SHIVAJI UNIVERSITY, KOLHAPUR.

Accredited By NAAC with 'A++' Grade

Revised Syllabus
for
Ph. D. Course Work
in
Mechanical Engineering

To be implemented from
June, 2023 onwards

STRUCTURE FOR Ph.D. COURSE WORK (MECHANICAL ENGINEERING)
June 2023

Sr. No.	Name of Course	Teaching Scheme		Examination Scheme			Credits
		Theory	Tutorial	Theory	Tutorial	Total	
01	Research Methodology	5Hrs/Week		100		100	05
02	Seminar*		4 Hrs/Week		50	50	04
03	Advances in Mechanical Engineering (Paper II)	4Hrs/Week		100		100	04
04	Advances in Mechanical Engineering (Paper III)	3hrs/Week	1 Hrs/Week	80	20	100	04
	Total	10Hrs/Week	5Hrs/Week	280	70	350	17

Seminar*:- A seminar should be present by the Candidate to the Respective Research Centre after Completion of Course Work Papers. Research Centre should appoint a Committee with research guide for Presentation. A marks of Seminar should send to university after Completion of presentation with sign of Experts.

The continuous assessment of seminar shall be based on the following heads;
a. Performance of the student in collection of the reference material and its understanding for seminar -40 Marks
b. Punctuality, Enthusiasm and aptitude of student in Preparing seminar / completing the report-10 Marks

Paper I:Research Methodology

Teaching Scheme:	**Examination Scheme:**
Lectures: 5 hrs./week	Theory Examination: 100 Marks

Unit–I Introduction to Research Methodology

Research Methodology: An Introduction Objectives of Research, Types of Research, Research Methods and Methodology, Defining a Research Problem, Techniques involved in Defining a Problem Research Design Need for Research Design, Features of Good Design, Different Research Designs, Basic Principles of Experimental Designs, Sampling Design, Steps in Sampling Design, Types of Sampling Design, Sampling Fundamentals, Estimation, Sample size Determination, Random sampling [15 Hrs]

Unit–II Research Tools

Measurement and Scaling Techniques Measurement in Research, Measurement Scales, Sources in Error, Techniques of Developing Measurement Tools, Scaling, Meaning of Scale, Scale Construction Techniques [15 Hrs]

Unit–III Hypothesis and Research Methodology

Methods of Data Collection and Analysis Collection of Primary and Secondary Data, Selection of appropriate method Data Processing Operations, Elements of Analysis, Statistics in Research, Measures of Dispersion, Measures of Skewness, Regression Analysis, Correlation Techniques of Hypotheses, Parametric or Standard Tests Basic concepts, Tests for Hypotheses I and II, Important parameters limitations of the tests of Hypotheses, Chi-square Test, Comparing Variance, As a non-parametric Test, Conversion of Chito Phi, Cautioninusing Chi-square test

[15 Hrs]

Unit–IV Research Output Techniques

Analysis of Variance and Co-variance ANOVA, One way ANOVA, Two Way ANOVA, ANOCOVA Assumptions in ANOCOVA, Multivariate Analysis Technique Classification of Multivariate Analysis**,** factor Analysis, R-type Q Type factor Analysis, Path Analysis [15 Hrs]

Reference Books:

1. "Research Methodology", C.R. Kothari, Wiley Eastern.
2. "Formulation of Hypothesis", Willkinson K.P,L Bhandarkar, Hymalaya Publication, Bombay.
3. "Research in Education", John W Best and V.Kahn, PHI Publication.
4. "Research Methodology-A step by step guide for beginners", Ranjit Kumar, Pearson Education
5. "Management Research Methodology-Integration of principles, methods and Techniques", K.N. Krishna swami and others, Pearson Education

List of Ph.D. (Mechanical Engineering) Paper II

(Select any one subject out of the following)

1. Advances in Mechanical Engineering (CAD/ CAM/CAE- I)
2. Advances in Mechanical Engineering (CAD/CAM/CAE-II)
3. Advances in Mechanical Engineering (Design-I)
4. Advances in Mechanical Engineering (Design-II)
5. Advances in Mechanical Engineering (Design-III)
6. Advances in Mechanical Engineering (Design-IV)
7. Advances in Mechanical Engineering (Heat Power-I)
8. Advances in Mechanical Engineering (Heat Power-II)
9. Advances in Mechanical Engineering (Heat Power-III)
10. Advances in Mechanical Engineering (Heat Power-IV)
11. Advances in Mechanical Engineering (Production-I)
12. Advances in Mechanical Engineering (Production-II)
13. Advances in Mechanical Engineering (Production-III)
14. Advances in Mechanical Engineering (Production-IV)

Ph.D. (Mechanical Engineering) Paper –II

1. ADVANCES IN MECHANICAL ENGINEERING (CAD/CAM/CAE-I)

Teaching Scheme:	**Examination Scheme:**
Lectures: 4 hrs./week	Theory Examination: 100 Marks

Unit I. Manufacturing Systems

Manufacturing Systems: Different aspects, integrated manufacturing systems, Mass Customization, Multi-Product Small Batch Production- Economies of Scope with Diversification; Logistic Systems- Material flow: conversion / transportation / storage, Manufacturing Optimization: Criteria for Evaluation, Optimization of single stage manufacturing- Unit production time and cost; Optimization of multistage manufacturing system, Shop Floor Data Collection Systems, Lean Production, Agile Manufacturing

[12 Hrs]

Unit II. Computer Aided Manufacturing

Part programming on Lathe and machining centers using G & M codes, Different types of tools and tool holders used on CNC Machines, parameters for selection of configuration of cutting tools, Modular tools and fixtures, use of pallets for work holding, palletizing of fixtures, Advanced CNC processes - EDM, Wire cut EDM, Abrasive water jet, LASER cutting, Optimization of tool path [10 Hrs]

Unit III. Advanced Materials & Processing

Composition of materials, properties and applications of: Inter-metallics, Ni and Ti aluminides, smart materials, shape memory alloys, Metallic glass- quassi crystals, Dielectrics, semiconductors, conductors & super conducting materials, Polymer materials, formation of polymer structures, production techniques of fibers, foams, adhesives and coatings. Composites: Fiberglass, boron, carbon, organic, ceramic and metallic fibers, ultrasonic machining, laser beam machining and electrochemical machining, abrasive floor machining, magnetic abrasive finishing, wire EDM, electrochemical grinding, physical vapor deposition, chemical vapour deposition, electro less coating and thermal metal spraying [12 Hrs]

Unit IV. Precision Engineering

Need for high precision, Classes of achievable machining accuracy – normal, precision, high precision and ultra-precision machining; Concept of accuracy – part accuracy, Precision Machining Processes: Classification of material removal processes in terms of the energy source used and the tool-work piece reaction, Diamond turning and milling – machines, tool design and alignment, Fixed abrasive processes - Basic mechanics of grinding, bondless diamond grinding wheels, jig grinding, electrolytic in-process dressing, Ultra-precision grinding, nano-grinding; Loose abrasive

processes – polishing, modes of material removal, Chemical mechanical planarization.

[14 Hrs]

Reference Books:

1. Pham Dand DimovS, "Rapid manufacturing-The technologies and applications of rapid prototyping and rapid tooling.Springer-Verlag,London,2001.
2. Katsudo Hitomi,(1998),"Manufacturing Systems Engineering", Viva Low Priced Student Edition, ISBN81-85617-88-0
3. Radhakrishan P., Subramaniyan S. and Raju V., "CAD / CAM / CIM", (3/E), New Age International Publication
4. Katsudo Hitomi, (1998), "Manufacturing Systems Engineering", Viva Low Priced Student Edition, ISBN 81-85617-88-0
5. Murty, R. L. (2009), - Precision Engineering in Manufacturing, (New Age International Publishers) ISBN: 81-224-0750-1
6. Venkatesh, V.C. & Izman, S. (2007), - Precision Engineering, (TMH), ISBN: 0-07-062090-3
7. Dornfeld, David & Lee, Dae-Eun, (2008), - Precision Manufacturing, (Springer Science + Business Media, LLC), ISBN: 978-0-387-32467-8

2. ADVANCES IN MECHANICAL ENGINEERING (CAD/CAM/CAE-II)

Teaching Scheme:	**Examination Scheme:**
Lectures: 4 hrs./week	Theory Examination: 100 Marks

Unit I. Modern manufacturing systems

Concept of F.M. Cell and F. M. System, Functions of a manufacturing cell, Types and components of FMS, Tests of flexibility, Group Technology and FMS, Architecture of typical FMS, Shop Floor Control system, dynamic scheduling in FMS, Flexible Assembly Systems: Basic concepts, classification, planning and scheduling in FAS, Reconfigurable Manufacturing Systems: Definition, goals, elements, rationale, characteristics, principles, RMS and FMS [12 Hrs]

Unit II. Low Cost Automation

Automated manufacturing systems, reasons to justify automation, automation principles and strategies, Developing an Electro-pneumatic control system- project design, selection and configuration of components and implementation Programmable Logic Controllers: Brief review of structure, operation and functions, input/output of PLC, shift registers, data movement and comparison, Multiple actuator circuits with PLC control- sequence, latching, timers, counters; Interfacing with sensors and actuators for analog input/outputs, Supervisory Control And Data Acquisition (SCADA): Concept of SCADA, its industrial significance and applications. [12 Hrs]

Unit III. Technology Management

Holistic Model of Management of Technology (MOT), Technology-strategy relationship, Elements of technology strategy and formulation of a technology strategy, Integration oftechnology strategy and business strategy for competitive success technology, Technology Transfer: Model of TT, System of TT with Public and Private Enterprises, Intellectual Property Rights: Patentable and non-patentable inventions, statutory exceptions, Persons entitled to apply for patents [12 Hrs]

Unit IV. Database Management

Data models, data base languages, data base administrator, design issues, mapping constraints, keys, entity relationship diagram, Structured query language: basic structure, set operations, aggregate functions, null values, nested sub-queries, views, modification of data base, File structures: file organization, organization of records in files, data dictionary storage, sequential files, data definition language, indexing: query optimization,

transactions, transaction recovery, Conceptual DBMS, types of data structures and their applications in FMS, Integrated DBMS in FMS and its implementation [12 Hrs]

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Reference Books:

1. Groover, Mikell P., 3/e, "Automation, Production Systems & Computer Integrated Manufacturing", Pearson Education or PHI
2. Viswanadhan, N. & Narahari, Y., "Performance Modelling of Automated Manufacturing Systems" 2/e, PHI
3. Automation, Production Systems & C.I.M. – Groover, Michell P. 3/e, Pearson Education
4. Hand Book of Technology Management, by Gerard H. Gaynor, McGraw Hill.
5. Data Base System Concepts - Abraham Silberschatz, Henry F. Korth, S. Sudarshan,
6. An Introduction to Data Base Systems - C. J. Date, 7/e (2003) (PearsonEducation)
7. Principles of Data Base Systems –Jeffery D. Ullman, 2/e (2000) Galgotia Publications.
8. Principles of Data Base Management – James Martin (10th Reprint, 1998) (EEE)(PHI).
9. Willer, "Non- traditional Machining Processes", SME publications.

3. ADVANCES IN MECHANICAL ENGINEERING (DESIGN-I)

Teaching Scheme:	**Examination Scheme:**
Lectures: 4 hrs./week	Theory Examination: 100 Marks

Unit I. Bending, Buckling and Torsion

1. **Bending**

   Bending of plate to cylindrical surface, bending of a long uniformly load edrect angular plate, pure bending in two perpendicular directions, bending of circular plates loaded symmetrically w.r.t. center, bending of circular platesof variable thickness, circular plate with circular hole at center symmetrically loaded and load distributed along inner and outer edges,

2. **Buckling**

   Behaviour of rectangular plate under compression, governing equation for plate buckling, buckling analysis of sheets and stiffed panels under compression, concept of the effective sheet width, buckling due to shear and combined loading, crippling

3. **Torsion**

   Modes of Failure, Torsion of a prismatic bar of circular cross section, Design of transmission shafts, Saint Venant's semi inverse method, Linear elastic solutions, soap film analogy, Torsion of a rectangular cross section members, thin wall torsion members with restrained ends.

[14 Hrs]

Unit II. Advanced Theory of Elasticity (3-dimensional problems) and fracture Mechanics

1. **Advanced Theory of Elasticity (3-dimensional problems)**

   Transformation of stress and strain, Linear stress-strain temperature relations, Applications of energy methods.

2. **Fracture Mechanics**

3. Linear Elastic Fracture Mechanics, Elastic Plastic Fracture Mechanics, Fracture Mechanisms in Metals [12 Hrs]

Unit III. Tribology Friction and Wear

Theory of friction- sliding and rolling friction, Friction properties of metallic and non metallic materials, friction in extreme conditions, Wear, types of wear, mechanisms of wear, wear resistant materials, Lubrication: Hydrodynamic lubrication, Reynolds equation, Thermal, inertia and turbulent effects, Elasto, Plasto and magneto hydrodynamic lubrication,

Hydrostatic, Gas lubrication, Surface Engineering:Diffusion Coatings, Electro and Electroless platings, Hot dip coating, Metal Spraying,Cladded coatings, Crystallizing coatings [12 Hrs]

Unit IV. Mechanical Engineering Design

Introduction to design, the engineering model, computer aided design and Engineering, materials, load analysis, stresses, strains, deflection and stability, stress element representation for different types of loads. Locating critical sections, force flow concept, methodology for solving machine component problems [10 Hrs]

Reference Books:

1. ShieglyJ.E.,Machinedesign
2. T L Anderson, Fracture Mechanics- Fundamentals and Applications, CRC Publishers, 2nd edition, 1995
3. Ashok Saxena, Nonlinear Fracture Mechanics for Engineers, CRC Publications
4. Boresi A.D., Schmidt R.J, and Sidebottom O.M, "Advanced Mechanics of Materials", Wiley
5. Williams J.A. "Engineering Tribology" Oxford University press, 1994.
6. Hulling J. " Principles of Tribology" McMillan, 1984
7. Richard Budynas, "Advanced strength of applied stress analysis", McGraw Hill
8. Cook R.D., Young W.C., "Advanced Mechanics of Materials", Prentice Hall
9. Timoshenko and Goodier, "Theory of Elasticity", McGraw-Hill Publications
10. Srinath L.S, "Advanced Mechanics of Solids", Tata Mc-Graw Hill, New Delhi, 2003

4. ADVANCES IN MECHANICAL ENGINEERING (DESIGN-II)

Teaching Scheme:	**Examination Scheme:**
Lectures: 4 hrs./week	Theory Examination: 100 Marks

Unit I. Finite Element Method

Introduction to Finite Element Method, Engineering Analysis, History, Advantages, Classification, Basic steps, Convergence criteria, Role offinite element analysis in computer-aided design., Mathematical Preliminaries, Differential equations formulations, Variational formulations, weighted residual methods [12 Hrs]

Unit II. Motion of Rigid Bodies

Introduction to Rigid-body Rotation, Rigid-body Coordinates, Rigid-body Rotation about a Body-Fixed Point, Inertia Tensor, Matrix and Tensor Formulations of Rigid-Body Rotation, Angular Momentum and Angular Velocity Vectors, Euler's equations of motion for rigid-body rotation, Lagrange equations of motion for rigid-body rotation, Hamiltonian equations of motion for rigid-body rotation, Rotation of Deformable Bodies
[12 Hrs]

Unit III. Lagrange dynamics

Introduction to Lagrangian Dynamics, Newtonian plausibility argument for Lagrangian mechanics, Lagrange Equations from d'Alembert's Principle, Lagrange equations from Hamilton's Principle, Constrained Systems, Applying the Euler-Lagrange equations to classical mechanics, The Lagrangian versus the Newtonian approach to classical mechanics
[12 Hrs]

Unit IV. Mechanisms

Kinematic Analysis of Complex Mechanisms: velocity-acceleration analysis of complex mechanisms by the normal acceleration and auxiliary point methods.Dynamic Analysis of Planar Mechanisms: - Inertia forces in linkages, kinetostatic Analysis ofmechanisms by matrix method. Analysis of elastic mechanisms, beam element, displacementfields forbeam element, element mass and stiffness matrices, system matrices, elastic linkage model, equations ofmotion. [12 Hrs]

Reference Books:

1. Boresi A.D., Schmidt R.J, and Sidebottom O.M, "Advanced Mechanics of Materials", Wiley
2. Williams J.A. "Engineering Tribology" Oxford University press, 1994.

3. Hulling J. " Principles of Tribology" McMillan, 1984
4. Richard Budynas, "Advanced strength of applied stress analysis", McGraw Hill
5. Cook R.D., Young W.C., "Advanced Mechanics of Materials", Prentice Hall
6. Timoshenko and Goodier, "Theory of Elasticity", McGraw-Hill Publications

5. ADVANCES IN MECHANICAL ENGINEERING (DESIGN -III)

Teaching Scheme:	**Examination Scheme:**
Lectures: 4 hrs./week	Theory Examination: 100 Marks

Unit I. Vibrations and Acoustics

1.Vibrations

Multi-degree freedom systems, Approximate and numerical methods, Continuous systems, Nonlinear systems

2. **Acoustics**

Wave propagation, generation/transmission of sound, noise control, Frequency and wavelength, simple harmonic motion, superposition of waves, sound waves, acoustical properties and levels [12 Hrs]

Unit II. Noise Vibration Harshness

Introduction to NVH, Sound and vibration theory, Test facilities and instrumentation, Signal Processing techniques, NVH control Strategies & comfort [10 Hrs]

Unit III. System Design Design Optimization

1.**System Design**

Systems design for Cooling of Electronic Equipment's Enclosure design, power packing factors, electronic packing.

2.**Design Optimization**

Classical Optimization Techniques: Single-variable and Multi-variable Optimization, Hessian Matrix, Saddle Point, Lagrange Multipliers Method and Kuhn-Tucker Conditions.

3**. Single-variable Optimization Techniques**

Linear and Non-Linear behavior, Unrestricted Search, Solution using Graphical Method and Numerical Methods, Interval-halving Method, Golden section Method, Newton Method, Secant Method

4.**Multi-variable Optimization Techniques**

Non-linear Equations, Steepest Descent Method, Conjugate Gradient Method, Davidson-Fletcher-Powell Method [14 Hrs]

Unit IV. Theoretical and Experimental Stress Analysis

Stress, Theory of Elasticity, Theory of Plasticity, Overview of Experimental Stress Analysis, different techniques like photo elasticity, strain gauges, digital image correlation, Moiré, Brittle Coatings, Holography, Speckle Methods, Thermo elastic Stress Analysis and

Caustics, isoclinic and isochromatic fringe patterns, evaluation of stresses from these fringe patterns [12 Hrs]

Reference Books:

1. Kinsler, Freyand Coppens, "Fundamentals of Acoustics", John Wiley& Sons
2. Allan D Pierce, "Acoustics: An Introduction to its Physical Principles and Applications", Acoustical Society of Amer, 1989.
3. Balakumar Balachandran and Edward Magrab, "Vibrations", Thomson Brooks/Cole, 2004.
4. Kelly S.G., "Mechanical vibrations", McGraw-Hill, 2007
5. Srinath L.S, "Advanced Mechanics of Solids", Tata Mc-Graw Hill, New Delhi, 2003

6. ADVANCES IN MECHANICAL ENGINEERING (DESIGN -IV)

Teaching Scheme:	**Examination Scheme:**
Lectures: 4 hrs./week	Theory Examination: 100 Marks

Unit I. Mechatronics and Robotics

1.**Mechatronics**

Sensors Performance terminology, system modeling of sensors; displacement, position and proximity sensors, velocity and acceleration sensors, flow sensors, force sensors, temperature sensors, ultrasonic and fiber-optic sensors; Signal processing: Transducer signal conditioning process, principals of analogue and digital signal conditioning, protection, filtering, operational and instrumentation amplifiers and their gains, analogue to digital and digital to analogue conversion, multiplexers, pulse modulation; Programmable Logic Controller: Input/output processing, programming, functional block diagram (FBD), ladder diagram, logic functions, latching, sequencing, jumps, internal relays, counters, shift registers, master and jump control

2. **Robotics**

Kinematics, Dynamics, Trajectory, Control [18 Hrs]

Unit II. Reliability Engineering

Reliability evaluation of complex systems, Safeties and certifications, Terro technological Aspects [10 Hrs]

Unit III. Bio-medical Device Design

Applications, FDA approval procedures, Certification and Classification [10 Hrs]

Unit IV. Micro Electro Mechanical Systems (MEMS)

From Microphysics to Macrophysics, Thermodynamics of Microstructures, Reliability of MEMS [10 Hrs]

Reference Books:

1. John J Craig,“Introduction to Robotics–Mechanics and Control”, Prentice Hall,3rdEdition, 2004.
2. FuK.S.,GonzalesR.C.,andLeeC.S.G.,“Robotics:Control,Sensing,Vision and Intelligence, Tata Mc-Graw Hill, 2008.
3. Hsu, Tai-Ran, (2003), MEMS & MICROSYSTEMS: Design & Manufacture, TMH, ISBN:0-07-048709-X
4. Mechatronics, 3/e --- W. Bolton (Pearson Education)
5. Mechatronics: Principles, Concepts and Applications - N.P. Mahalik (TMH)
6. Mechatronics System Design – Devdas Shetty, Richard A. Kolk (Thomson)
7. Davis J. “Surface Engineering for corrosion and Wear Resistance”, Wood head Publishing, 2001.
8. Tadausz Burakowski, “Surface Engineering of Metals:Principles, Equipments, Tehnologies” Taylor and Francis.

7. ADVANCES IN MECHANICAL ENGINEERING (HEAT POWER-I)

Teaching Scheme:	Examination Scheme:
Lectures: 4 hrs./week	Theory Examination: 100 Marks

Unit I: Conduction, Convection and Radiation

1.**Conduction**

One dimensional heat conduction equation, Boundary and Initial conditions, Steady state heat conduction

2.**Convection**

Fundamentals of convection, Classification of fluid flows, Velocity boundary layer,Thermal boundary layer

3.**Radiation**

Thermal radiation, Blackbody radiation, Radiation Intensity, Radiative properties

[16 Hrs]

Unit II: Thermodynamics

Thermodynamic and heat transfer, Heat and other forms of energy, The first law of thermodynamics, Heat transfer mechanism [10 Hrs]

Unit III: Mass Transfer

Analogy between heat and mass transfer, Mass diffusion, Boundary conditions

[10 Hrs]

Unit IV: Heat Exchangers

Types of heat exchanger, Overall heat transfer coefficient, The Log mean temperature difference method, The effectiveness –NTU method [12 Hrs]

Reference Books:

1. John B Heywood, "Internal Combustion Engine Fundamentals", McGraw Hill International Edition, 1998.
2. W.M Kays Combustion and M.E. Crawford, "Convective Heat and Mass Transfer", McGraw Hill Intl.
3. T Cebeci, "Convective Heat Transfer", Springer
4. Williams,F.A., "Combustion Theory" The Benjamin and Cummings Publishing Company Inc.,1985
5. Makart chouk, A., "Diesel Engine Engineering: Thermodynamics, Dynamics, Design, and Control". New York, and Basel: Marcel Dekker, Inc., 2002.
6. Blair, G., "The Basic Design of Two-Stroke Engines", Warrendale, PA: Society of Automotive Engineers, 1990.
7. Process Heat Trasnfer by D.Q. Kern
8. Process heat transfer Holand and Frass
9. Turns,S.R., "An Introduction to Combustion, Concepts and Applications", Mc-Graw Hill, 2000
10. Law,C.K., "Combustion Physics", Cambridge University Press,2006

8. ADVANCES IN MECHANICAL ENGINEERING (HEAT POWER -II)

Teaching Scheme:	**Examination Scheme:**
Lectures: 4 hrs./week	Theory Examination: 100 Marks

Unit I: Kinematics of Fluid Flow and Fundamental Governing Equations

1. **Kinematics of Fluid Flow**

   Fundamental kinematic properties of fluid motion, Reynolds number

2. **Fundamental Governing Equations**

   The continuity equation, The momentum equation, Conservation of energy equation

[14 Hrs]

Unit II: Laminar Flow, Potential Flow and Laminar Boundary Layers

1. **Laminar Flow**

   Laminar versus Turbulent flow, Steady versus Unsteady flow

2. **Potential Flow**

   Incompressible flow, Laplace equation, Irrotational flow

3. **Laminar Boundary Layers**

   Navier-Stokes equation, Prandtl number [16 Hrs]

Unit III: Introduction to Turbulent Flow

Boundary layer equations [08 Hrs]

Unit IV: Introduction to Compressible Flow

Flow distribution, Compressible versus incompressible flow, Mach number [10 Hrs]

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Reference Books:

1. "Fluid Mechanics Fundamentals and Applications" by Yunus Cengel and John Cimbala
2. "Fluid Mechanics" by Frank White
3. "Fluid Mechanics" by Streeter V L and Wylie E B
4. "Fluid Mechanics, SI Version (WSE)" by Fox and Mcdonald
5. "Fluid Mechanics for Chemical Engineers with Microfluidics and CFD" by J O Wilkes
6. "Computational Fluid Mechanics And Heat Transfer" by Anderson Tannehill Pletcher
7. "Foundations of Fluid Mechanics" by S W Yuan
8. "Fundamentals of Fluid Mechanics" by A L Prasuhn
9. "Introduction to Fluid Mechanics" by R W Fox
10. "Process Fluid Mechanics" by M Denn

9. ADVANCES IN MECHANICAL ENGINEERING (HEAT POWER -III)

Teaching Scheme:	**Examination Scheme:**
Lectures: 4 hrs./week	Theory Examination: 100 Marks

Unit I: Advanced Gas Dynamics

Linear and rotational dynamics, Gas variables [10 Hrs]

Unit II: Vortex Dynamics and Turbulence

1. **Vortex Dynamics**

   Main causes of vortex formation, Forced and free vortices, Vortex element

2. **Turbulence**

   Turbulant flow equation, Turbulant velocity [16 Hrs]

Unit III: Energy Conversion System

Energy conservation and transformation, Law of energy conversion [10 Hrs]

Unit IV: Turbo Machinery

Introduction and classification, The design of high efficiency turbo machinery [12 Hrs]

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Reference Books:

1. "Dynamics of Gas-surface Interactions (Advances in Gas-phase Photochemistry and Kinetics)" by C T Rettner and M Ashfold
2. "Gas Dynamics - Vol. 1" by Joe D Hoffman and Maurice J Zucrow
3. "Gas Dynamics and Jet Propulsion" by S L Somasundaram
4. "Advances in Applied Mechanics: Rarefied Gas Dynamics, 4th International Symposium 3rd Suppt" by J H Leeuw
5. Vortex Dynamics (Cambridge Monographs on Mechanics) Illustrated Edition, Kindle Edition by P. G. Saffman
6. "Turbulent Flows" by Pope Stephen B
7. "Modeling and Simulation of Turbulent Flows (Iste)" by Roland Schiestel
8. "Turbulent Flow (Princeton Legacy Library)" by Galen Brandt Schubauer and Chan MouTchen
9. "Direct Energy Conversion" by George W Sutton
10. "Direct energy conversion literature abstracts" by Naval Research Laboratory Technical Information Division
11. "Energy Conversion Engineering" by Kenneth Weston
12. "Turbomachines" by B U Pai

13. "Turbomachines: Design and Control" by AppuuKuttan
14. "Thermal Turbomachines (WIND)" by DrOnkar Singh

10. ADVANCES IN MECHANICAL ENGINEERING (HEAT POWER -IV)

Teaching Scheme:	**Examination Scheme:**
Lectures: 4 hrs./week	Theory Examination: 100 Marks

Unit I: Advanced Topics in Refrigeration and Cryogenics

Refrigeration applications in preservation of Food, transport by trucks and containers; Railwaycars; Marine Refrigeration; Fans and Blowers, Sound Control. Construction of psychrometric charts, enthalpy deviation curves, advances in cryogenics, absorption system [12 Hrs]

Unit II: Advanced Topics in I C Engines

Engine Emissions & Control, Engine Electronics, Modeling Real Engine Flow and Combustion Process, Fuel/Air Mixture Requirements (Any two), , Premixed and Diffusion flames [12 Hrs]

Unit III:CFD

Computational approach to Fluid Dynamics and its comparison with experimental and analytical methods, Basics of PDE: Elliptic, Parabolic and Hyperbolic Equations [12 Hrs]

Unit IV: Advanced Trends in Heat Exchanger

Heat Exchanger design theory, recent trends in heat exchangers, advanced material in HE, Electronic cooling, Nanomaterial, micro channel heat exchangers. [12 Hrs]

Reference Books:

1. Heat Exchanger Design methodology by R.K Shah
2. Compact Heat Exchanger by Kays and London
3. Heat Exchanger Design by Sadic and Kakac

4. Process heat transfer Holand and Frass
5. Handbook of air-conditioning system design, Carrier Incorporation, McGraw Hill Book Co., U.S.A.
6. Hainer R.W. ‘Control Systems for Heating, Ventilation and Air – Conditioning’, Van Nastrand Reinhold Co., New York, 1984.
7. "Cryogenic Systems" by R Barron
8. "Advances in Cryogenic Engineering" by K D Timmerhaus
9. "Cryogenic Engineering" by Thomas Flynn
10. "Internal Combustion Engine Fundamentals" by John Heywood
11. "Internal Combustion Engines: Applied Thermo sciences" by Colin R Ferguson
12. "Internal Combustion Engines" by Ganesan V
13. "Computational Fluid Dynamics" by Anderson J D
14. "Computational Fluid Dynamics and Heat Transfer" by Tenehill J C and Pletcher R H

11. ADVANCES IN MECHANICAL ENGINEERING (PRODUCTION-I)

Teaching Scheme:	**Examination Scheme:**

Lectures: 4 hrs./week	Theory Examination: 100 Marks

Unit I. Powder Processing, Polymers and Composites

1. **Powder Processing**

Powder metallurgy, advantages, limitations, applications, production of metal powder - atomization, crushing and milling, electrolysis process, chemical process, characterization of metal powders, processing of powders - primary and secondary operations.

2.**Polymers and Composites**

General introduction to composite materials: Concept and definition, classification of composites (CMC, MMC, PMC).Functional roles of reinforcement and matrix and importance of interface. Polymer matrix composites (PMCs): Fiber reinforced and particulate filled polymer composites. Reinforcements (glass, carbon/graphite, Kevlar), Matrices – Thermoset matrices – polyesters, epoxides, phenolics, vinyl esters, polyimides, cyanate esters – Thermoplastic matrices. Choice of reinforcements and matrices for different application needs. Elastic behavior of unidirectional and multi directional composites, Laminated composite beams and plates (Any one) [14 Hrs]

Unit II. Reliability Engineering

Reliability evaluation of complex systems, Safeties and certifications, Terro technological Aspects **Modelling of Manufacturing Systems -**Markov chains – Continuous and Discrete, Petri nets – Timed and Stochastic [10 Hrs]

Unit III. Material handling and plant layout

Evaluating and justifying material handling projects, location and layout analysis; group-of-items flow; space requirements; Unit material handling: unit load concepts, storage systems, positioning equipment, Bulk material handling, Excavators, Transportation interface, Safety and environment issues [12 Hrs]

Unit IV. Supply Chain Management

Introduction- Strategic Decisions and Source of Management in Supply Chain, Inventory Management and logistics in SCM, Information technology and system in SCM,

Application of mathematical modeling in SCM, Reverse supply chain, Integration & Collaborative Supply Chain , agile supply chain, case study discussions [12 Hrs]

Reference Books:

1. Materials handling handbook, Raymond Kulwiec,2nd Ed.,Wiley.
2. Plant Lay out and Material Handling, Apple, JamesM.,3rd.ed.Wiley.
3. Goldak J.A., and Akhlaghi M., "Computational Welding Mechanics", Springer, NewYork, 2005.
4. Radaj D., "Heat Effects on Welding: Temperature field. Residual stress and Distortion",Springer, 1992.
5. IsaacandDanielM.,"EngineeringMechanicsofCompositeMaterials",OxfordUniv ersity Press, 1994.
6. JonesR.M.,"MechanicsofCompositeMaterials",McGrawHill,NewYork,1975
7. Calcote L.R., "Analysis of Laminated Composite Structures", Van Nostr and Rainfold, NewYork, 1969
8. Kapur K.C., and Lamberson L.R., "Reliability in Engineering Design", Wiley India Pvt.Ltd., 2009.
9. Viswanadham, N and Narahari, Y. "Performance Modelling of Automated Manufacturing Systems",Prentice Hall of India, New Delhi, 2000

12. ADVANCES IN MECHANICAL ENGINEERING (PRODUCTION -II)

Teaching Scheme:	**Examination Scheme:**

Lectures: 4 hrs./week	Theory Examination: 100 Marks

Unit I. Modelling of Manufacturing Systems

Concept of system and elements of system, Discrete and continuous system, Models of system and Principles of modeling and simulation, Monte carlo simulation, Types of simulation, Steps in simulation model, Advantages, limitations and applications of simulation, Applications of simulation in manufacturing system [12 Hrs]

Unit II. Metal Forming and Metal Machining

1.**Metal Forming**

Application of metal forming, Theory of Plastic deformation, Strain hardening, Recovery, Recrystallization and Grain Growth, Effect of Temperature, Composition and Strain rates on metal forming, Characteristics and applications of Hot working and Cold working, Classification of metal forming processes according to stresses

2.**Metal Machining**

Hybrid electro-chemical processes, Hybrid thermal processes, Solid, liquid and powder based material addition processes (Analytical Study) [16 Hrs]

Unit III. Lean Production

Introduction to Lean and Factory Simulation: History of Lean and comparison to other methods – The 7 Wastes, their causes and the effects – An overview of Lean Principles / concepts / tools – Stockless Production. The Tools of Lean Manufacturing: Continuous Flow – Continuous Flow Manufacturing and Standard Work Flow – 5S and Pull Systems (Kanban and ConWIP systems) – Error Proofing and Set-up Reduction – Total Productive Maintenance (TPM) – Kaizen Event examples. Toyota production systems, Ford production systems [12 Hrs]

Unit IV. Join processes

Metal joining: Appraisal of various welding processes, factors in design of weldments – general design guidelines-pre and post treatment of welds-effects of thermal stresses in weld joints design of brazed joints. Computational Welding Mechanics- Models for welding heat sources, Thermal analysis of welds, Fracture Mechanics of welded structures [10 Hrs]

Reference Books:

1. Materials handling handbook, Raymond Kulwiec,2nd Ed.,Wiley.
2. Plant Layout and Material Handling, Apple, James M.,3rd.ed.Wiley.
3. Goldak J.A., and Akhlaghi M., "Computational Welding Mechanics", Springer, NewYork, 2005.
4. Radaj D., "Heat Effects on Welding: Temperature field. Residual stress and Distortion", Springer, 1992.
5. IsaacandDanielM.,"EngineeringMechanicsofCompositeMaterials",OxfordUniv ersity Press, 1994.
6. JonesR.M.,"MechanicsofCompositeMaterials",McGrawHill,NewYork,1975
7. Calcote L.R., "Analysis of Laminated Composite Structures", Van Nostr and Rainfold, NewYork, 1969
8. KapurK.C., and Lamberson L.R., "Reliability in Engineering Design", Wiley India Pvt.Ltd., 2009.
9. Viswanadham, N and Narahari, Y. "Performance Modelling of Automated Manufacturing Systems", Prentice Hall of India,NewDelhi,2000

13. ADVANCES IN MECHANICAL ENGINEERING (PRODUCTION -III)

Teaching Scheme:	**Examination Scheme:**

Lectures: 4 hrs./week	Theory Examination: 100 Marks

Unit I. Introduction to Advanced Machining Processes

Hybrid electro-chemical processes, Hybrid thermal processes, Solid, liquid and powder based material addition processes (Analytical Study)

[12 Hrs]

Unit II. Advanced casting technology

Casting Design & Pattern / Die Making, pattern and die design considerations, Computer aided casting component design, Computer aided design and manufacturing of patterns and dies. Sand Molding & Core Making Practices: High pressure molding technology, flaskless molding technology, magnetic molding, Core shooters used in shell core making and cold box process, Permanent Mold & Special Casting Techniques: Process parameters for Die casting- gravity, pressure and low pressure, Centrifugal casting, Vacuum casting, Investment casting, Squeeze casting, Casting defects and their classification, rejection analysis, remedial measures**,** High Integrity Die Casting, Vacuum die casting, Squeeze casting, Semi solid metal working, Design considerations for high integrity die Castings [12 Hrs]

Unit III. Quality Control of manufacturing process

Quality in Design and manufacturing, inspection principles and strategies, Automated inspection, contact Vs non contact, CMM. Manufacturing support systems. Quality function deployment, An overall quality system, quality engineering in production design, quality engineering in design of production processes. Loss Function and Quality Level: Derivation and use of quadratile loss function, economic consequences of tightening tolerances as a means to improve quality, evaluations and types tolerances. (N-type, Stype and L-type)

[12 Hrs]

Unit IV. Quantity Function Deployment and Scheduling

1. **Quantity Function Deployment**

Meaning of QFD, Purpose of QFD, Phases of QFD Process, House of quality, Use of House of quality template, Case studies .

2.**Scheduling**

Warehouse location and capacity scheduling; Aggregate Planning and Master Production Planning and Scheduling; Operations scheduling and Control: Basic Sequencing and scheduling techniques,, Material Requirement and Shop Scheduling Systems, ; Project scheduling, Scheduling under Resources constraint, Cash scheduling to multi-projects situation Project monitoring and control aspects; [12 Hrs]

Reference Books:

1. Materials handling handbook ,Raymond Kulwiec,2nd Ed.,Wiley.
2. Plant Layout and Material Handling, Apple, JamesM.,3rd.ed.Wiley.
3. Metal Forming Handbook–Schuler, Springer-Verlag Berlin.
4. Diesfor Plastic Extrusion – M.V. Joshi – McMillan.
5. Tool Design–C. Donaldson, Le Cain & Goold(TMH)
6. Tool Design – H.W.Pollack (Taraporwalla)
7. ASM Handbook – Forming – ASME
8. Handbook of DieDesign, 2/e –Suchy, I (McGrawHill), 2006.
9. Tool Design, Donaldson, (TMH)
10. Tool Design, Pollock, Reston Pub. Co. Inc.
11. An Introduction to Jig & Tool Design, M.H.A. Kempster,(ELBS)
12. Fundamentals of Tool Design, Ed. Frank Wilson, ASTME(TMH)
13. Jigs and Fixture Design Manual, Henirkson (IndustrialPress,NY)
14. A Text Book of Prod. Engineering, P.C.Sharma, S.Chand
15. Jigs and Fixture, P.H.Joshi,Tata Mc-Graw HillPub.Co
16. CMTI Machine Tool Design Handbook, (TMH)
17. Design Data Handbook –PSG College of Tech., Coimbtore
18. Jigsand Fixture Design 5e E.G.Hoffman CENGAGE Learning
19. Rong,Yeming; “Computer Aided FixtureDesign”,MarcelDekker,ISBN0-8247-99615
20. M/c standard 8005

14. ADVANCES IN MECHANICAL ENGINEERING (PRODUCTION -IV)

Teaching Scheme:	Examination Scheme:
Lectures: 4 hrs./week	Theory Examination: 100 Marks

Unit I .Jig & Fixture Design

Fundamentals of jig-fixture design, Tolerance analysis, Modular fixtures, Computer aided fixture design, Expert systems in fixture design, fixture design optimization, estimating fixture rigidity, effect of contact stiffness in fixture assembly [10 Hrs]

Unit II. Advanced Tool & Die Design

Die Design for Deep Drawing and Stretch Drawing: design considerations, die materials, Die Design for Hydro Forming: Process Technology, Die design considerations, Extrusion Dies: Die Design for metal and plastic extrusion, die materials [12 Hrs]

Unit III. High Integrity Die Casting

Introduction to High Integrity Die Casting Processes., Molten Metal Flow in High Integrity Die Casting, Vacuum Die Casting, Squeeze Casting, Semi-Solid Metalworking, Thermal Balancing and Powder Die Lubricant, Design for Manufacturability of High Integrity Die, Component Integration Using High Integrity Die

[12 Hrs]

Unit IV. Inventory Management and Resource Planning

Fundamentals of Inventory Management, Purpose and functions of Inventory Management, Inventory replenishment techniques, Inventory Control Process, Introduction to the tools and techniques of Inventory Management, Performance metrics and calculations, The hidden costs of Inventory Management ,Evolution of Resource planning, Evaluation and modules of resource planning, ERP and related technologies - Business Process Reengineering (BPR), Management Information System (MIS), Executive Information System (EIS), Decision support System (DSS), Supply Chain Management (SCM).

[14 Hrs]

Reference Books:

1. Materials handling handbook, Raymond Kulwiec,2nd Ed.,Wiley.

2. Plant Layout and Material Handling, Apple,JamesM.,3rd.ed.Wiley.
3. Metal Forming Handbook–Schuler,Springer-Verlag Berlin.
4. Dies for Plastic Extrusion – M.V. Joshi – McMillan.
5. Tool Design–C. Donaldson, Le Cain & Goold(TMH)
6. Tool Design – H.W.Pollack (Taraporwalla)
7. ASM Handbook – Forming – ASME
8. Handbook of Die Design, 2/e –Suchy, I (McGrawHill), 2006.
9. Tool Design, Donaldson, (TMH)
10. Tool Design, Pollock, Reston Pub. Co. Inc.
11. An Introductionto Jig & Tool Design ,M.H.A.Kempster,(ELBS)
12. Fundamentals of Tool Design, Ed. Frank Wilson, ASTME(TMH)
13. Jigs and Fixture Design Manual, Henirkson(Industrial Press,NY)
14. A Text Book of Prod. Engineering, P.C.Sharma,S.Chand
15. Jigs and Fixture,P.H.Joshi,TataMc-GrawHillPub.Co
16. CMTI Machine Tool Design Handbook, (TMH)
17. Design Data Handbook –PSG College of Tech., Coimbtore

List of Ph.D. (Mechanical Engineering) Paper III (ELECTIVE)

(Select any one subject out of the following)

Advances in Mechanical Engineering (CAD/ CAM/CAE)

1. Advances In Computer Aided Manufacturing And Reverse Engineering
2. Advances In Manufaturing Low Cost Automation And Robotics
3. Advances In Material Processing And Work System Design
4. Advances In Computer Aided Process Planning And Graphics
5. Advances In Computer Aided Planning
6. Advances In Additive Manufacturing
7. Advances In Green Manufacturing
8. Advances In Automation In Manufacturing
9. Advances In Computer Aided Process Planning

Advances in Mechanical Engineering(DESIGN ENGINEERING)

10. Advanced Theory of Vibrations
11. Mathematical Modeling and Optimization
12. Analysis and Synthesis of Mechanisms
13. Advanced Finite Element Analysis
14. Noise and Vibration Harshness
15. Optimization Techniques
16. Mechatronics System Design
17. MEMS and Nano techonology
18. Product Design and Development
19. Advanced Tribology
20. Experimental Design

Advances in Mechanical Engineering (HEAT POWER ENGINEERING)

21. Advanced Thermodynamics

22. Advanced Heat Transfer
23.Advanced Fluid Dynamics
24.Exergy Analysis of Thermal Systems
25.Advanced Refrigeration and Air Conditioning
26. Advanced IC Engines
27. Cryogenic Engineering
28. Alternative Fuels for Ic Engines
29. Design of Heat Transfer Equipments
30. Modeling and Analysis in Thermal Engineering

Advances in Mechanical Engineering (PRODUCTION ENGINEERING)

31. Supply chain management & Logistics
32. Decision Making in Manufacturing Environment
33. Metal Forming Technology
34. Advanced casting technology
35. Manufacturing Systems
36. Precision Engineering
37. Advanced Materials & Processing
38. Modern manufacturing systems
39. Low Cost Automation
40. World Class Manufacturing

1. ADVANCES IN COMPUTER AIDED MANUFACTURING AND REVERSE ENGINEERING

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit. I. Advances in Reverse Engineering

Systems RE Methodology, RE Steps, Contact systems Active non-contact systems Manipulation of acquired data Interface between Reverse Engineering and Computer-Aided Design System level Design, and Examples, Computer-Aided RE Reverse Engineering in Computer Applications, Re-engineering of PLC programs, Identify electronic components, PCB RE [12 Hrs]

Unit. II. Advances in Manufacturing Systems

Manufacturing Systems

Structural aspects, transformational aspects, procedural aspects,integrated manufacturing systems, Mass Customization, Multi-Product Small Batch Production- Economies of Scope with Diversification; Logistic Systems- Material flow: conversion / transportation / storage, Manufacturing Optimization: Criteria for Evaluation, Optimization of single stage manufacturing- Unit production time and cost; Optimization of multistage manufacturing system Shop Floor Data Collection Systems- Types of data, on-line and off-line data collection, Automatic data collection systems. Lean Production- concept, principles, Agile Manufacturing- concept, principles [12 Hrs]

Unit. III. Advances in Computer Aided Manufacturing

Part programming on Lathe and machining centers using G & M codes Different types of tools and tool holders used on CNC Machines, parameters for selection of configuration of cutting tools Modular tools and fixtures, use of pallets for work holding, palletizing of fixtures Advanced CNC processes - EDM, Wire cut EDM, Abrasive water jet, LASER cutting, Optimization of tool path [12 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. VineshRajaandKiranJFernandes,“ReverseEngineering–AnIndustrialperspective”,Springer, London, 2008
2. PhamDandDimovS,“Rapidmanufacturing- he technologies and applications of rapid prototyping and rapid tooling.Springer-Verlag,London,2001.
3. Katsudo Hitomi,(1998),“Manufacturing Systems Engineering”,Viva Low Price D Student Edition, ISBN81-85617-88-0
4. B.Wu,“ManufacturingSystemsDesign&Analysis:ContextandTechniques”(2/ e),Chapman & amp; Hall, UK, ISBN 041258140X

2. ADVANCES IN MANUFATURING LOW COST AUTOMATION AND ROBOTICS

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit.I. Advances in Modern manufacturing systems

Concept of F.M. Cell and F.M.System, Functions of a manufacturing cell, Types and components of FMS, Tests of flexibility, Group Technology and FMS, Architecture of typical FMS, Shop Floor Control system, dynamic scheduling in FMS,Flexible Assembly Systems: Basic concepts, classification, planning and scheduling inFAS, Reconfigurable Manufacturing Systems: Definition, goals, elements, rationale,characteristics, principles, RMS and FMS [12 Hrs]

Unit.II.. Advances in Low Cost Automation

Automated manufacturing systems, reasons to justify automation, automation principles and strategies, Developing an Electropneumatic control system- project design, selection and configuration of components and implementation Programmable Logic Controllers: Brief review of structure, operation and functions, input/output of PLC, shift registers, data movement and comparison Multiple actuator circuits with PLC control- sequence, latching, timers, counters; Interfacing with sensors and actuators for analog input/outputs Supervisory Control And Data Acquisition (SCADA): Concept of SCADA, its industrial significance and applications. [12 Hrs]

Unit. III. Advances in Robotics

Model-based learning approaches, Model-free learning approaches, Optimization methods and casestudies, Soft Robotics (2L; F Iida): Soft material/body robot modelling, Soft actuators and sensors, Control and learning of soft robots, Human-Robot Interaction :Introduction to human-robot interaction, Theoretical frameworks (spatial, nonverbal, verbal interactions), Research methods, applications, robots in society, Distributed Robotics, Multi-Agent Systems: Planning and control in multi-robot systems [12 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1.Mikell P.Groover,(2002),"Automation, Production Systems and Computer Integ Rated Manufacturing", (2/e), Pearson Education, ISBN 81-7808-511-9

2.RadhakrishanP.,SubramaniyanS.andRajuV.,"CAD/CAM/CIM",(3/E),NewA Ge International Publication

3. Jon Stenerson and Kelly Curran"Computer Numerical Control",Prentice-HallofIndiaPvt.Ltd.NewDelhi,2008

4. P.N.Rao"CAD/CAMprinciples and operations",Tata Mc GrawHill

5. Ronald C. Arkin 1949. Behavior-Based Robotics / Ronald C. Arkin. Cambridge, Mass. : MIT Press, c1998.; 1998.

6. Bruno Siciliano 1959; Oussama Khatib editor., eds. Springer Handbook of Robotics / Edited by Bruno Siciliano, Oussama Khatib. 2nd Edition. Cham : Springer International Publishing, 2016.; 2016.

3. ADVANCES IN MATERIAL PROCESSING AND WORK SYSTEM DESIGN

Teaching Scheme:	Examination Scheme:
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit.I. Advances in Advances Materials & Processing

Compositions, properties and applications of: Inter-metallic, Ni and Ti aluminides, Smart materials, shape memory alloys Metallic glass-quasi crystals, Dielectrics, semi conductors, conductors & amp; super conducting materials, Polymer materials, formation of polymer structures, production techniques of fibers, foams, adhesives and coatings. Composites: Fibers-glass, boron, carbon, organic, ceramic and metallic fibers, Electrochemical grinding, physical vapor deposition, chemical vapor deposition, electro-less coating and thermal metal spraying

[12 Hrs]

Unit. II. Advances in Work system design

Work System Design

Introduction, Introduction and Concept of Productivity, Measurement of Productivity, Productivity Measures, Productivity Measurement Models Factors Influencing Productivity, Causes of Low P Work Study: Basic Concept, Steps Involved in Work Study, Concept of Work Content, Techniques of Work Study, Human Aspects of Work Study productivity, Productivity Measurement Models, Productivity Improvement Techniques, Method Study: Basic Concept, Steps Involved in Method Study, Recording Techniques, Operation Process Charts, Operation Process Charts: Flow Process Charts, Flow Process Charts: Examples, Two-Handed-Process Charts, Multiple Activity Charts, Flow Diagrams. Work Sampling: Basics, Procedure of Work Sampling Study, Numerical Problems on work sampling, Introduction to Synthetic Data and PMTS, Introduction to MTM and MOST, Ergonomics: Basic Concept, Industrial Ergonomics, Ergonomics: Anthropometry, Man-Machine System-1 , Man-Machine System-2, Case Study: Office Chair, Case Study: Tower Crane Cabin, Case Study: Car Seat, Case Study: Computer System, Case Study: Assembly Line

[12 Hrs]

Unit. III. Advances in Precision Engineering

Definition, difference in precision and accuracy, need for high precision, Classes of achievablemachining accuracy – normal, precision, high precision and ultra precision machining; Concept of accuracy – part accuracy Precision Machining Processes: Classification of material removal processes in terms of the energy source used and the tool-workpiece reaction Diamond turning and milling – machines, tool design and alignment Fixed abrasive processes - Basic mechanics of grinding, bondless diamond grinding wheels, jig grinding, electrolytic in-process dressing, Ultra- precision grinding, nano grinding; Loose abrasive processes – polishing, modes of material removal

[12 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Katsudo Hitomi, (1998), "Manufacturing Systems Engineering", Viva Low Priced Student Edition, ISBN 81-85617-88-0Willer,"Non- Traditional Machining Processes", SME publications.
2. G.F.Benidict,"Advanced Manufacturing Processes",Marcel Dekker Publisher
3. E.Paul De Garmo,J.T.Black&RonaldA.Kohser,"Materials & amp; Processes in Manufacturing", (PHI)
4. Murty, R. L. (2009), - Precision Engineering in Manufacturing, (New Age International Publishers) ISBN: 81-224-0750-1
5. Venkatesh, V.C. & Izman, S. (2007), - Precision Engineering, (TMH), ISBN: 0-07-062090-3
6. Dornfeld, David & Lee, Dae-Eun, (2008), - Precision Manufacturing, (Springer Science + Business Media, LLC), ISBN: 978-0-387-32467-8
7. Introduction to Work Study: International Labor Office (ILO), Geneva.

8. Motion and Time Study Design and Measurement of Work: Ralph M. Barnes, Wiley, The University of California.
9. Industrial Engineering and Production Management: M. Telsang, S. Chand and Company Ltd.

4. ADVANCES IN COMPUTER AIDED PROCESS PLANNING AND GRAPHICS

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

UNIT - I

Introduction to computer graphics fundamentals; Curves and surfaces modeling; Concepts of Solid modeling; Visual realism; Assembly of parts and product data Exchange. Finite Element Analysis related to 1D and 2D problems. Problems of static and dynamic analysis using Finite Element Analysis. [12 Hrs]

UNIT - II

NC, CNC and DNC –CNC Programming Basics - Computer Aided Process Planning-Group technology - Part families - classification and coding - Production flow analysis - Machine cell design - Benefits. Components of FMS- Characteristics of JIT-Kanban system-lean production system. [12 Hrs]

UNIT - III

Engineering Data Management (EDM), Product Data Management (PDM), Collaborative Product Definition Management (cPDm), Collaborative Product Commerce (CPC), Product Lifecycle Management (PLM) -Additive manufacturing processes-Benefits Applications – rapid tooling - Reverse Engineering – Digitizing technique

[12 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Katsudo Hitomi, (1998), “Manufacturing Systems Engineering”, Viva Low Priced Student Edition, ISBN 81-85617-88-0Willer,“Non- Traditional Machining Processes”, SME publications.
2. G.F.Benidict,“Advanced Manufacturing Processes”,Marcel Dekker Publisher
3. E.Paul De Garmo,J.T.Black&RonaldA.Kohser,“Materials & amp; Processes in Manufacturing”, (PHI)
4. Murty, R. L. (2009), - Precision Engineering in Manufacturing, (New Age International Publishers) ISBN: 81-224-0750-1
5. Venkatesh, V.C. & Izman, S. (2007), - Precision Engineering, (TMH), ISBN: 0-07-062090-3
6. Dornfeld, David & Lee, Dae-Eun, (2008), - Precision Manufacturing, (Springer Science + Business Media, LLC), ISBN: 978-0-387-32467-8
7. Introduction to Work Study: International Labor Office (ILO), Geneva.
8. Motion and Time Study Design and Measurement of Work: Ralph M. Barnes, Wiley, The University of California.
9. Industrial Engineering and Production Management: M. Telsang, S. Chand and Company Ltd.

5. ADVANCES IN COMPUTER AIDED PLANNING

Teaching Scheme:	Examination Scheme:
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

UNIT- I:

CAD Tools: Definition of CAD Tools, Graphics standards, Graphics software: requirements of graphics software, Functional areas of CAD, Efficient use of CAD software. Basics of Geometric Modelling: Requirement of geometric 3D Modeling, Geometric models, Geometric construction methods, Modelling facilities desired.

Geometric Modeling: Classification of wireframe entities, Curve representation methods, Parametric representation of analytic curves: line, circle, arc, conics, Parametric representation of synthetic curves: Hermite cubic curve, Bezier curve, B-Spline curvewire, NURBS, Curve manipulations. [12 Hrs]

UNIT- II:

1.Surface Modeling

Classification of surface entities, Surface representation methods, Parametric representation of analytic surfaces: plane surface, ruled surface, surface of revolution, tabulated cylinder, Parametric representation of synthetic curves: Hermite cubic surface, Bezier surface, B-Spline surface, Blending surface, Surface manipulations.

2.Solid Modelling

Geometry and topology, Boundary representation, The Euler-Poincare formula, Euler operators, Constructive solid geometry: CSG primitives, Boolean operators, CSG expressions, Interior, Exterior, closure, Sweeping: linear and non-linear, Solid manipulations, feature modeling. [12 Hrs]

UNIT-III:

Transformations:2-D and 3-D transformations: translation, scaling, rotation, reflection, concatenation, homogeneous coordinates, Perspective projection, orthotropic projection, isometric projection, Hidden surface removal, shading, rendering. Evaluation Criteria: Evaluation criteria of CAD software, Data exchange formats: GKS, IGES, PHIGS, CGM,

STEP Dimensioning and tolerances: Linear, angular, angular dimensions, maximum material condition (MMC), Least material condition (LMC), Regardless of feature size (RFS). R22M.Tech. CAD/CAM JNTUH [12 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. CAD/CAM Concepts and Applications/ Alavala/PHI.
2. Mastering CAD/CAM/ Ibrhim Zeid/ McGraw Hill International.
3. CAD/CAM Principal and Applications/ P. N. Rao/ TMH/3rd Edition
4. CAD/CAM /Groover M.P./ Pearson education
5. CAD / CAM / CIM, Radhakrishnan and Subramanian/ New Age
6. Principles of Computer Aided Design and Manufacturing/ Farid Amirouche/ Pearson 4.

Computer Numerical Control Concepts and programming/ Warren S Seames/ Thomson.

6. ADVANCES IN ADDITIVE MANUFACTURING

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

UNIT–I:

Introduction: Prototyping fundamentals: Need for time compression in product development, Need for Additive Manufacturing, Historical development, Fundamentals of Additive Manufacturing, AM Process Chain, Advantages and Limitations of AM, Commonly used Terms, Classification of AM process, Fundamental Automated Processes: Distinction between AM and CNC, other related technologies

Liquid-based AM Systems: Stereo lithography Apparatus (SLA): Models and specifications,Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Solid ground curing (SGC): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Poly jet: Process, Principle, working principle, Applications, Advantages and Disadvantages, Case studies. Micro fabrication. Solid-based AM Systems: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Multi-Jet Modelling (MJM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies [12 Hrs]

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UNIT–II:

Powder Based AM Systems: Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Three-dimensional Printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Laser Engineered Net Shaping (LENS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Electron Beam Melting (EBM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages,

Case studies R22M.Tech. CAD/CAM JNTUH Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT. Rapid Tooling Classification: Indirect Rapid Tooling Methods: Arc Spray Metal Deposition, Investment Casting, Sand Casting, 3D Keltool process. Direct Rapid Tooling: Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP.

[12 Hrs]

UNIT–III:

AM Data Formats: Reengineering for Digital Representation, STL Format, STL File Problems,Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. Mesh Refining by Sub division Techniques. AM Software's: Need for AM software, Features of various AM software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor, Surgi Guide, 3-matic, Simplant, Mesh Lab. UNIT–V: AM Applications: Application – Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS application, Artsand Architecture. RP Medical and Bioengineering Applications: Planning and simulation ofcomplex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Biomolecules. Web Based Rapid Prototyping Systems [12 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Rapid prototyping: Principles and Applications by Chua C.K., Leong K.F. and LIM C.S, World Scientific publications, Third Edition, 2010.
2. Rapid Manufacturing by D.T. Pham and S.S. Dimov, Springer, 2001. 2. Wholers Report 2000 by Terry Wohlers, Wohlers Associates, 2000. 3. Rapid Prototyping & Engineering Applications by Frank W.Liou, CRC Press, Taylor & Francis Group, 2011.

7. ADVANCES IN GREEN MANUFACTURING

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

UNIT-I:

Concepts of sustainability and sustainable development – Need for sustainable development -Components of sustainability- Social, Economic, Environmental dimensions - Linkages between technology and sustainability - Sustainable Manufacturing –Scope, Need and Benefits

[10 Hrs]

UNIT-II:

Tools and Techniques of Sustainable Manufacturing – Environmental Conscious Quality Function Deployment, Life cycle assessment, Design for Environment, R3 and R6 cycles, Design for Disassembly -Sustainable Product Development – Various Phases.

EIA Methods –CML, EI 95 and 99, ISO 14001 EMS and PAS 2050 standards, Environmental Impact parameters - Interactions between energy and technology and their implications for environment and sustainable development.

Design for recycling – Eco friendly product design methods – Methods to infuse sustainability in early product design phases – Multi-Criteria Decision Making in Sustainability. [16 Hrs]

UNIT-III:

Frameworks for measuring sustainability- Indicators of sustainability – Environmental, Economic, Societal and Business indicators - Concept Models and Various Approaches, Product Sustainability and Risk/Benefit assessment– Corporate Social Responsibility.

[10 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. G. Atkinson, S. Dietz, E. Neumayer, — "Handbook of Sustainable Manufacturing". Edward Elgar Publishing Limited,2007.
2. D. Rodick, "Industrial Development for the 21st Century: Sustainable Development Perspectives", UN New York,2007

8. ADVANCES IN AUTOMATION IN MANUFACTURING

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

UNIT- I:

1.**Introduction to Automation**

Automation in Production Systems-Automated Manufacturing Systems, Computerized Manufacturing Support Systems, Reasons for Automation, Automation Principles and Strategies. Manufacturing operations, Production Concepts and Mathematical Models. Costs of Manufacturing Operations, Basic Elements of an Automated Systems, Advanced Automation Functions, Levels of automation.

2.**Introduction to Material Handling**

Overview of Material Handling Equipment, Considerations in Material Handling System Design, the 10 Principles of Material Handling. Material Transport Systems, Automated Guided Vehicle Systems, Monorails and other Rail Guided Vehicles, Conveyor Systems, Analysis of Material Transport Systems. Storage Systems, Storage System Performance, Storage Location Strategies, Conventional Storage Methods and Equipment, Automated Storage Systems, Engineering Analysis of Storage Systems. Automatic data capture-overview of Automatic identification methods, bar code technology, other ADC technologies. [14 Hrs]

UNIT - II:

1.**Manual Assembly Lines**

Fundamentals of Manual Assembly Lines, Alternative Assembly Systems, Design for Assembly, Analysis of Single Model Assembly Lines, Line balancing problem, largest candidate rule, Kilbridge and Wester method, and Ranked Positional Weights Method, Mixed Model Assembly Lines, Considerations in assembly line design.

2.**Transfer lines**

Fundamentals of Automated Production Lines, Storage Buffers, and Applications of Automated Production Lines. Analysis of Transfer Lines with no Internal Storage, Analysis of Transfer lines with Storage Buffers. [14 Hrs]

UNIT- III:

Automated Assembly Systems, Fundamentals of Automated Assembly Systems, Design for Automated Assembly, and Quantitative Analysis of Assembly Systems - Parts Delivery System at Work Stations, Multi- Station Assembly Machines, Single Station Assembly Machines, Partial Automation. R22M.Tech. CAD/CAM JNTUH [08 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Automation, Production systems and computer integrated manufacturing by Mikel P. Groover, Pearson Education.
2. CAD CAM: Principles, Practice and Manufacturing Management by Chris Mc Mohan, Jimmie Browne, Pearson Edu. (LPE)
3. Automation by Buckinghsm W, Haper & Row Publishers, New York, 1961 3. Automation for Productivity by Luke H.D, John Wiley & Sons, New York, 1972.

9. ADVANCES IN COMPUTER AIDED PROCESS PLANNING

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

UNIT- I:

Introduction: The Place of Process Planning in the Manufacturing Cycle-Process planning and production Planning-Process planning and Concurrent Engineering, CAPP, Group Technology.

[08 Hrs]

UNIT- II:

1.Part Design Representation

Design Drafting-Dimensioning-Conventional Tolerance- Geometric Tolerance-CAD-nput/output devices -Topology - Geometric Transformation – Perspective Transformation-Data Structure-Geometric modelling for process planning--GT Coding-The OPITZ system-The MICLASS System.

2.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. [16 Hrs]

UNIT- III:

Computer Aided Process Planning Systems: Logical Design of process planning-Implementation Considerations-Manufacturing system components, Production Volume, No. of production families - CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP. UNIT-V: An Integrated Process Planning Systems: Totally integrated process planning systems-An Overview- Modulus Structure-Data Structure-Operation-Report Generation, Expert process planning [12 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Gideon Halevi and Roland D. Weill, "Principle of process planning- A Logical Approach & quot;, Chapman & Hall, 1995
2. Chang T. C. & Richard A. Wysk, "An Introduction to automated process planning systems & quot;, Prentice Hall 1985.
3. Chang, T.C., "An Expert Process Planning System", Prentice Hall,1985
4. Nanua Singh, & quot; Systems Approach to Computer Integrated Design and Manufacturing & quot;, John Wiley &Sons,1996 3. Rao P.N., & quot; Computer Aided Manufacturing & quot;, Tata McGraw Hill Publishing Co.,2000

10.ADVANCES IN MECHANICAL ENGINEERING (DESIGN ENGINEERING)

1. Advanced Theory of Vibrations

Teaching Scheme:	Examination Scheme:
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I :

1. **Fundamentals of Vibration**

   Review of Single and Two degree freedom systems subjected to Forced and Motion Excitation. Response to arbitrary periodic and a periodic excitations Impulseresponse - Transient vibration - Laplace transformation formulation. Fourier transforms- definition, Relation to transfer functions, first order systems, applications. Basic Concepts like Passive, Semiactive and Active Parameters.

2. **Two Degree Freedom System**

   Optimum design of single, two degree of freedom systems, Vibration Absorber and Vibration isolators. [09 Hrs]

Unit II:

3. **Multi Degree Freedom System**

   Normal mode of vibration - Flexibility matrix and stiffness matrix- Eigen value and Eigen vector – Orthogonal properties - Modal matrix - Modal analysis – Forced vibration by matrix inversion - Modal damping in forced vibration - Numerical methods of determining natural frequencies.

4. **Vibration of Continuous Systems**

   Systems governed by wave equations - Vibration of strings -Vibration of rods - Euler's equation for beams - Effect of rotary inertia and shear deformation -Vibration of plates.

   [09 Hrs]

Unit III:

5. Experimental Methods in Vibration Analysis: Vibration instruments - vibration exciters Measuring Devices - Analysis - Vibration Tests - Free and Forced Vibration tests. Collection of FRF, experimental modal analysis methods, Examples of vibration tests - Industrial case studies.
6. Analytical Dynamic Analysis: Dynamic analysis - Equation of motions - Mass matrices –

Free vibration analysis - Natural frequencies of Longitudinal - Transverse and torsional vibration -Introduction to transient field problem.

7. Validation of Analytical Models: Preliminary check, correlation of analytical model with experimental model, model updating- fundamentals. [09 Hrs]

Unit IV:

8. Non-Linear Vibrations: Introduction, Sources of nonlinearity, Qualitative analysis of nonlinear systems. Phase plane, Conservative systems, Stability of equilibrium, Limit cycles-van der polo scillator, Perturbation method, Chaos, Method of iteration, Self-excited oscillations, Lind stedt's Method.
9. Random Vibrations: Random phenomena, Time averaging and expected value, Frequency response function, Probability distribution, Correlation, Power spectrum and power spectral density, Fourier transforms, FTs and response. [09 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Rao, J.S. & Gupta K., "Ind. Course on Theory and Practice Mechanical Vibration", New Age International (P) Ltd., 1984.
2. Thomson, W.T., "Theory of Vibration with Applications" CBS Publishers and Distributors, New Delhi ,1990
3. Den Hartog, J.P., "Mechanical Vibrations", Dover Publications, 1990.
4. Rao, S.S., "Mechanical Vibrations", Addison Wesley Longman, 1995.
5. D.J. Ewins, Modal Testing: Theory and Practice, Research Press Ltd, Letch worth (Here fordshire,England) (1984).
6. M.I. Friswell, J.E. Mottershead, Finite Element Model Updating in Structural Dynamics (Solid Mechanics & Its Applications.) Kluwer Academic Publishers (1995)
7. Mechanical Vibrations - S. Graham Kelly, Schaum's Outlines, Tata McGraw Hill, 20078. Elements of Vibration Analysis, Lenord Meirovitch, Mc,Graw Hill Ltd, 2004
9. Vibration: Fundamental and Practice, Clarence W. de Silva, CRC Press LLC, 2000.
10. Fundamentals of Mechanical Vibration. - S. Graham Kelly. 2 nd edition McGraw Hill.

11. Mathematical Modeling and Optimization

Teaching Scheme:	Examination Scheme:
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I:

Research Modeling: The Reality, the experiment and the model, Concept of modeling, Models as Approximations ,Types of Modeling, Need and Classification of mathematical modeling, Use of Analogy, Data consideration and Testing of Models, Modeling of dynamic systems with differential equations [08 Hrs]

Unit II:

Simulation : Simulation of data in the form of mathematical equations, Linear-Non-linear equations, determining the Unknowns of Equations using Least Square Criterion, Process of Simulation, Steps andFeatures of Simulation Experiments and their Validation.

[08 Hrs]

Unit III:

a. Classical Optimization Techniques: Single-variable and Multi-variable Optimization, Hessian Matrix, Saddle Point, Lagrange Multipliers Method and Kuhn-Tucker Conditions.

b. Single-variable Optimization Techniques: Linear and Non-Linear behavior, Unrestricted Search, Solution using Graphical Method and Numerical Methods, Interval-halving Method, Golden section Method, Newton Method, Secant Method c. Multi-variable Optimization Techniques:, Non-linear Equations, Steepest Descent Method, Conjugate Gradient Method, Davidson- Fletcher-Powell Method [12 Hrs]

Unit IV:

Taguchi Method: Introduction, Loss Function and Signal –to-noise ratios, Control Factors and Noise Factors, Orthogonal Design, Design of Experiments, steps in carrying out experiment, analysis ofvariances etc.Term Work: Term paper based on literature survey on any advance topic in this subject. [08 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Wilkinson K.P.L. Bhandarkar, Formulation of Hypothesis, Himalaya Publishing House
2. Ranjit Kumar, (2006), Research Methodology – A Step-By-Step Guide for Beginners, (Pearson Education, Delhi) ISBN : 81-317-0496-3
3. C.R. Kothari, “Research Methodology”, Wiley Eastern Publication.
4. Dr S.S. Rao, ”Optimization Theory and Applications”, Wiley Eastern Ltd., New Age International, New Delhi, 2nd Edition, 1994.
5. Adler and Granovky, ”Optimization of Engineering Experiments”, Meer Publications

12. Analysis and Systhesis of Mechanisms

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I :

1. **Basic Concepts**

   Definitions and assumptions, planar and spatial mechanisms, kinematic pairs, degree of freedom

2. **Kinematic Analysis Of Complex Mechanisms**

   velocity-acceleration analysis of complex mechanisms by the normal acceleration and auxiliary point methods. [06 Hrs]

Unit II:

3. Dynamic Analysis of Planar Mechanisms: - Inertia forces in linkages, kinetostatic Analysis of mechanisms by matrix method. Analysis of elastic mechanisms, beam element, displacement fields forbeam element, element mass and stiffness matrices, system matrices, elastic linkage model, equations ofmotion.

4. Curvature theory: Fixed and moving centrodes, inflection circle, Euler- Savy equation, Bobillier constructions, cubic of stationary curvature, Ball's point, Applications in dwell Mechanisms [10 Hrs]

Unit III:

5. Graphical Synthesis of Planar Mechanisms: Type, number and dimensional synthesis, function generation, path generation and rigid body guidance problems, accuracy (precision) points, Chebychev Spacing, types of errors, Graphical synthesis for function generation and rigid body guidance with two,three and four accuracy points using pole method, center point and circle point curves, Bermester points, Synthesis for five accuracy points, Branch and order defects, Synthesis for path generation. [10 Hrs]

Unit IV:

6. Analytical synthesis of Planar Mechanisms:- Analytical synthesis of four-bar and slider-crank mechanism, Freudenstein's equation, synthesis for four accuracy points, compatibility

condition, synthesis of four-bar for prescribed angular velocities and accelerations using complex numbers. Complex numbers method of synthesis, the dyad, center point and circle point circles, ground pivot specifications, three accuracy point synthesis using dyad Method, Robert Chebychev theorem, Cognates

7. Kinematic Analysis of Spatial Mechanisms : Denavit-Hartenberg parameters, matrix method of analysis of spatial mechanisms. [10 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Theory of Machines and Mechanisms, A. Ghosh and A.K.Mallik, Affiliated East-West Press.
2. Kinematic Synthesis of Linkages, R. S. Hartenberg and J. Denavit, McGraw-Hill.
3. Mechanism Design - Analysis and Synthesis (Vol.1 and 2), A. G. Erdman and G. N. Sandor, Prentice Hall of India.
4. Theory of Machines and Mechanisms, J. E. Shigley and J. J. Uicker, 2nd Ed., McGraw-Hill.
5. Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines, Robert L.Norton, Tata McGraw-Hill, 3rd Edition.
6. Kinematics and Linkage Design, A.S.Hall, Prentice Hall of India.

13. Advanced Finite Element Analysis

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I :

1. Introduction to Finite Element Method :

Engineering Analysis, History, Advantages, Classification, Basic steps, Convergence criteria, Role of finite element analysis in computer-aided design., Mathematical Preliminaries, Differential equations formulations, Variational formulations, weighted residual methods.

2. One-Dimensional Elements-Analysis of Bars and Trusses:

Basic Equations and Potential Energy Functional, 1-D Bar Element, trusses, Admissible displacement function, Strain matrix, Stress recovery, Element equations, Stiffness matrix, Consistent nodal force vector: Body force, Initial strain, Assembly Procedure, Boundary and Constraint Conditions, Single point constraint, Multi-point constraint, 2-D Bar Element, Shape Functions for Higher Order Elements. [09 Hrs]

Unit II :

3. Two-Dimensional Elements-Analysis of Plane Elasticity Problems:

Three-Noded Triangular Element (TRIA 3), Four-Noded Quadrilateral Element (QUAD Shape functions for Higher Order Elements (TRIA 6, QUAD 8).

4. Axi-symmetric Solid Elements:

Analysis of Bodies of Revolution under axi-symmetric loading: Axisymmetric Triangular and Quadrilateral Ring Elements. Shape functions for Higher Order Elements.

5. Three-Dimensional Elements:

Applications to Solid Mechanics Problems: Basic Equations and Potential Energy Functional, Four-Noded Tetrahedral Element (TET 4), Eight-Noded Hexahedral Element (HEXA 8), Tetrahedral elements, Hexahedral elements: Serendipity family, Hexahedral elements: Lagrange family. Shape functions for Higher Order Elements [09 Hrs]

Unit III:

6. Beam Elements:

Analysis of Beams and Frames: 1–D Beam Element, 2–D Beam Element, Problems, plate bending and shell elements.

7. Heat Transfer and Fluid Flow:

Steady state heat transfer, 1 D heat conduction governing equation, boundary conditions, One dimensional element, Functional approach for heat conduction, Galerkin approach for heat conduction, heat flux boundary condition, 1 D heat transfer in thin fins. Basic differential equation for fluid flow in pipes, around solid bodies, porous media. [09 Hrs]

Unit IV :

8. Dynamic Considerations:

Formulation for point mass and distributed masses, Consistent element mass matrix of one dimensional bar element, truss element, axisymmetric triangular element, quadrilatateral element, beam element. Lumped mass matrix, Evaluation of Eigen values and Eigen vectors, Applications to bars, stepped bars, and beams. Introduction to FE Software Packages, Algorithmic approach for developing the code by the individuals

9. Non-linear Analysis

Sources and types of non-linearity, Incremental approach to solution of nonlinear problems, Iterative solution methodologies, Considerations for simulation of non-linear problems

[09 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Rao S. S. “Finite Elements Method in Engineering”- 4th Edition, Elsevier, 2006

2. Frank L. Stasa,” Applied finite Element Analysis for Engineers”, CBS International Edition, 1985.

3. J.N.Reddy, “Finite Element Method”- McGraw -Hill International Edition.

4. Bathe K. J. Finite Elements Procedures, PHI. Cook R. D., et al. “Concepts and Application of Finite

Elements Analysis”- 4th Edition, Wiley & Sons, 2003.

5. Chandrupatla T. R., “Finite Elements in engineering”- 2nd Editions, PHI, 2007.2.

6. Zeinkovich, “The Finite Element Method for Solid and Structural Mechanics, 6th Ed., Elsevier 2007.

14. NOISE VIBRATION AND HARSHNESS

Teaching Scheme:	Examination Scheme:
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I :

1.Introduction to NVH:

Sources of noise and vibration. Design features, Common problems, Marque values, Noise quality. Pass by Noise requirements. Target vehicles and objective targets. Development stages in a new vehicle programme and the altering role of NVH engineers.

2.Sound and vibration theory:

Sound measurement, Human sensitivity and weighting factors. Combining sound sources. Acoustical resonances. Properties of acoustic materials. Transient and steady state response of one degree of freedom system applied to vehicle systems. Transmissibility, Modes of vibration. [12 Hrs]

Unit II :

3.Test facilities and instrumentation:

Laboratory simulation: rolling roads (dynamometers), road simulators, semi-anechoic rooms, wind tunnels, etc. transducers, signal conditioning and recording systems. Binaural head recordings, sound intensity technique, Acoustic holography, statistical Energy Analysis. [12 Hrs]

Unit III:

4.Signal Processing:

Sampling, aliasing and resolution. Statistical analysis. Frequency analysis. Campbell's plots, cascade diagrams, coherence and correlation functions. [06 Hrs]

Unit IV:

5.NVH control Strategies & comfort:

Source ranking. Noise path analysis. Modal analysis. Design of Experiments, optimization of dynamic characteristics. Vibration absorbers and Helmholtz resonators. Active control techniques. [06 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Norton M. P., Fundamental of Noise and vibration, Cambridge University Press, 1989
2. Munjal M. L., Acoustic Ducts and Mufflers, John Wiley, 1987
3. Baxa, Noise Control of Internal Combustion Engine, John Wiley, 1984
4. Ewins D. J., Model Testing: theory and practice, John Wiley, 1995
5. Boris and Kornev, Dynamic Vibration Absorbers, John Wiley, 1993
6. Mcconnell K, “Vibration testing, Theory and practice”, John Wiley, 1995.
7. Wong J Y, “Theory of Ground Vehicles”, John Wiley & Sons, New York, 1978.

15. Optimization Techniques

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I :

A. **Linear models**

1. Linear programming-extensions: Revised simplex method, Dual Simplex method, Bounded variables method, primal-dual relationships, duality theorems, economic interpretation of dual, dual of transportation model, sensitivity analysis in LPP and transportation models, Karmarkar's interior point algorithm

2. Dynamic programming: formulation, recursive approach, Goal programming: formulation, graphical solution, algorithm [10 Hrs]

Unit II :

3. Integer programming: Formulation, Cutting plane algorithm, Branch and bound algorithm Nonlinear models:

4. Classical Optimization: Single and Multi-variable Optimization, Hessian Matrix, Saddle Point, Lagrange Multipliers, Kuhn-Tucker Conditions [08 Hrs]

Unit III :

5. Single-variable Optimization: Unrestricted Search, Exhaustive Search, Dichotomous Search, Interval-halving Method, Fibonacci Method, Golden section Method, Quadratic Interpolation Method, Newton Method, Quasi- Newton Method, Secant Method

6. Multi-variable Optimization: Evolutionary Optimization Method, Simplex Search Method, Pattern Search Method [10 Hrs]

Unit IV :

7. Conjugate Direction Method, Steepest Descent Method, Newton's Method, Conjugate Gradient Method, Davidon-Fletcher-Powell Method

8. Introduction to Constrained Optimization: Interior Penalty Function Method, Exterior Penalty function Method [08 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Introduction to Operations Research, Hillier and Lieberman, Tata McGraw Hill

2. Quantitative techniques in Management by N D Vohra, McGraw Hill

3. Deb K (2004). Optimization for Engineering Design: Algorithms and Examples, Prentice Hall of India.

4. Rao S (1996). Engineering optimization, Theory and Practice, New Age International Publishers

5. Ravindran A, Ragsdell K and Reklaitis G (2006). Engineering Optimization: Methods and Applications, 2nd edition, John Wiley and Sons Inc.

16.Mechatronics System Design

Teaching Scheme:	Examination Scheme:
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I :

1. **Introduction**

   Introduction to mechatronic system, evolution, scope and components of mechatronic systems, mechatronics in product and measurement system, control system and modes of control, traditional design and mechatronic design

2. **Actuators, Sensors and Transducers**

   Hydraulic, pneumatic and electrical actuators and their system modeling, performance terminology, system modeling of sensors; displacement, position and proximity sensors, velocity and acceleration sensors, flow sensors, force sensors, temperature sensors, ultrasonic and fibre-optic sensors, selection of sensor, piezo-electric sensors.

[08 Hrs]

Unit II :

3. **Hardware Components:**

   Number systems in Mechatronics, binary logic, Karnaugh map
   minimization, transducer signal conditioning process, principals of analogue and digital signal conditioning, protection, filtering, operational and instrumentation amplifiers and their gains, analogue to digital and digital to analogue conversion, multiplexers, pulse modulation.

4. **Programmable Logic Controller**

   Review of logic gates, basic structure, features, input/output processing, programming, functional block diagram (FBD), ladder diagram, logic functions, latching, sequencing, jumps, internal relays, counters, shift registers, master and jump control, data handling, data movement, data comparison, arithmetic operations, code conversion, analog input and output, applications for automation, diagnostics and condition monitoring.

[12 Hrs]

Unit III :

5. Microcontroller: Comparison between microprocessor and microcontroller, organization of microcontroller system, architecture of MCS 51 controller, pin diagram of 8051, addressing modes, programming of 8051, interfacing input and output devices, interfacing D/A converters and A/D converters, Various applications for automation and control purpose.

6. Real-Time Interfacing: Introduction, Elements of Data Acquisition and Control System, Overview of I/O Process, Installation of the I/O Card and Software, Installation of the application Software, Examples, Over framing. [10 Hrs]

Unit IV :

16. Advanced Applications in Mechatronics

Mechatronic control in automated manufacturing, Artificial Intelligence in mechatronics, Fuzzy Logic application in Mechatronics, Microsensors in Mechatronics, Case studies of Mechatronic systems. [06 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Mechatronics, 3/e --- W. Bolton (Pearson Education)
2. Mechatronics -Dan Necsulescu (Pearson Education)
3. The 8051 Microcontroller: Architecture, Programming and Applications, 2/e—Kenneth J. Ayala (Penram International)
4. Mechatronics: Principles, Concepts and Applications - N.P.Mahalik (TMH)

5. Introduction to Mechatronics & Measurement Systems – David G. Alciatore & Michael B. Histand (TMH)
6. Process Control & Instrumentation Technology –Critis D. Johnson (Pearson Education)
7. Mechatronics System Design - Devdas Shetty, Richard A. Kolk (CENGAGE)
8. Computer Control of Manufacturing Systems - Yoram Koren (McGraw Hill)
9. Automated Manufacturing Systems: Sensors, Actuators - S. Brain Morriss (McGraw Hill)
10. Industrial Automation – David W. Pessen (John Wiley & Sons)
11. Examples of Pneumatic Applications – FESTO Controls Pvt. Ltd. Bangalore.
12. Modular Pick and Place Device– FESTO Controls Pvt. Ltd. Bangalore.
13. Rationalization with Handling Technology– FESTO Controls Pvt. Ltd. Bangalore.
14. Rationalization with Small Workpiece Feeding- FESTO Controls Pvt. Ltd. Bangalore.
15. Sensors for Handling & Processing Technology- FESTO Controls Pvt. Ltd. Bangalore.
16. Sensors in Production Engg. - FESTO Controls Pvt. Ltd. Bangalore.
17. Handbook of Industrial Automation – Richard L. Shell & Ernest L. Hall (Marcel Decker Inc.)
18. Programmable Logic Controllers" Programming Methods and Applications (with CD Rom) –
19. Jack R. Hackworth & Fredrick D. Hackworth,Jr.(Pearson Education)

17. MEMS and Nano Technology

Teaching Scheme:	Examination Scheme:
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I :

1. **Introduction:**

   Micro-Electro-Mechanical Systems (MEMS), Microsystems and their products, miniaturization, applications, mechanical MEMS, thermal MEMS, micro-opto electro-mechanical systems, magnetic MEMS, radio frequency (RF) MEMS, micro fluidic systems, bio and chemo devices, Nanotechnology – definition, nano scale, consequences of the nano scale for technology and society, need and applications of nano electromechanical systems (NEMS)

2. **Micro Fabrication Processes & Materials**

   Materials for MEMS – substrate and wafers, silicon as a substrate material, crystal structure, single crystal and polycrystalline, mechanical properties, silicon compounds, silicon piezo-resistors, gallium arsenide, quartz, piezo-electric crystals, polymers, packaging materials; **Fabrication Processes** – Bulk micro manufacturing, photolithography, photoresists, structural and sacrificial materials, X-ray and electron beam lithography, Thin film deposition – spin coating, thermal oxidation, chemical vapour deposition (CVD), electron beam evaporation, sputtering; Doping – diffusion, ion implantation; Etching – wet etching, dry etching; Surface micromachining, bulk vs. surface micromachining; Wafer bonding – glass-frit, anodic and fusion bonding; LIGA process and applications.

   [14 Hrs]

Unit II :

3. **Micro sensors and actuators**

   Sensing and actuation, Chemical sensors, Optical sensors, Pressure sensors, Thermal sensors – thermopiles, thermistors, micro machined thermocouple probes, thermal flow sensors, MEMS magnetic sensor, Piezoelectric material as sensing and actuating elements – capacitance, piezo mechanics, Piezo actuators as grippers, microgrippers, micromotors, microvalves, micropumps, relay, microspring thermal actuator, data storage cantilever.

4.Microsystem Design

Design constraints and selection of materials, selection of manufacturing process, selection of signal transduction technique, electromechanical system and packaging.

[10 Hrs]

Unit III:

4. **Nano materials**

Molecular building blocks to nanostructures – fullerenes, nano scaled biomolecules, chemical synthesis of artificial nanostructures, molecular switches and logic gates, nano composites; Carbon nanotubes - structure, single walled, multi walled, properties of carbon nanostructures and their synthesis, Potential applications of nano-structures.

[06 Hrs]

Unit IV :

5. **Nano finishing Techniques**

Abrasive flow machining, magnetic abrasive finishing, magnet orheological finishing, elastic emission machining, ion beam machining, chemical mechanical polishing, Nano manipulation, Nanolithography, Top-down versus bottom –up assembly, Visualisation, manipulation and characterization at the nanoscale; Applications - in Energy, Tribology, Informatics, medicine, etc [06 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Bharat Bhushan (Ed.), (2004), Handbook of Nanotechnology, Spinger-Verlag Berlin Heidelberg New York, ISBN 3-540-01218-4

2. Hsu, Tai-Ran, (2003), MEMS & MICROSYSTEMS: Design & Manufacture, TMH, ISBN:0-07-048709-X

3. Mahalik, N. P., (2007), MEMS, TMH, ISBN: 0-07-063445-9

4. Mahalik, N.P. (Ed.) (2006), Micro manufacturing & Nanotechnology, Springer India Pvt. Ltd., ISBN: 978-81-8128-505-8 (Distributed by New Age International, New Delhi)

5. Nano systems: Molecular Machinery, Manufacturing & Computation, K E Drexler, (Wiley), (1992), ISBN 0471575186

6. P.Rai- Choudhury, Handbook of Microlithography, Micromachining & Micro fabrication, SPIE,1997.

7. David Ferry, Transports in Nanostructures, Cambridge University Press, 2000.

8. Poole, Charles & Owen, Frank J., - Introduction to Nanotechnology, Wiley (India) Pvt. Ltd. ISBN: 978-81-265-10993

9. Various Internet resources: www.nanotechweb.org, www.nano.gov, www.nanotec.org.uk

18. PRODUCT DESIGN & DEVELOPMENT

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I

Introduction to Design Engineering: Morphology of design, need analysis, specification of a problem. Problem formulation and problem analysis, design process and design cycle, creative design and introduction to decision making. Analysis of the product, standardization, simplification. Basic design considerations. Design for Production: Producibility requirements in the design of machine components. Design for forging, casting, machining ease and powder metallurgical parts. Strength, stiffness and rigidity considerations in product design. [12 Hrs]

Unit II

Design Optimisation: Search for alternative solution and optimization aspects in design, qualitative discussions of various optimisation techniques. [06 Hrs]

Unit III

Human factors in engineering design: Aesthetic and ergonomic considerations. Design of controls and displays. Value Engineering: Nature and measurement of value, maximum value, normal degree of value, importance of value, the value analysis job plan. Steps to problem solving and value analysis, value analysis tests, material and process selection in value engineering. [10 Hrs]

Unit IV

Economic Factors Influencing Design: Product value. Design for safety, reliability and environmental considerations. Economic analysis, profit and competitiveness, break-even analysis. Economics of a new product design. Modern Approaches to Product Design: Concurrent Design, Quality Function Deployment (QFD). [08 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Chitale and Gupta: Product Design and Manufacturing, Prentice Hall of India.
2. Ulrich, K. T., and Eppinger, S.D., Product Design and Development, McGraw-Hill.

19.ADVANCED TRIBOLOGY

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

UNIT-I Introduction

Introduction to tribology and its historical background. Industrial importance. Factors influencing tribological phenomena. Engineering Surfaces-Properties and Measurement Engineering surfaces - surface characterization, computation of surface parameters. Surface measurement techniques. Apparent and real area of contact. Contact of engineering surfaces.

[10 Hrs]

UNIT-II Surface Contact

Hertzian and Non-hertzian contact. Contact pressure and deformation in non-conformal contacts. Frition Genesis of friction, friction in contacting rough surfaces, sliding and rolling friction, Various laws and theory of friction. Stick slip friction behaviour, frictional heating and temperature rise. Friction measurement techniques. [08 Hrs]

UNIT-III Wear

Wear and wear types. Mechanisms of wear -Adhesive, abrasive, corrosive, erosion, fatigue, fretting, etc., wear of metals and non-metals. Wear models – asperity contact, constant and variable wear rate, geometrical influence in wear models, wear damage. Wear in various mechanical components, wear controlling techniques. Lubrication Introduction to lubrication. Lubrication regimes. Lubricants and their properties. Solid Lubricants.

[10 Hrs]

UNIT-IV Nano tribology

Introduction to micro and nano tribology. Measurement tools used in nano tribology: SFA, STM, AFM micro scale and nano scale wear Nano fabrication /nano machining Nano hydrodynamics Nano lubrication Tribo logical issues in MEMS. [08 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. “Engineering Tribology” by Prasanta Sahoo, PHI.
2. “Engineering Tribology” by Stachowiak& Batchelor, Elsevier.
3. “Nano tribology and Nano mechanics: An Introduction” by Bharat Bhushan, Springer.
4. “Nano tribology” by Hsu & Ying, Springer

20.EXPERIMENTAL DESIGN

Teaching Scheme:	Examination Scheme:
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

UNIT-I Introduction:

Objectives for experimental design. Basic design concepts. Steps for the design of experiments. types of experimental designs. Analysis of Means. Experimental designs and six sigma Completely Randomized Design: Model for a completely randomized design \vith a single factor. ANOM for a completely randomized design. ANOM with unequal variances. Randomized Block Design. Incomplete Block Designs. Latin Square Design. Graeco - Latin Square Design [10 Hrs]

UNIT-II Full Factorial Design with Two Levels:

Nature of Factorial Designs. Deleterious Effects of Interactions. Effect Estimates. The 23 Design. Built-in-Replication. Role of expected mean squares in experimental design Fractional Factorial Designs with Two Levels: 2 k - 1 Designs. Effect Estimates and Regression Coefficients; 2k-2 Designs. Basic Concepts; Design Efficiency; John's 3/4 Designs [10 Hrs]

UNIT-III Design with more than two levels:

3 k Designs; Conditional Effects; 3"-P Designs; Orthogonal Arrays with mixed levels [06 Hrs]

UNIT-IV Robust Design:

DOE and Taguchi Approach; Experimental Design using orthogonal arrays; Experimental Designs with Two-Level Factors only; Experimental Designs with Three and Four Level Factors; ANOV A; Analysis using Signal- to- Noise Ratios; Some case studies; QT4 Software Response Surface Methodology; Response surface experimentation; Process improvement with Steepest Ascent; Analysis of Second-order response surfaces; Central Composite Designs; Box -Behnken Designs; Analyzing the fitted surface; Design-Expert Software [10 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Modern Experimental Design by Thomas P Ryan. John Wiley
2. Response Surface Methodology by Myers R H and Montgomery Dc. John Wiley
3. Design of Experiments using the Taguchi Approach by Ranjit K Roy. John Wiley

21.ADVANCES IN MECHANICAL ENGINEERING (HEAT POWER ENGINEERING)

1.ADVANCED THERMODYNAMICS

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I.

Equation of State: State postulate for Simple System and equation of state, Ideal gas equation, Deviation from ideal gas, Equation of state for real gases, generalized Compressibility chart, Law of corresponding states [06 Hrs]

Unit II.

Properties of Pure Substances: Phase change process of pure substances, PVT surface, P-v &P- T diagrams, Use of steam tables and charts in common use [06 Hrs]

Unit III.

1.**Laws of thermodynamics**

2nd law Analysis for Engg. Systems, Entropy flow & entropy generation, Increase of e ntropy principle, entropy change of pure sub, T-ds relations, entropy generation, thermo electricity, Onsager equation. Exergy analysis of thermal systems, decrease of Exergy principle and Exergy destruction, Third law of thermodynamics, Nerst heat theorem and thermal death of universe.

2.**Thermodynamic Property Relations**

Partial Differentials, Maxwell relations, Clapeyron equation, general relations for du, dh, ds, and Cv and Cp, Joule Thomson Coefficient, Δh, Δu, Δs of real gases. [12 Hrs]

Unit IV.

Combustion Technology: Chemical reaction - Fuels and combustion, Enthalpy of formation and enthalpy of combustion, First law analysis of reacting systems, adiabatic flame temperature Chemical and Phase equilibrium - Criterion for chemical equilibrium, equilibrium constant for ideal gas mixtures, some remarks about Kp of Ideal-gas mixtures, fugacity and activity, Simultaneous relations, Variation of Kp with Temperature, Phase equilibrium, Gibb's phase rule, Gas Mixtures – Mass & mole fractions, Dalton's law of partial pressure, Amagat's law, Kay's rule. [12 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Thermodynamics – An Engineering Approach, Yunus Cengel and Michael Boles,7th Ed., Tata McGraw Hill
2. Modern Engineering Thermodynamics, Robert Balmer, Elseveir.
3. Advanced Thermodynamics for Engineers, Winterbone, John Wiley
4. Advanced Thermodynamics for Engineers, Kenneth Wark, McGraw Hill
5. Thermodynamics for Engineers, Mathur, Gupta, Metropolitan Book Co. Pvt. Ltd.
6. Fundamentals of Engineering Thermodynamics, Michael Moran, Howard Shapiro, John Wiley

22. ADVANCED HEAT TRANSFER

Teaching Scheme:	Examination Scheme:
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I.

1.**Brief introduction to different modes of heat transfer**

conduction: general heat conduction equation-initial and boundary conditions. Finite difference methods for conduction: id & 2d steady state and simple transient heat conduction problems-implicit and explicit methods.

2.**Transient heat conduction**

lumped system analysis, Heisler charts, semi-infinite solid, use of shape factors in c onduction, 2d transient heat conduction, product solutions. [10 Hrs]

Unit II.

Forced Convection

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

[06 Hrs]

Unit III.

External flows

Flow over a flat plate: integral method for laminar heat transfer coefficient for different velocity and temperature profiles. Application of empirical relations to variation geometries for laminar and turbulent flows. Internal flows: Fully developed flow: integral analysis for laminar heat transfer coefficient types of flow-constant wall temperature and constant heat flux boundary conditions hydrodynamic &thermal entry lengths; use of empirical correlations. [08 Hrs]

Unit IV.

Free convection

Approximate analysis on laminar free convective heat transfer, Boussines que approximation, different geometries, combined free and forced convection. Boiling and condensation: Boiling curve, correlations, Nusselts theory of film condensation on a vertical plate, assumptions & correlations of film condensation for different geometries.

Radiation heat transfer: Radiant heat exchange in grey, non-grey bodies, with transmitting. Reflecting and absorbing media, specular surfaces, gas radiation-radiation from flames. Radiotory heat transfer through participating medium [12 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Yunus A.Cengel, Heat and Mass Transfer – A practical Approach, 3rd edition, Tata McGraw - Hill, 2007.

2. Holman J.P, Heat Transfer, Tata Mc Graw Hill, 2002.

3. S. P.Sukhatme, A Textbook on Heat Transfer

4. OzisikM.N., Heat Transfer – A Basic Approach, McGraw-Hill Co., 1985

5. Incropera F.P. and DeWitt. D.P., Fundamentals of Heat & Mass Transfer, John Wiley & Sons, 2002.

6. Ghoshdastidar. P.S., Heat Transfer, Oxford University Press, 2004

7. M.M. Modest, Radiative Heat Transfer, Tata-McGraw-Hill

23.ADVANCED FLUID DYNAMICS

Teaching Scheme:	Examination Scheme:
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I.

Concept of continuum and definition of a fluid. Body and surface forces, stress tensor, Scalar and vector fields, Eulerian and Lagrangian approach.

Motion of fluid element - translation, rotation and vorticity; strain rate tensor, continuity equation, stream function and velocity potential. Transport theorems, constitutive equations, [08 Hrs]

Unit II.

Derivation of Navier Stokes equations for compressible flow. Exact solutions of Navier Stokes equations: plane Poiseuille flow and Couette flow, Hagen-Poiseuille flow, flow over a flat pate, cylinders and spherical bodies, Stoke's first and second problem, Hiemenz flow, flow near a rotating disk, flow in convergent- divergent channels. Slow viscous flow: Stokes and Oseen's approximation, theory of hydrodynamic lubrication. [10 Hrs]

Unit III.

Boundary layer: derivation, exact solutions, Non dimensionalization of Boundary layer equation, Blasius (similarity solution) , Falkner Skan, Von-karmon integral equation series solution and numerical solutions. Approximate methods. Momentum integral method. [06 Hrs]

Unit IV.

1.**Turbulent flow**

algebraic models, hydrodynamic stability, velocity correlations, Reynold's stresses, Prandtl's Mixing Length Theory, Karman's velocity defect law, universal velocity distribution, Plane and axi-symmetric jets, Two equation model(k-epsilon), large eddy simulation.

2.**Compressible flow**

1D flow, speed of sound, variable c/s flow , converging-diverging nozzle, normal shock relation, past slender bodies, compressible boundary layer. Computational fluid dynamics: Introduction, fundamentals of numerical analysis of partial differential equations (PDE).

[12 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. F.M.White ,Fluid Mechanics, McGraw-Hill

2. K.Muralidhar and Bishwas, Advance Engineering fluid mechanics, Alpha science international limited

3. Fox and McDonald, Introduction to Fluid Mechanics, J.H. Wiley and Sons.

4. S.M.Yahya, Fundamentals of Compressible Flow, Wiley Eastern Ltd.

5. H. Schlichting, Boundary Layers Theory, McGraw-Hill.

6. J.M.Robertson, Hydrodynamics in Theory and Application, Prentice Hall.

7. A.H.Shapiro, The Dynamics and Thermodynamics of Compressible Fluid Flow, Ronald

24.ENERGY ANALYSIS OF THERMAL SYSTEMS

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I.

Exergy Destruction: Lost available work referred to heat engine cycle, refrigeration cycle, heat pump cycle, non-flow and steady flow processes, Mechanism of exergy destruction, modified Gouy-Stodola theorem, concept of effective temperature [06 Hrs]

Unit II.

1.**Exergy Analysis of Simple Processes**

Mixing and separation process of fluids of different temperature, heat transfer across a temperature difference, expansion and compression process, combustion process.

2.**Energy Analysis of Power Plant Cycles**

Maximum power subject to size constraint with fixed heat input and its application to Brayton cycle Steam turbine power plants: External and internal irreversibility, superheater, reheater, vacuum condenser, regenerative feed water heating, combined feed water heating and reheating. [12 Hrs]

Unit III.

1.**Gas turbine power plant:** External and internal irreversibility, regeration, reheater, and intercooler, combined steam and gas turbine power plant.

2.**Exergy analysis of Refrigeration cycle:** Joule-Thomson Expansion, Work-Producing Expansion, Brayton Cycle, Optimal Intermediate Cooling, Exergy analysis of Air-conditioning applications: Mixtures of air and water vapour, total flow exergy of humid air & liquid water, Evaporative cooling process and other aspects,Cryogenic systems and small capacity units. [12 Hrs]

Unit IV.

Exergy-economic Analysis: Fundamental of exergy-economics, exergy costing of different thermal components: steam or gas turbine, boiler, cogeneration system

[06 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Advanced Engineering Thermodynamics by Adrian Bejan, John Wiley & Sons, Inc.

2. The Exergy Method of Thermal Plant Analysis by T J Kotas, Krieger Publishing Company 3. Thermal Design and Optimization by Adrian Bejan, George Tsatsaronis, Michael Moran, John Wiley & Sons, Inc.

4. Advance Thermodynamics for Engineers by Winterbore D E, Arnold Publication

5. Advanced Thermodynamics for Engineers by Kenneth Wark, McGraw Hill Publishing Co. Ltd.

6. Fundamentals of Engineering Thermodynamics by Michel J Moran, Howard N Shapiro, Daisie D Boettner, Margaret B Bailey, John Wiley & Sons, Inc.

25.ADVANCED REFRIGERATION AND AIR CONDITIONING

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I.

1.Vapor compression refrigeration, actual cycle, second law efficiency, multistage compression with inter-cooling, Multi-evaporator systems, Cascade systems.

2.Performance characteristics and capacity control of reciprocating and centrifugal compressors, screw compressor and scroll compressor, compressor motor selection

3.Design, selection of evaporators, condensers, system balance, control systems.

[12 Hrs]

Unit II.

History, Nomenclature, Refrigerants, alternative refrigerants, CFC/HCFC phase-out regulations, action with lubricating oil, retrofitting, refrigerant blends, effects on refrigeration components. Thermoelectric and nonconventional refrigeration systems, adiabatic de-magnetization. [08 Hrs]

Unit III.

Vapor absorption refrigeration, Li-Br and aqua ammonia system, calculation of mass flow rate and system performance, energy balance, controls, analysis of rectifier and analyzer, single effect and double effect systems, vapor transformer. [08 Hrs]

Unit IV.

Air-conditioning systems: central and unitary systems, design of various components, humidification and dehumidification equipments, automatic controls. Energy conservation and air conditioning for special applications, Waste heat recovery, industrial air-conditioning, textile processing. [08 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Stoecker W. F. and Jones J. P.,Principles of Refrigeration and air-conditioning, McGraw Hill
2. Arora C. P., Refrigeration and air-conditioning, Tata McGraw Hill.
3. Gosney W. B., Principles of refrigeration, Cambridge University Press.
4. Stoecker W. F., H. B. of Industrial refrigeration, McGraw Hill Companies, Inc.
5. Dossat R. J., Principles of Refrigeration, Pearson Education
6. ASHARAE Hand Book

26.ADVANCED IC ENGINES

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I.

1.Spark Ignition Engines Mixture requirements, Fuel Induction systems, Stages of combustion, Normal and abnormal combustion, factors affecting knock, Combustion chambers, Engine design, Basic concepts of SI engine simulation technique.

2.Compression Ignition Engines Stages of combustion in C.I. Engine, Direct and indirect Injection systems, Combustion chambers, Fuel spray behavior, spray structure, spray characteristics, air motion, engine design, Basic concepts of CI engine simulation technique.

3.Fuels for SI and CI Engines Qualities of SI & CI engine fuels, rating of SI & CI engine fuels, fuel additives for SI & CI engines, Fuel supply systems for SI and CI engines to use gaseous fuels like hydrogen, CNG, biogas and, other possible fuels. [16 Hrs]

Unit II.

Super-charging and Turbo-charging Purpose of supercharging, effects of supercharging on SI & CI engines performance and its limitations, different types of turbo-charges, methods of turbo charging & its limitations. [06 Hrs]

Unit III.

Engine Emissions & Control: Air pollution due to IC engines, Emissions-HC, CO, NOx, particulates, GHGs (CO2, CH4 and N2O), emission norms, emission control methods-exhaust gas recirculation, three-way catalytic convertor, particulate trap, modern methods. [06 Hrs]

Unit IV.

Recent Trends Homogeneous Charge Compression Ignition Engine, Lean Burn Engine, Stratified Charge Engine, Electronic Engine Management, Common Rail Direct Injection Diesel Engine, Gasoline Direct Injection Engine, Data Acquisition System –pressure pick up, charge amplifier PC for Combustion and Heat release analysis in Engines. [08 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. E.F. Obert, Internal Combustion Engines and Air Pollution, Intext Educational Publishers, 1973.

2. John B Heywood, Internal Combustion Engine Fundamentals, McGraw Hill

3. M.L. Mathur and R.P.Sharma, Internal Combustion Engines, DhanapatRai Publications, New Delhi.

4. L.C. Litchy, Combustion Engines Processes, McGraw Hill, 1967.

5. V. Ganesan, Int. Combustion Engines, II Edition, TMH, 2002.

6. V. Ganesan, Computer simulation of spark ignition process: University process, Hyderabad 1993.

27.CRYOGENIC ENGINEERING

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I.

Introduction: Industrial applications, research and development, properties of cryogenic fluids-oxygen, nitrogen, air, hydrogen and helium. Behaviour of Structural Materials at Cryogenic temperature: Mechanical properties, thermal properties, thermoelectric properties. [08 Hrs]

Unit II.

Liquefaction of Cryogenic Gases: Inversion Temperature, Liquefaction Performance Parameters, Ideal cycle, liquefaction of air, Hydrogen and helium, critical components of liquefiers, efficiency, Cryogenic heat exchangers. Separation of Gases: Ideal separation, properties of mixtures, Rectifiers column, separation of air, purification. [08 Hrs]

Unit III.

1.**Cryogenic Refrigeration Systems**

Ideal refrigeration systems, J-T Refrigeration systems, Philips refrigerator, Vuilleumier refrigerator, Solvey refrigerator, G-M regrogerator.

2.**Insulation**

Vacuum insulation, fibrous materials, Solid foams, Gas filled power, omparison, critical thickness. [10 Hrs]

Unit IV.

1.**Storage**

Size and shape of vessel, portable commercial containers, large stationary container, power, transport, storage system, Liquid level indicators.

2.**Transfer of Liquefied Gases**

Two phase flow transfer through insulated and uninsulated lines, cryogenic pumps and valves. [10 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. R. F. Barron, Cryogenic Systems, Oxford University Press, 1985.

2. Advanced Cryogenic Engineering, Proceedings of Cryogenic Engineering Conference, Vol 1-145, Plenum press, New York, 1968.

28.ALTERNATIVE FUELS FOR IC ENGINES

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I.

Introduction Need for alternate fuel, availability and properties of alternate fuels, general use ofalcohols, LPG, hydrogen, ammonia, CNG and LNG, vegetable oils and biogas, merits and demerits of various alternate fuels, introduction to alternate energy sources. Like Electric vehicle, hybrid, fuel cell and solar cars. [08 Hrs]

Unit II.

1.Alcohols Properties as engine fuel, alcohols and gasoline blends, performance in SI engine, methanol and gasoline blends, combustion characteristics in CI engines, emission characteristics ,DME, DEE properties performance analysis, performance in SI & CI Engines.

2.CNG, LPG, Hydrogen and Biogas Availability of CNG, properties, modification required to use in engines, performance and emission characteristics of CNG, LPG and Biogas using in SI & CI engines, Hydrogen; storage and handling, performance and safety aspects.

3.Vegetable Oils Various vegetable oils for engines, transe sterification, biodiesel and its properties, performance, emission and combustion characteristics of engine. [14 Hrs]

Unit III.

Electric and Hybrid Vehicle Layout of an electric vehicle, advantage and limitations, specifications, system components, electronic control system, high energy and power density batteries, hybrid vehicle. [06 Hrs]

Unit IV.

Fuel Cell and Solar Fuel cell vehicles, specifications, system components, selection of fuel cell, thermal management, maintenance, advantage and limitations, Solar powered vehicles, specifications, system components, advantage and limitations [08 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. M.K. Gajendra Babu, K.A. Subramanian, Alternative Transportation Fuels: Utilization in Combustion Engines, CRC Press, 2013.

2. Richard L. Bech fold, Alternative Fuels Guide Book - SAE International Warrendale 1997. 3. B. P. Pundir, Engine Emissions, Alpha Science International Limited, 2007

4. B. P. Pundir, IC Engines Combustion and Emissions, Alpha Science International Limited, 2010.

5. Nagpal, Power Plant Engineering, Khanna Publishers - 1991.

29.DESIGN OF HEAT TRANSFER EQUIPMENTS

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I.

1.**Classification of Heat Exchangers**

Introduction, Classification, Overview of Heat Exchanger Design Methodology, Process and Design Specifications, Thermal and Hydraulic Design, Mechanical Design, Optimum Design , Heat Exchanger Variables and Thermal Circuit, Assumptions, Basic Definitions, ε - NTU Method , The P-NTU Method , TEMA , Multi-pass Exchangers, LMTD, Heat Exchanger Arrays and Multi-passing, Sizing and Rating Problems, Kern Method, Bell Delaware Method, Numerical on Shell and tube HEX.

2.**Solution Methods for Determining Exchanger Effectiveness**

Exact Analytical Methods, Approximate Methods, Numerical Methods, Matrix Formalism, Chain Rule Methodology, Flow-Reversal Symmetry, Design Problems, Longitudinal Wall Heat Conduction Effects, Multipass Exchangers, Non-uniform Overall Heat Transfer Coefficients, Temperature - Length - Combined Effect [10 Hrs]

Unit II.

1.**Heat Exchanger Pressure Drop Analysis**

Importance of Pressure Drop, Devices, Extended Surface Heat Exchanger Pressure Drop, Tubular Heat Exchanger Pressure Drop, Tube Banks, Shell-and-Tube Exchangers, Plate Heat Exchanger Pressure Drop, Pipe Losses, Non-dimensional Presentation of Pressure Drop Data

2.**Heat Transfer Characteristics**

Dimensionless Surface Characteristics, Experimental Techniques for Determining Surface Characteristics, Steady-State Kays and London Technique, Wilson Plot Technique, Transient Test Techniques, Friction Factor Determination, Hydrodynamic ally Developing Flows, Thermally Developing Flows, Extended Reynolds Analogy, Heat Exchanger Surface Geometrical Characteristics, Selection of Heat Exchangers and Their Components, Temperature Difference Distributions [10 Hrs]

Unit III.

Cooling tower fundamentals: Types, Nomenclature, material for construction, Structural components in details, Mechanical components (Fan, Speed reducer, Valves, Safety), Electrical components, Thermal performance testing – conduction and evaluation.

[06 Hrs]

Unit IV.

1.**Furnaces**

Furnace, Types, Parts used in furnace, Nozzles used, Heat transfer related design of systems, Insulations, Applications in process industries.

2.Thermal Devices

Heat pipe, Thermal interface material, use of nano particle in heat transfer equipments, Steam Trap, Electronics cooling systems, Thermal interface materials, Heat transfer augmentation techniques [10 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Cooling Tower, Fundamentals- John C. Hensley, SPX Cooling Technologies
2. Heat exchangers Selection, Rating and Thermal Design – Sadik Kakac,Hongtan Liu,Anchasa Pramunjanaroenkij, CRC Press
3. Process Heat Transfer – Donald Q. Kern, Tata McGraw-Hill
4. Process Heat Transfer – Hewitt ,Shires & Bott, CRC Press
5. Heat Pipes Theory, Design & Applications – D.A. Reay, P.D.Dunn, Pergamon
6. Cooling Techniques for Electronic Equipment– Dave S. Steinberg, Wiley-InterScience Publication
7. Fundamentals of Heat Exchanger Design -Ramesh K. Shah, Dusan P. Sekulic,WileyIndia

30.MODELING AND ANALYSIS IN THERMAL ENGINEERING

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I.

Introduction: Engineering Design, design and analysis, Workable and optimum system, formulation Thermal systems, basic characteristics and analysis. [06 Hrs]

Unit II.

1.**Modeling of Thermal systems**

Procedure of mathematical modeling, basic features of modeling, System and types of Model, characteristic of models, Curve fitting, exact fit, best fit.

2.**Modeling and analysis of thermal systems, including**

thermodynamics, fluid mechanics, heat and mass transfer, refrigeration and air-c onditioning, system components (heat exchangers, expansion devices, pumps, c ompressors, turbines, boilers). [12 Hrs]

Unit III.

1.Thermal system simulation Sequential simulation, simultaneous simulation, successive substitution, Newton-Raphson method.

2.Optimization of thermal systems, formulation, optimization methods; Lagrange Multipliers, Search Methods, Linear programming, Dynamic programming and geometric programming.

[12 Hrs]

Unit IV.

Develop methodologies for the design and optimization of thermal systems. A non-linear equation solver, Engineering Equation Solver (EES), Pinch technology: basic concepts, T-h, h-s diagrams, design of recovery system using pinch technology [06 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Yogesh Jaluria,Design and Optimization of Thermal Systems, McGraw Hill Companies, Inc.
2. W.F.Stoecker: “Design of Thermal Systems”, 3rd Ed., McGraw Hill,1989.
3. B.K.Hodge: “Analysis and Design of Thermal Systems”, Prentice Hall Inc., 1990.
4. I.J.Nagrath&M.Gopal: “Systems Modeling and Analysis”, Tata McGraw Hill.
5. D.J. Wide: “Globally Optimal Design”, Wiley- Interscience, 1978.
6. R.F.Boehm, Design Analysis of Thermal systems, John Willey and son's
7. A. Bejan,M.moran, Thermal Design and Optimization, John Willey and son's

31. **ADVANCES INMECHANICAL ENGINEERING(PRODUCTIONENGINEERING)**

Supply Chain Management & Logistics

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I:

1. Introduction and overview of supply chain management, inbound and outbound logistics, supply chain as a source of competitive advantage. Definition of logistics and SCM, evolution, scope, importance and decision phases – drivers of sc performance and obstacles.
2. Supply chain network design: distribution in supply chain – factors in distribution network design

   –design options-network design in supply chain – framework for network decisions - managing cycle inventory and safety.
3. Sourcing, and pricing in supply chain: supplier selection and contracts - design collaboration - procurement process. Revenue management in supply chain
4. Strategic considerations for supply chain: porter's industry analysis and value-chain models, the concept of total cost of ownership, supply stream strategies, classification and development guidelines, measuring effectiveness of supply management, logistics engineering. [10 Hrs]

Unit II :

5. Operations research models for operational and strategic issues in supply chain management. The bullwhip effect and supply-chain management game. Coordination and technology in supply chain, effect of lack of co-ordination and obstacles – Information Technology and SCM - supply chain-IT framework. E-business and SCM. Metrics for supply chain performance
6. Logistics Management: Definition of logistics and the concepts of logistics. Logistics Activities: Functions of the logistics system – facility location, transportation, warehousing, order

processing, information handling and procurement, , Logistics environment, Logistics information systems, Logistics audit and control [08 Hrs]

Unit III :

7. Inbound logistics. Buyer-Vendor co-ordination, Procurement, Vendor development, reduced sourcing and supplier partnership - benefits, risks and critical success factors, multi-level supply control.
8. Distribution Management, Outbound logistics, Facility location, Classical location problems, Strategic planning models for location analysis, location models, multi objective analysis of location models.
9. Transportation alternatives and technologies; transportation performance analysis; total transportation cost analysis; fleet development and management; fleet performance indicators; routing and scheduling; shipment planning; vehicle loading; transportation management andinformation systems requirements.
10. Logistics Customer Service, Modeling logistics systems, Simulation of logistic systems, cost effective distribution strategies, Value of information in logistics, E-logistics, risk pooling effect, International and global issues in logistics, Integrated functional activities in logistics, Role of government in international logistics and Principal characteristics of logistics in various countries and regions
11. Logistics in different industries: Third party, and fourth party logistics, Reverse logistics, Airline Schedule Planning, Railway Networks, Postal services, the maritime industries, health care industry and other service industries [10 Hrs]

Unit IV :

12. Logistics in The Design and Development Phase**:** Design Process, Related Design Discipline, Supplier Design Activities, Design Integration and Reviews, Test and Evaluation. Logistics in The Production / Construction Phase: - Production / Construction Requirements, Industrial Engineering and Operations Analysis, Quality Control, Production Operation,Transition from Production to user operation.

13. Logistic in the Utilization and Support Phase: - System / Product Support, TPM, Data Collection, Analysis and System Evaluation, Evaluation of Logistic Support Elements, System Modification.5

14. Logistics in the System Requirement, Material Recycling and Disposal Logistic Management: Logistic Planning, Development of a Work Breakdown Structure, Scheduling of Logistics Tasks, Cost Estimation and control, Organization for Logistics, Management and control. [08 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. David Bloomberg, Stephen LeMay, Joe Hanna: Logistics, Prentice Hall, 2002
2. Thomas Teufel, Jurgen Rohricht, Peter Willems: SAP Processes: Logistics, Addison-Wesley, 2002.
3. Julien Bramel, David Simchi-Levi. "The logic of logistics: theory, algorithms, and applications for logistics management", Springer,2006
4. Murphy, G.J. "Transport and Distribution", 2nd Edition, Business Books
5. Ballou, R.H., Business Logistics Management/Supply Chain, 5th edition, 2004, Prentice-Hall
6. Logistics and Supply Chain Management –Strategies for Reducing Cost and Improving Service. Martin Christopher, Pearson Education Asia, Second Edition
7. Supply Chain Management, Strategy, Planning, and operation – Sunil Chopra and Peter Meindl- PHI, Second edition, 2007
8. Logistics, David J.Bloomberg, Stephen Lemay and Joe B.Hanna, Prentice Hall India 2002
9. Logistics and Supply Chain Management –Strategies for Reducing Cost and Improving Service. Martin Christopher, Pearson Education Asia, Second Edition
10. Modeling the supply chain, Jeremy F.Shapiro, Thomson Duxbury, 2002
11. Handbook of Supply chain management, James B.Ayers, St.Lucle Press, 2000.

32.Decision Making in Manufacturing Environment

Teaching Scheme:	Examination Scheme:
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I Introduction to Decision Making

Introduction, Decision-making Methods Used, Group Decision Making (GDM), A Logical Approach to Fuzzy DM Problems, i) Method Proposed by Chen and Hwang (1992) ii) Converting Linguistic Terms to Fuzzy Numbers iii) Converting Fuzzy Numbers to Crisp Scoresiv)Demonstration of the Method [09 Hrs]

Unit II Multiple Attribute Decision-making Methods

Simple Additive Weighting (SAW) Method, Weighted Product Method (WPM), Analytic Hierarchy Process (AHP) Method, Revised Analytic Hierarchy Process (RAHP) Method, Multiplicative Analytic Hierarchy Process (MAHP), TOPSIS Method, Entropy Method, Standard Deviation Method, AHP Method , Modified TOPSIS Method, Sensitivity Analysis [09 Hrs]

Unit III Applications of Fuzzy MADM Methods in the Manufacturing Environment

Material Selection for a Given Engineering Application, Evaluation of Product Designs Machinability Evaluation of Work Material, Cutting Fluid Selections for a Given Machining Application, Evaluation of Flexible Manufacturing Systems, Machine Selection in a FlexibleManufacturing Cell, [09 Hrs]

Unit IV Robot Selection for a Given Industrial

Application, Selection of Automated Inspection Systems, Selection of Material Handling Equipment, Selection of Rapid Prototyping Process in Rapid Product Development, VendorSelection in a Supply Chain Environment [09 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Rao, R.V. (2007). Decision Making in the Manufacturing Environment Using Graph Theory and Fuzzy Multiple Attribute Decision Making Methods. Springer-Verlag, London
2. Saaty, T.L., *Analytic Hierarchy Process*, (1980) McGraw Hill Publications: New York, NY.
3. Yoon, Y.P. and Hwang, C.L., (1995). *Multiple Attribute Decision Making*, SAGE Publications:Beverly Hills, CA.
4. Related journal papers

33.Metal Forming Technology

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I:

Mechanics of metal working, stress strain relationship, yield criteria, Slip line field theory, Equilibrium in Cartesian, cylindrical and spherical coordinates [10 Hrs]

Unit II:

Slab method and lower and upper bond me thods for load, their significanc e in investigating and modeling of metal working operations [10 Hrs]

Unit III:

Plastic work, work hardening, strain rate and temperature, deformation zone geometry [06 Hrs]

Unit IV:

Formability, forming limit diagram, workability in sheet metal forming, forging, rolling, and in extrusion and wire drawing [10 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. George E. Dieter - Mechanical Metallurgy, McGrew Hill, London, 1988
2. G. E. Dieter - Workability Testing Techniqu es, American Society for Metals, Metals Park, 1984
3. Metal Forming Handbook, -Schuler, Springer-Verlag Berlin Heidelberg New York, (2008) ISBN 3-540-61185-1

34.Advanced casting technology

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I:

Casting Design & Pattern / Die Making, pattern and die design considerations, Computer aided casting component design, Computer aided design and manufacturing of patterns and dies [10 Hrs]

Unit II:

Sand Molding & Core Making Practices: High pressure molding technology, flaskless molding technology, magnetic molding, Core shooters used in shell core making and cold box process [10 Hrs]

Unit III:

Permanent Mold & Special Casting Techniques: Process parameters for Die casting- gravity, pressure and low pressure, Centrifugal casting, Vacuum casting, Investment casting, Squeeze casting, [10 Hrs]

Unit IV:

Casting defects and their classification, rejection analysis, remedial measures [06 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Principles of Metal Castings - Heine, Loper and Rosenthal (TMH)
2. Advanced Pattern Making – Cox I. L. (The Technical Press, London.)
3. ASM Handbook – Vol. 15 Castings.
4. AFS and Control hand book – AFS.
5. Fundamentals of Metal Casting Techno logy - P.C. Mukherjee (Oxford, IBH)
6. Foundry Engineering – Taylor, Fleming & Wulff (John Wiley)
7. The Foseco Foundryman's Handbook, -Foseco, CBS Publishers & Distributors , ISBN: 9780750619394
8. The New Metallurgy of Cast Metals Castings – Campbell, CBS Publishers & Distributors, ISBN- 9788131200919
9. Fundamentals of Metal Casting – Flinn, Addison Wesley
10. Principles of Metal Manufacturing Proce sses, J. Beddoes & M.J. Bibby (Elsevier, Butterworth, Heinemann) (2003)

35.Manufacturing Systems

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I:

ManufacturingSystems: Structural aspects, transformational aspects, procedural aspects, integrated manufacturing systems, Mass Customization, Multi-Product Small Batch Production- Economies of Scope with Diversification [10 Hrs]

Unit II:

Logistic Systems- Material flow: conversion / transportation / storage [06 Hrs]

Unit III:

Manufacturing Optimization: Criteria for Evaluation, Optimization of single stage manufacturing- Unit production time and cost; Optimization of multistage manufacturing system [10 Hrs]

Unit IV:

Shop Floor Data Collection Systems- Types of data, on-line and off-line data collection, Automatic data collection systems. Lean Production- concept, principles, Agile Manufacturing- concept, principles [10 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Katsudo Hitomi, (1998), " Manufacturing Systems Engineering", Viva Low Priced Student Edition, ISBN 81-85617-88-0

2. B. Wu, "Manufacturing Systems Design & Analysis: Context and Techniques" (2/e), Chapman & Hall, UK, ISBN 041258140X

3. Mikell P. Groover, (2002), "Automatio n, Production Systems and Computer Integrated Manufacturing", (2/e), Pearson Education, ISBN 81-7808-511-9

4. Radhakrishan P., Subramaniyan S. and Raju V., "CAD / CAM / CIM", (3/E), New Age International Publication

36.Precision Engineering

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I :

Definition, difference in precision and accuracy, need for high precision, Classes of achievable machining accuracy – normal, precision, high precision and ultra precision machining; Concept of accuracy – part accuracy [10 Hrs]

Unit II:

Precision Machining Processes: Classification of material removal processes in terms of the energy source used and the tool-workpiece reaction [08 Hrs]

Unit III:

Diamond turning and milling – machines, tool design and alignment [06 Hrs]

Unit IV:

Fixed abrasive processes - Basic mechanic s of grinding, bondless diamond grinding wheels, jig grinding, electrolytic in-process dressing, Ultra-precision grinding, nano- grinding; Loose abrasive processes – polishing, modes of material removal [12 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Murty, R. L. (2009), - Precision Engineerin g in Manufacturing, (New Age International Publishers) ISBN: 81-224-0750-1
2. Venkatesh, V.C. & Izman, S. (2007), - Precision Engineering, (TMH), ISBN: 0-07-062090-3
3. Dornfeld, David & Lee, Dae-Eun, (2008), - Precision Manufacturing, (Springer Science + Business Media, LLC), ISBN: 978-0-387-32467-8

37.Advanced Materials & Processing

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I:

Compositions, properties and applications of: Inter-metallic, Ni and Ti aluminides, Smart materials, shape memory alloys [08 Hrs]

Unit II:

Metallic glass-quasi crystals, Dielectrics, semi conductors, conductors & super conducting materials, Polymer materials, formation of polymer structures, production techniques of fibers, foams, adhesives and coatings. [12 Hrs]

Unit III:

Composites: Fibers-glass, boron, carbon, organic, ceramic and metallic fibers, [06 Hrs]

Unit IV:

Electrochemical grinding, physical vapor deposition, chemical vapor deposition, electro-less coating and thermal metal spraying [10 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Willer, “Non- traditional Machining Processes”, SME publications.
2. G.F.Benidict, “Advanced Manufacturing Processes”, Marcel Dekker Publisher
3. E. Paul DeGarmo, J. T. Black & Ronald A. Kohser, “Materials & Processes in Manufacturing”, (PHI)
4. Geoff Eckold “Design & Manufacturing of Composite Structures”, (Jaico Publishing House)
5. S. Kalpaljian & Steven R. Schmidt, (Pearson Education) “Manufacturing Processe for Engineering Materials”,
6. Krishnan K.Chawla, “Composite Material Science and Engineering”, Springer- Verlog, 1987

38. Modern Manufacturing Systems

Teaching Scheme: PaperIII	**Examination Scheme:**
Lectures: 3 hrs./week	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I:

Concept of F.M. Cell and F.M.System, Functions of a manufacturing cell, Types and components of FMS [08 Hrs]

Unit II:

Tests of flexibility, Group Technology and FM S, Architecture of typical FMS, Shop Floor Control system, dynamic scheduling in FMS [12 Hrs]

Unit III:

Flexible Assembly Systems: Basic concepts, classification, planning and scheduling in FAS [08 Hrs]

Unit IV:

Reconfigurable Manufacturing Systems: De finition, goals, elements, rationale, characteristics, principles, RMS and FMS [08 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Ranky, Dr. Paul, (1984), "The Design & Operation of FMS",
2. Groover, Mikell P., 3/e, "Automation, Production Systems & Computer Integrated Manufacturing", Pearson Education or PHI
3. Viswanadhan, N. & Narahari, Y., "Performance Modelling of Automated Manufacturing Systems" 2/e, PHI
4. Sewik, "Production Planning & Scheduling in Flexible Assembly Systems", Springer Verla g, ISBN 3-540-64998-0
5. Changeable and Reconfigurable Manufacturing Systems (Springer Series in Advanced Manufacturing) (Ed. Hoda A. Elmaraghy)

39.Low Cost Automation

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week PaperIII	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

Unit I:

Automated manufacturing systems, reasons to justify automation, automation principles and strategies, Developing an Electro pneumatic control system- project design, selection and configuration of components and implementation [12 Hrs]

Unit II:

Programmable Logic Controllers: Brief review of structure, operation and functions, input/output of PLC, shift registers, data movement and comparison [08 Hrs]

Unit III:

Multiple actuator circuits with PLC control- sequence, latching, timers, counters; Interfacing with sensors and actuators for analog input/outputs [08 Hrs]

Unit IV:

Supervisory Control And Data Acquisition (SCADA): Concept of SCADA, its industrial significance and applications. [08 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. Automation, Production Systems & C.I. M. – Groover, Michell P. 3/e, Pearson Education
2. Pneumatic Controls – Joji P. (2008), (Wiley India), (ISBN 978-81-265-1542-4)
3. Electropneumatics, Basic Level - G. Prede, D. Scholz, (FESTO Didactic), (2002), FESTO Controls Pvt. Ltd., Bengaluru.
4. Programmable Logic Controllers: Programming Methods & Applications – John R, Hackworth & Frederick D. Hackworth, Jr. (PHI)
5. Programmable Logic Control: Principles & Applications – NIIT, (2008), (PHI)
6. SCADA, Stuart A. Boyer (ISA Publi.) ISBN 1-55617-660-0.
7. Practical SCADA for industry, David Bailey, (Elsevier Publi.) ISBN 0-7506-5805-3.

40. WORLD CLASS MANUFACTURING

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs./week PaperIII	Theory Examination: 80 Marks
Tutorial: 1hr/week	Term Work: 20 Marks

UNIT I: INDUSTRIAL DECLINE AND ASCENDANCY

Manufacturing excellence - US Manufacturers - French Manufacturers - Japan decade – American decade - Global decade [06 Hrs]

UNIT II: BUILDING STRENGTH THROUGH CUSTOMER – FOCUSED PRINCIPLES

Customer - Focused principles - General principles - Design - Operations - Human resources Quality and Process improvement - Promotion and Marketing [08 Hrs]

UNIT III: VALUE AND VALUATION

Product Costing - Motivation to improve - Value of the enterprises QUALITY - The Organization :Bulwark of stability and effectiveness - Employee stability – Quality Individuals Vs. Teams – Team stability and cohesiveness - Project cohesiveness and stability [10 Hrs]

UNIT IV: STRATEGIC LINKAGES AND IMPEDIMENTS

1.**Product decisions and customer service** - Multi-company planning - Internal manufacturing planning - Soothing the demand turbulence

2.**Bad plant design** - Mismanagement of capacity - Production Lines - Assembly Lines – WholePlant Associates - Facilitators - Teamsmanship - Motivation and reward in the age of continuous Improvement [12 Hrs]

Term Work:

The student will write a term paper in a specific area from the above syllabus describing the present status of research in that area, based on at least 20 papers published in journals of repute.

Reference Books:

1. By Richard B. Chase, Nicholas J. Aquilano, F. Robert Jacobs – "Operations Management for Competitive Advantage", McGraw-Hill Irwin, ISBN 0072323159

2. Moore Ran, "Making Common Sense Common Practice: Models for Manufacturing Excellence", Elsevior Multi worth

3. Narayanan V. K., "Managing Technology & Innovation for Competitive Advantage", Pearson Education Inc.

4. Korgaonkar M. G., "Just In Time Manufacturing", MacMillan Publishers India Ltd.,

5. Sahay B. S., Saxena K. B. C., Ashish Kumar, "World Class Manufacturing", MacMillan Publishers