresses in cylindrical, spherical shells, General theory of membrane stresses in vessel under internal pressure and its application to ellipsoidal, Toripherical end closures, Bending of circular plates and determination of stresses in simple supported and clamped circular plate Introduction to ASME code and formulae.	30	1
II	Junction stresses, opening and reinforcements Discontinuity stresses, Stress concentration in plate having circular hole due to bi-axial lording Theory of reinforced opening and reinforcement limits.	30	1
III	Supports for vertical & horizontal vessels Design of base plate and support lugs Types of anchor bolt, its material and allowable stresses. Design of saddle supports.	30	1
IV	Buckling of vessels under external pressure. Elastic buckling of long cylinders, Buckling modes Collapse under external pressure Design fort stiffening rings Buckling under combined external combined external pressure and axial loading.	30	1

Reference Books:

1. Harvey J F, ’Pressure vessel design’ CBS publication.
2. Brownell. L.E & Young E.D, ‘ Process equipment design’ , Wiley Eastern Ltd., India.

NON LINEAR VIBRATION (MME2074)

Course Objective:

1. To understand the concepts of vibration and control.
2. To understand the rotating machines and vibrations.
3. To understand the non-linear vibration systems and nonlinear elastic properties.
4. To understand the concept of noise, measurement control and absorbers.

Learning Outcome:

At the end of the course student should be able to:

1. To analyze free and forced vibrations of machines, engines and structures.
2. To understand vibration isolation and vibration absorbers.
3. To understand the concept of allowable exposure.
4. To understand the utility and application of dampers.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Transient vibrations Response of a single degree of freedom system to step Any arbitrary excitation, convolution (Duhamel's) integral, Impulse response functions.	**30**	**1**
II	Vibration Control Balancing of rotating machine In-situ balancing of rotors Control of natural frequency of damping Vibration isolation & vibration absorbers.	**30**	**1**
III	Vibration Measurement FFT analyzer, signal analysis Time domain & frequency domain analysis of signals. Experimental modal analysis, Machine Conditioning and monitoring fault diagnosis Non Linear Vibration Systems with non-linear elastic properties, free vibrations of system with non-linear elasticity and damping, phase –plane technique, Duffing's equation, jump phenomenon, Limit cycle, perturbation method.	**30**	**1**
IV	Noise and its Measurement Sound waves, governing equation its propagation Fundamentals of noise Decibel, Sound Pressure Level, Sound Intensity, Sound fields, reflection, absorption and transmission, Noise measurement, Sound meter, Allowed exposure levels and time by B>I>S. Octave Band analysis of sound, Fundamental of Noise control source control, path control enclosures, noise absorbers, noise control	**30**	**1**

	at receiver.		

Reference Books:

1. Engineering Vibrations, P Sahoo Prentice Hall of India

2. Principles and Applications of Vibrations D.F. Moore Pergamon Press