UNIVERSITY INSTITUTE OF ENGINEERING & TECHNOLOGY
MAHARSHI DAYANAND UNIVERSITY, ROHTAK
SCHEME OF STUDIES & EXAMINATIONS

Doctor of Philosophy (Ph.D.) – MECHANICAL ENGINEERING
Scheme w.e.f. 2012-13

Pre-Ph-D Course

i) The duration of the Pre-Ph.D. course will be of one semester.

ii) The Department concerned shall design the Pre-Ph.D. course as per latest guide lines of UGC which are:

"The Pre-Ph.D. course must include a course on research methodology which may include quantitative methods and computer applications. It may also involve review of published research in relevant area".

iii) The scheme for Pre-Ph.D. course work is as under:

a) Common course:

      PhD-FET-101: Research Methodology (Quantitative Techniques and Computer
                           Applications in Research)

b) Departmental course:

      PhD-FET-102: Review of Literature and Seminar (in Relevant Research Area)
      PhD-FET-103: Elective Subject (Departmental Elective Subject)

iv) The qualifying marks in each paper of the course work shall be 50%.

vi) It is only on satisfactory completion of Pre-Ph.D Programme, which shall be an essential part and parcel of the Ph.D. programme that a candidate shall be eligible to apply for registration in Ph.D. Programme.

Sr. No.	Course No.	Course Title	Marks** of Internal	Examination Marks		Total Marks	Duration of Exam
				Theory	Practical		
1	PhD-FET-101	Research Methodology (Quantitative Techniques and Computer Applications in Research)	20	80	-	100	3
2	PhD-FET-102	Review of Literature and Seminar (in Relevant Research Area)	20	-	80	100	3
3	PhD-FET-103	Elective Subject (Departmental Elective Subject)	20	80	-	100	3
	Total		60	160	80	300	

** Based on two assignments of 10 marks each

PhD-FET- 101: RESEARCH METHODOLOGY
(Quantitative Techniques and Computer Applications in Research)

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions taking at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	**T**	**P/D**		
3	**-**	**-**	**Marks of Internal:**	**20**
			Examination:	**80**
Duration of Exam:		**3 Hrs**	**Total Marks:**	**100**

UNIT I: Element of Research
Scientific process meaning and definition, a brief history of scientific process. Introduction to research methodology- Meaning of research, objective of research, types of research, significance of research, problem encountered by researchers in india, Research problem- Definition, necessity and techniques of defining research problem, formulation of research problem, objective of research problem, research design- Meaning, need and features of good research design, types of research designs, basic principles of Experimental design. Sampling design, census and sample surveys, different types of sample designs, characteristics of good sample design, Techniques of selecting a random sample. Data collection-primary and secondary data, methods of selecting primary and secondary data,

UNIT II: Hypothesis & Statistical Analysis
Hypothesis- definition, testing of hypothesis, procedures of hypothesis testing, flow diagram for hypothesis testing, parametric and non-parametric tests for testing of hypothesis, limitations of tests of hypothesis. Hypothesis tests- One sample test-two sample tests/ chi square tests, association of attributes. T-tests, statistical analysis, correlation and regression analysis- analysis of variance, completely randomized design, randomized complete block design, Latin square design-partial and multiple correlations – discriminent analysis - cluster analysis – principle component and factor analysis, repeated measure analysis. Probability and probability distributions; Binomial, Poisson, distribution, Basic ideas of testing of hypotheses; Tests of significance based on normal distributions.

UNIT III: Paper Writing and Report Generation
Basic concepts of paper writing and report generation, review of literature, concepts of bibliography and references, significance of report writing, steps of report writing, types of research reports, methods of presentation of report.

UNIT IV: Computer Applications in Research
Computer Applications: Fundamentals of computers-Definition, types of computers, RAM, ROM, CPU, I/O devices, Number systems-Binary, octal and hexadecimal, base conversion, logic gates- AND, OR, NOT, Operating system-definition, types of operating system, Database system – definition & applications, Networks – definition & applications, Internet & its applications, Web Searching, Email, Uses of software's MS-Office-Power Point, Word, Excel and Access.

Text Books:
1. C. R. Kothari – Research Methodology Methods and Techniques – Wishwa Prakashan Publishers – Second Edition.

PhD- FET-102: REVIEW OF LITERATURE AND SEMINAR
(in Relevant Research Area)

1. The research student is required to prepare a concept paper/working, paper/review paper by reviewing at least 50 research papers / references books / unpublished doctoral dissertations / other reports etc.

2. To qualify the paper the research student is required either to present the prepared paper in an International Conference/ Seminar/ Workshop or publish the same in a research journal. Acceptance for publication or presentation will be considered as published/ presented.

3. A duly constituted committee of three teachers of the department by the Director/Head shall evaluate the completion of the paper.

SYLLABUS (Pre PhD-ME)

List of Electives:

PhD-ME-101	COMPUTER AIDED DESIGN
PhD-ME-102	DESIGN OF MECHANISMS
PhD-ME-103	ADVANCED MECHANICAL VIBRATIONS
PhD-ME-104	APPLIED NUMERICAL METHODS
PhD-ME-105	ADVANCED MECHANICS OF SOLIDS
PhD-ME-106	INDUSTRIAL ROBOTICS
PhD-ME-107	MEASUREMENT AND CONTROL
PhD-ME-108	EXPERIMENTAL STRESS ANALYSIS
PhD-ME-109	ADVANCED TRIBOLOGY
PhD-ME-110	OPTIMIZATION TECHNIQUES
PhD-ME-111	COMPUTER AIDED ENGINEERING
PhD-ME-112	FINITE ELEMENT METHODS
PhD-ME-113	ADVANCED FLUID ENGINEERING
PhD-ME-114	COMPUTATIONAL FLUID DYNAMICS
PhD-ME-115	ADVANCED HEAT AND MASS TRANSFER
PhD-ME-116	REFRIGERATION ENGINEERING
PhD-ME-117	AIR-CONDITIONING
PhD-ME-118	RENEWABLE ENERGY & ENERGY MANAGEMENT
PhD-ME-119	GAS TURBINE AND JET PROPULSION
PhD-ME-120	PRODUCTION PLANNING & CONTROL
PhD-ME-121	MECHATRONICS
PhD-ME-122	MATERIALS MANAGEMENT
PhD-ME-123	OPERATIONS MANAGEMENT
PhD-ME-124	STRATEGIC ENTREPRENEURSHIP
PhD-ME-125	MACHINE VISION
PhD-ME-126	PRODUCTIVITY MANAGEMENT
PhD-ME-127	ERGONOMICS
PhD-ME-128	ADVANCED MANUFACTURING TECHNIQUES
PhD-ME-129	COMPUTER AIDED MANUFACTURING
PhD-ME-130	NON-CONVENTIONAL MACHINING
PhD-ME-131	EXPERIMENTAL DESIGNS
PhD-ME-132	THERMO FABRICATION
PhD-ME-133	QUALITY & RELIABILITY MANAGEMENT
PhD-ME-134	ADVANCED INTERNAL COMBUSTION ENGINES
PhD-ME-135	DIRECT ENERGY CONVERSION
PhD-ME-136	GAS DYNAMICS
PhD-ME-137	CRYOGENICS
PhD-ME-138	NUCLEAR ENGINEERING
PhD-ME-139	SOLAR ENERGY

Note: The departmental elective subjects will be offered as per availability of expertise and the required infrastructure in the department.

(**PhD-ME-101**) COMPUTER AIDED DESIGN

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		Marks of Internal:	20
3	-	-		Examination:	80
Duration of Exam:	3 Hrs			**Total Marks:**	100

UNIT-I

Introduction
Introduction, Review of vectors & Matrices, Basics of geometric and solid modeling, explicit, implicit, intrinsic and parametric equations, coordinate systems.

Transformations
Introduction, transformation of points and line, 2-D translation, shearing, rotation, reflection, scaling and combined transformation, homogeneous coordinates, 3-D scaling, shearing, rotation, reflection and translation, combined transformations, orthographic, axonometric, oblique and perspective projections.

UNIT-II

Curves
Geometry and topology, algebraic and geometric forms of straight lines, circles, conics, cubic splines, Ferguson curve, Hermite curve, bezier curves and B-spline curves, NURBS, composite curves, tangents and normal, blending functions, reparametrization.

UNIT-III

Solids

Solid models and representation schemes, their properties, boundary representation, constructive solid geometry, sweep representation, cell decomposition, octree encoding, spatial occupancy enumeration.

Analytical properties:
Analytical properties (Intersection & development) of curves and surfaces.

UNIT-IV

Surfaces
Algebraic and geometric forms, tangents and twist vectors, normal, blending functions, reparametrization. Plane surface, sixteen point form, four curve form, ruled surface, surface of revolution, tabulated cylinder, lofted surface, bi-cubic surface, bezier surface, B-spline surfaces, Coons' patch, blending surface, offset surface, rational surface.

Reference Books:

1. CAD/CAM by Groover and Zimmer, Prentice Hall
2. CAD/CAM: Theory and Practice by I. Zeid, McGraw Hill
3. Geometric Modeling by M.E. Mortenson

(PhD-ME-102) DESIGN OF MECHANISMS

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		Marks of Internal:	20
3	-	-		Examination:	80
Duration of Exam:	3 Hrs			**Total Marks:**	100

UNIT-I

Mechanisms

Reviews of concepts, transmission angle, methods of velocity and acceleration analysis, relative velocity and Instantaneous centre methods, Kennedy's theorem.

Path Curvature

Centrodes or polodes, fixed and moving centrodes, centrode normal and tangent, Euler-Savary equation, conjugate points, Hartmann construction, inflection point, inflection circle, Bobilliar construction, Collineation axis, Cubic of stationary curvature.

UNIT-II

Synthesis of Mechanisms

Introduction, number synthesis, dimensional synthesis, spacing of accuracy points, motion generation, path generation and function generation, graphical and analytical methods, Freudenstein's equation, coupler points.

Complex-number Modeling in Kinematic Synthesis

Complex number notation, the dyad or standard form equation, four-bar motion generation, maximum number of solutions for unknown dyads, path and function generation, triad loops, synthesis of multi-loop linkages, Burmester theory, synthesis of geared mechanisms, Computer program.

UNIT-III

Dynamics of mechanisms

Analytical methods for force analysis of mechanisms, complex number methods, Kinetostatic analysis using matrix method, time response of four-bar mechanisms, computer program.

Balancing

Force and shaking moment balancing of linkages, Optimization of shaking moments, Effect of moment balance on input torque, balancing of flexible rotors, field balancing, computer program.

UNIT-IV

Cam Dynamics

Rigid and elastic-body cam systems, analysis of eccentric plate cam, jump or float, torque-displacement diagram, analysis of an elastic cam system, follower command, spring surge, unbalance and windup.

Kinematics of industrial robots

Absolute and moving reference systems, direction cosines, Eulerian angles, Denavit-Heartenberg parameters, Transformation-matrix position analysis, matrix velocity and acceleration analysis. Computer programs.

Reference Books :

1. Theory of Machines by Shigley and Uicker Jr., McGraw-Hill
2. Advanced Mechanism Design, by Sandor and Erdman, Prentice Hall of India
3. Theory of machines by S S Rattan, Tata McGraw-Hill Publishing Co. Ltd., New Delhi
4. Theory of mechanisms and Machines by Ghosh and Malik, Affiliated East-West Press, Pvt. Ltd., New Delhi.

(PhD-ME-103) ADVANCED MECHANICAL VIBRATIONS

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		
3	-	-	**Marks of Internal:**	**20**
			Examination:	**80**
Duration of Exam: 3 Hrs			**Total Marks:**	**100**

UNIT-I

Introduction to vibrations
Brief introduction to vibrations, its causes, advantages and disadvantages, classification: un-damped and damped vibrations, single and two degree of freedom models. Introduction to lateral, torsional and bending vibrations. Harmonic and harmonic analysis. Free and harmonically excited vibrations. Vibrations under general forcing conditions.

Vibrations of continuous system
Transverse vibrations of a cable, longitudinal and torsional vibrations of a rod, lateral vibrations of a beam, vibrations of membranes. Reyleigh's method. Rayleigh-Ritz method.

UNIT-II

Vibration Control
Introduction, vibration nomograph and vibration criteria, reduction of vibration at the source, balancing of rotating machines, whirling of rotating shafts, balancing of reciprocating engines, control of vibrations, control of natural frequencies, vibration isolation, vibration absorbers.

Vibration measurement and applications
Introduction, transducers, vibration pickups, frequency measuring instruments, vibration exciters, signal analysis, dynamic test of machines an structures, experimental modal analysis, machine condition monitoring and diagnosis.

UNIT-III

Numerical Integration methods in vibration analysis
Introduction, Finite difference method, central difference method, Runge-Kutta methods for single, multi and continuous systems. Houbolt method, Wilson method, Newmark method. The finite element method.

Non linear vibration
Introduction, examples of non-linear vibration problems, exact methods, approximate analysis methods, sumharmonic and superharmonic oscillations, systems with time-dependent coefficients (Mathieu equations), graphical methods, stability of equilibrium states, limit cycles, chaos.

UNIT-IV

Random Vibrations
Random vibrations and random processes, probability distributions, mean value and standard deviation, joint probability distribution of several random variables, correlation function of a random process, Gaussian random process, fourier analysis, power spectral density, wide and narrow band process, response of a single degree of freedom system, response due to stationary random excitations, response of a multidegree system.

Reference Books:
1.   Mechanical Vibrations by S.S. Rao, Pear and on Publication.
2.   Mechanical Vibration by Thomson, Printice Hall.
3.   Mechanical Vibration by Den Hartog, McGraw-Hill

(PhD-ME-104) APPLIED NUMERICAL METHODS

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		Marks of Internal:	20
3	-	-		Examination:	80
Duration of Exam:	3 Hrs			Total Marks:	100

UNIT-I

Approximations and Errors in Computations
Introduction, Numbers and their Accuracy, Errors and their Computation, Error in Series Approximation.

Numerical Solution of Ordinary Differential Equations
Introduction, Solution by Taylor's Picard's Method, Euler's Method, Runge-Kutta Methods, Predictor-Corrector Methods, the Cubic Spline Method, Simultaneous and Higher Order Equations, Boundary Value Problems: Finite-Difference Method, The Shooting Method, The Cubic Spline Method.

UNIT-II

Numerical Solution of Partial Differential Equations

Introduction, Finite-Difference Approximations, Laplace's Equation: Jacobi's Method, Gauss-Seidel Method, SOR Method, ADI Method, Parabolic Equations, Iterative Methods, Hyperbolic Equations.

Numerical Differentiation and Integration
Introduction, Numerical Differentiation, Numerical Integration, Euler-Maclaurin Formula, Adaptive Quadrature Methods, Gaussian Integration, Singular Integrals, Fouries Integrals, Numerical Double Integration.

UNIT-III

Least- square Curve Fitting and Function Approximation
Introduction, Least-square Curve Fiting, Spline Inaterpolation,Cubic Splines, Chebyshev Minimax Approximation, Chebyshev Polynomials.

Numerical Solution of Nonlinear Systems
Introduction, Picard Iteration, Newton's Method, Perturbed Iterative Scheme.

UNIT-IV

System of Linear Algebraic Equations
Introduction, Methods for Large Linear Systems, Direct Methods, LU- Decomposition Methods, Iterative Methods, Ill-conditioned Systems.

Reference Books :
1. Niyogi, Pradip, "Numerical Analysis and Algorithms", Tata McGraw –Hill
2. Balagurusamy,E., "Numerical Methods", Tata McGraw –Hill
3. Sastry, S.S., "Introduction Methods of Numerical Analysis", PHI
4. Chapra, S.C. and Canale, R.P., "Numerical Methods for Engineers", Tata McGraw –Hill
5. Gerald, F. Curtis, "Applied Numerical Analysis", Peason Educatio

(PhD-ME-105) ADVANCED MECHANICS OF SOLIDS

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		Marks of Internal:	20
3	-	-		Examination:	80
Duration of Exam:	3 Hrs			Total Marks:	100

UNIT-I

Three Dimensional Stress and Strain:
Principal stresses and Principal strains, Mohr's circle representation of tri-axial stresses and strains.
Unsymmetrical Bending:
Shear centers for sections with one axis of symmetry. Shear center for any unsymmetrical section, stress and deflection of beams subjected to unsymmetrical bending.

UNIT-II

Bending of Plates:
Basic definitions, Stress, Curvature and Moment relations, Basic Equation of plate deflection. Different boundary conditions, simply supported rectangular plates, axis symmetric loaded circular plates.
Contact Stresses:
Due to Two Spherical Surfaces in Contact, Due to Two Parallel Cylindrical Rollers in Contact, Due to Two Curved Surfaces of Different Radii.

UNIT-III

Buckling of Columns:
Beam columns with single concentrated load, number of concentrated loads, continuous lateral load, end couple, couples at both ends of the column, triangular loads and combined loads.

UNIT-IV

Beam on Elastic Foundations:
General Theory, Infinite, Semi-infinite, and Finite beams, Classification of Beams. Beam supported by equally spaced elastic elements.

Reference Books :

1. 'Advanced Strength and Applied Elasticity' by Ugural & Fenster, Prentice Hall.
2. 'Advanced Mechanics of Solids' by L., Srinath, TMH
3. 'Intermediate Mechanics of Materials' by J. R. Barber, McGraw-Hill
4. 'Introduction to Solid Mechanics' by Shames & Pitarresi, PHI
5. 'Advanced Topics of Strength of Materials' by U.C. Jindal, Galgotia Publication.

(**PhD-ME-106**) INDUSTRIAL ROBOTICS

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		
3	-	-	**Marks of Internal:**	20
			Examination:	80
Duration of Exam: 3 Hrs			**Total Marks:**	100

UNIT-I

Introduction to Robotics
Evolution of Robots and Robotics, Laws of Robotics, Progressive advancement in Robots. Robot anatomy, Human Arm Characteristics, Design and Control issue, Manipulation and Control, Programming Robots.

Coordinate Frames, Mapping and Transforms
Coordinate Frames, Description of objects in space, Transformation of Vectors, Inverting a Homogeneous Transform, Fundamental Rotation matreies.

UNIT-II

Direct Kinematic Model
Mechanical structure and notations, Kinematic modeling of the manipulator, Denavit Hartenberg Notation, Manipulator Transformation Matrix.

The Inverse Kinematies
Manipulator workspace, solvability of Inverse kinematics model, solution techniques, closed form solution.

Manipulator Differential Motion and Statics
Linear and angular velocity of a rigid body, relationship between transformation matrix and angular velocity, manipulator Jacobian, Jacobian Inverse, Jacobian Singularities, Static Analysis.

UNIT-III

Dynamic Modeling
Largrangian Mechanies, Two Degree of Freedom manipulator-Dynamic Model, Lagrange-Euler formulation Newton-Euler formulation, Inverse Dynamics.

Control of Manipulators
Open and Close loop control, linear control schemes, linear second order SISO model of a manipulator joint. Joint Actuators, Computed Torque Control, force control of Robitics, Manipulators, Hybrid position/force control, Impedance Force/Torque Control.

Robotic Sensors
Sensors in Robitcs, classification of Robotic sensors, kinds of sensors used in robotics-Acoustic sensors optic, Pneumatic, force/Torque sensors.

UNIT-IV

Robot Applications
Industrial Applications-Material Handling, Processing Applications, Assembly applications, inspection application, Principles for Robot application and application planning, Robert safety, Non-Industrial Application.

Robert Languages and Programming
The Textual Robot Languages, Generations of Robot Programming Languages, Methods of Robot Programming.

Reference Books :
1. Fundamental of Robotics by Robert J. Sehilling Prentice Hall of India.
2. Introduction to Robotics by Saeed B. Niku Pearson Education Asia.
3. Robot Modeling and kinematics by Rachid Manseur, Luxmi Publications.

(PhD-ME-107) MEASUREMENT AND CONTROL

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	**T**	**P/D**		**Marks of Internal:**	**20**
3	**-**	**-**		**Examination:**	**80**
Duration of Exam:	**3 Hrs**			**Total Marks:**	**100**

UNIT-I

Measurements and Measurement Systems:
Introduction, significance of measurement, methods of measurement, primary secondary and tertiary measurements, mechanical electrical and electronics instruments, applications of measurement system, elements of a generalized measurement system and its functional elements, classifications of standards, primary, secondary and working standards.

Instrumentation Characteristics:
Static and dynamic characteristics, first and second order systems response, classification & sources of error, loading facts, mechanical, electrical.

UNIT-II

Analysis of Experimental Data:
Errors and uncertainties in experiments, role of statistics and variance types of data, presentation of the observations, criteria for rejecting data, specifying result of experiments, confidence level, uncertainty analysis, overall uncertainty. graphical analysis and curve fitting, theory of least squares, application in calibration, goodness of fit, significant figures and rounding off. (

Transducers:
General criteria for selection, strain gauge, rosettes; types, applications. Variable inductance transducers, capacitive, piezo-electric transducers transducers.
Advantages and limitations of digital transducers over analog transducers, digital encoding transducers, classification of encoders, construction of encoders, shaft encoder, optical encoder.

UNIT-III

Control systems:
Introduction, types of control systems, performance analysis, mathematical modeling, block diagram representation, representation of systems or processes, comparison elements, transfer function, representation of temperature control systems, signal flow graphs.

UNIT-IV

Types of controllers
Introduction, types of control action, hydraulic controllers, electronic controllers, controllers.

Transient and steady state response
Time domain representation, laplace transform representation, system with proportional control, proportional cum derivative control, proportional cum integral control, error constants.

Reference Books :
1. A course in Mechanical Measurement & Instrumentation by A.K. Sawhney, Dhanpat Rai & Sons.
2. Mechanical Measurement by Beckwith & Buck
3. Instrumentation for Measurement in Engineering by S. Gupta
4. Theory and application of Automatic Controls by B.C.Nakra.

(PhD-ME-108) EXPERIMENTAL STRESS ANALYSIS

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		Marks of Internal:	20
3	-	-		Examination:	80
Duration of Exam: 3 Hrs				Total Marks:	100

UNIT-I
Introduction
Introduction to elementary Elasticity, Strain and the Stress-Strain relations, Basic equations of strain, and Plane Elasticity theory.
Brittle-Coating Methods
Introduction, Coating Stresses, Brittle-Coating Crack Patterns, Crack Detection, Ceramic-based Brittle Coatings, Resin-based Brittle Coatings, Test Procedures, Calibration.

UNIT-II
Strain Measurement using Strain Gages
Introduction, Strain Sensitivity in Metallic Alloys, Gage Construction, Strain-Gage Adhesive and Mounting Methods, Gage Sensitivities and Gage Factor, Piezoresistive Properties of Semiconductors, Performance Characteristics of Foil Strain Gages and Semiconductor Gages. Strain-Gage Circuits, Analysis of Strain-Gage Data.

UNIT-III

Optical Methods
Basic Optics- Introduction, Optic Laws, Optical Instruments- the Polariscope, the Interferome Moire Methods- Introduction, Mechanism of Formation of Moire Fringes, Different approach to Moire Fringe Analysis;

UNIT-IV
Theory of Photoelasticity- Introduction, the Stress-optic Law, Effects of a Stressed Model in a Plane and in a Circular Polariscope, Fringe Manipulation, Isochromatic and Isoclinic Fringe Patterns, Compensation Techniques, Separation Method, Calibration Methods, Photoelastic Materials
2-D & 3-D Photoelasticity- Shear Difference Method in 3-D Stress, the Scattered-Light Method, Frozen-Stress Method; Bi-Refringent Coatings- Coating Stresses and Strains, Coating Sensitivity, Coating Materials, Effects of Coating Thickness.

Reference Books :

1.   Experimental Stress Analysis by Dally, J. W. & Riley, W. F.
2.   Strain Gauges by Lissner, H.R and Perry, C. C.
3.   Photoelastic Separation of Principle Stress by Drucker, D.C.
4.   Work on General B-D Photoelasticxity by Froncht, M. M.

(PhD-ME-109) ADVANCED TRIBOLOGY

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		Marks of Internal:	20
3	-	-		Examination:	80
Duration of Exam:	3 Hrs			Total Marks:	100

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.

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.

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.

UNIT-IV

Nanotribology

Introduction to micro and nano tribology. Measurement tools used in nanotribology: SFA, STM, AFM microscale and nanoscale wear Nanofabrication/nanomachining Nanohydrodynamics Nanolubrication Tribological issues in MEMS.

Reference Books :

1.   "Engineering Tribology" by Prasanta Sahoo, PHI.
2.   "Engineering Tribology" by Stachowiak & Batchelor, Elsevier.
3.   "Nanotribology and Nanomechanics: An Introduction" by Bharat Bhushan, Springer.
4.   "Nanotribology" by Hsu & Ying, Springer.

(PhD-ME-110) OPTIMIZATION TECHNIQUES

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		
3	-	-	**Marks of Internal:**	20
			Examination:	80
Duration of Exam: 3 Hrs			**Total Marks:**	100

UNIT-I

Introduction
Need of Optimization and Historical Development, Engineering Applications, Classification and Formulation of Optimization Problem.

Classical Optimization Techniques
Single-Variable and Multi-Variable Optimization, With and Without Constraints, Kuhn-Tucker Conditions.

UNIT-II

Non-Linear Programming
Introduction, One-Dimensional Optimization Methods, Unconstrained and Constrained Optimization Techniques; Elimination Methods, Exhaustive Search, Interval Halving, Fiboniacci, Golden Section Methods; Random Search Methods, Hooke and Jeeves Method, Powell's Method; Indirect Search Methods: Steepest Descent, Fletcher-Reeves, Newton's Method, DFP, BFGS Method; Internal and External Penalty Approach.

UNIT-III

Other Optimization Techniques
Introduction and Basic Concepts of Geometric Programming, Dynamic Programming, Integer Programming, Stochastic Programming, Their Applications.

UNIT-IV

Advance Topics in Optimization
Multi-Objective Programming, Introduction to Genetic Algorithms, Simulated Annealing and ANN Based Optimization.

Reference Books:
1. Engineering Optimization Theory and Practice by S.S. Rao, New Age International.
2. Optimization for Engineering Design by Kalyanmoy Deb, PHI.
3. Optimization Techniques by J.S. Arora, John Wiley.

(PhD-ME-111) COMPUTER AIDED ENGINEERING

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		Marks of Internal:	20
3	-	-		Examination:	80
Duration of Exam:	3 Hrs			Total Marks:	100

UNIT-I

Introduction:
Introduction to CAE, Methods for solving any engineering problem, Advantages of CAE.
Meshing :
Need for meshing, Types of elements, Meshing techniques, 1-D meshing, 2-D meshing, 3-D meshing, Special elements and special techniques.   rs)

UNIT-II

Material properties and Boundary Conditions :
Material classification, Material properties, Boundary conditions, Applying constraints.
Linear Static Analysis :
Definition, Design modifications based on linear static analysis, Linear static solvers.
Non Linear analysis :
Introduction, Comparison of linear and nonlinear FEA, Types of nonlinearity, Solution techniques for nonlinear analysis, Essential steps to start with nonlinear FEA, General procedure for nonlinear static analysis.

UNIT-III

Dynamic Analysis :
Static vs. Dynamic Analysis, Transient Response analysis (single DOF system), Dynamic analysis solvers, PSD.
Thermal analysis :
Introduction, Meshing for thermal analysis, Practical applications of thermal analysis.

UNIT-IV

Post Processing Techniques :
Validation and checking accuracy of results, Viewing results, Interpretation of results and design modifications, CAE reports.

Experimental Validation and Data Acquisition :
Strain gauge, Photo-elasticity, Load cells, Torque sensors, Evaluating acceleration, fatigue life, natural frequency etc.

Reference Books :
1. Practical Finite Element Analysis by Nitin S Gokhale. (Finite to Infinite Publishers).
2. CAC/CAM Theory & Practice by I, Zeid. McGraw Hill
3. The Finite Element Method for Engineers by Huebner, John Wiley

(PhD-ME-112) FINITE ELEMENT METHODS

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		Marks of Internal:	20
3	-	-		Examination:	80
Duration of Exam:	3 Hrs			**Total Marks:**	100

UNIT-I

Introduction to Finite Element Method:
Basic Concept, Historical background, Engineering applications, general description, Comparison with other methods.

Integral Formulations And Variational Methods:
Need for weighted-integral forms, relevant mathematical concepts and formulae, weak formulation of boundary value problems, variational methods, Rayleigh-Ritz method, and weighted residual approach.

UNIT-II

Finite Element Techniques:
Model boundary value problem, finite element discretization, element shapes, sizes and node locations, interpolation functions, derivation of element equations, connectivity, boundary conditions, FEM solution, post-processing, compatibility and completeness requirements, convergence criteria, higher order and isoparametric elements, natural coordinates, Langrange and Hermite polynomials.

UNIT-III

Applications To Solid and Structural Mechanics Problems:
External and internal equilibrium equations, one-dimensional stress-strain relations, plane stress and strain problems, axis-symmetric and three dimensional stress-strain problems, strain displacement relations, boundary conditions, compatibility equations, Analysis of trusses, frames and solids of revolution, computer programs.

Applications To Heat Transfer Problems:
Variational approach, Galerkin approach, one-dimensional and two-dimensional steady-state problems for conduction, convection and radiation, transient problems.

UNIT-IV

Applications To Fluid Mechanics Problems:

Inviscid incompressible flow, potential function and stream function formulation, incompressible viscous flow, stream function, velocity-pressure and stream function-vorticity formulation, Solution of incompressible and compressible fluid film lubrication problems.

Additional Applications :
Steady-state and transient field problems.

Reference Books:
1.   The Finite Element Method by Zienkiewicz, Tata McGraw Hill
2.   The Finite Element Method for Engineers by Huebner, John Wiley
3.   An Introduction to the Finite Element Method by J.N.Reddy, McGraw Hill
4.   The Finite Element Method in Engineering by S.S. Rao, Pergamon Press

(PhD-ME-113) ADVANCED FLUID ENGINEERING

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		Marks of Internal:	20
3	-	-		Examination:	80
Duration of Exam:	**3 Hrs**			Total Marks:	100

UNIT-I

Introduction
Review of basic concepts.

Integral analysis of flow
Basic laws in integral form; transport theorem; continuity, momentum and energy equations in integral form and their applications.

Differential analysis of flow
Continuity equation; derivation of Navier Stokes equation and exact solution energy equation.

UNIT-II

Ideal fluid flow
Kinematics of fluid flow; potential flow; Bernoulli's equation and applications; sources, sinks, doublets and vortices; superimposition of uniform stream with above; flow around comers; Rankine ovals; flow around uniform cylinders with and without circulation; pressure distribution on the surface of these bodies and D'Alemberts paradox.

UNIT-III

Viscous flow
Exact solution; plane Poiselle and Coutte flows; Hagon-Poiselle flow through pipes; flows with very small Reynold's numbers; Stokes flow around a sphere; elements of hydrodynamic theory of lubrication. Flows with very large Reynold's numbers; elements of two dimensional boundary layer theory; displacement thickness and momentum thickness; skin friction; Blaussius solution for boundary layer on a flat plate without pressure gradient; Karman-Porausen integral method for obtaining approximate solutions. Drag on bodies; form drag and skin friction drag; profile drag and its measurement.

UNIT-IV

Transition flows
Transition from laminar to turbulent flows, Reynold's stresses, turbulent boundary layer over a flat plate; transition for flat plate flow.

Compressible fluid flows
One dimensional isentropic flow; Fanno and Rayleigh lines; choking; shocks (normal and oblique).

Vortex Motion
Definitions; vortex lines; surfaces and tubes; vorticity; circulation; Kelvins circulation theorem; Helmholtzs vorticity theorem; Biot-savart law for induced vorticity; system of vortex filaments;

Reference Books:
1. Fundamentals of Mechanics of Fluid by Curriec, Mcgraw-Hill
2. Foundation of Fluid Mechanics, Yuan, Prentice Hall
3. Engineering fluid mechanics, K.L.Kumar, Eurasia
4. Fluid Mechanics and its applications, Gupta and Gupta, Willey Eastern

(PhD-ME-114) COMPUTATIONAL FLUID DYNAMICS

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		
			Marks of Internal:	20
3	-	-	**Examination:**	80
Duration of Exam:	3 Hrs		**Total Marks:**	100

UNIT-I

Introduction
Introduction to C.F.D. , models of the flow, governing differential equations – continuity equation, momentum equation, energy equation, Navier- stokes equation, physical boundary conditions.

Mathematical behavior of governing equation
Classification of quasi linear partial differential equation, General method of determining the Classification of partial differential equation, hyperbolic, parabolic, elliptic equations.

UNIT-II

Discritization methods
Finite difference methods, difference equations, explicit & implicit approach, errors & analysis of stability. Basics of finite control volume method, errors & analysis of stability.

UNIT-III

Heat conduction problem
Solution of One dimensional heat conduction through a pin fin by F.D.M solution of two dimensional heat conductional in a plate by F.D.M. Control volume formulation of the heat conduction problem and its solution.

UNIT-IV

Heat conduction with convection & diffusion
Steady state one dimensional convection and diffusion, unwinding, exact solution, exponential scheme, hybrid scheme, power law scheme, Discritization equation for two dimensions & three dimensions, false diffusion.

Fluid flow problem
Viscous incompressible flow, solution of the couette flow problem by F.D.M., calculation of the flow field using stream function –vorticity method numerical algorithms for solving complete navier stokes equation – MAC method; SIMPLE method.

Reference Books:
1. Numerical heat transfer and fluid flow by suhas. V. patankar
2. Computational fluid dynamics by John.d.Anderson, Jr
3. Introduction to Computational fluid dynamics by Anil .W. Date

(PhD-ME-115) ADVANCED HEAT AND MASS TRANSFER

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		Marks of Internal:	20
3	-	-		Examination:	80
Duration of Exam:	3 Hrs			**Total Marks:**	100

UNIT-I

Conduction

Review of the basic laws of conduction, convection and radiation. General heat conduction equation in different co-ordinates. One dimensional steady state conduction with variable. Thermal conductivity and with internal distributed heat sources, extended surfaces review, Tapered fins, design considerations. Two dimensional steady-state conduction, semi-infinite and finite flat plates and cylinders, graphical method, relaxation technique. Unsteady state conduction in solids with infinite thermal conductivity, infinite thick-solids, periodic variation, solutions using Grolber's and Heisfer's charts.

UNIT-II

Convection

Hydrodynamic and thermal boundary layers, differential equations, momentum and energy and their solutions, heat transfer in turbulent flow, eddy heat diffusivity, Reynold's analogy between skin friction and heat transfer. Free convection, empirical correlations, regimes of boiling, Nucleate and film boiling.

UNIT-III

Heat Exchangers

Introductions, effectiveness and number of transfer units, design of heat exchangers.

Radiation

Introduction, laws of radiation, heat exchange between black bodies and non-black bodies, shape factor algebra, Radiation shields, electrical net-work approach of radiation heat exchange.

UNIT-IV

Mass Transfer

Introduction, Fick's law, General equation of mass diffusion steady state, diffusion through a plain membrane, diffusion of water vapour through air, Mass transfer coefficient, convective mass transfer.

Heat Pipe

Introduction, Working of Heat pipe, Different types of Heat Pipe, Detail of Heat Pipe components, Advantages of Heat Pipe, Application of Heat Pipe, Performance of Heat Pipe, Limitation of Heat Pipe, Analysis and Design of Heat Pipe.

Reference Books :

1. Principles of Heat Transfer by Kreith
2. Heat Transfer by Holman
3. Fundamentals of Heat and Mass-transfer by D.S. Kumar
4. Heat and mass transfer by Eckert Darke.

(**PhD-ME-116**) REFRIGERATION ENGINEERING

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D			
3	-	-			

Marks of Internal:	20
Examination:	80
Total Marks:	100

Duration of Exam: 3 Hrs

UNIT-I

Introduction

Lubrication of reverse control cycle with vapour as a refrigerant, simple vapour compression cycle, pressure-Enthalpy diagram, Ewing's construction, Suction state for maximum COP. Standard rating cycle and effect of operating conditions, (Evaporator pressure, condenser pressure, suction vapour super heat, liquid sub cooling liquid vapour regenerative heat exchanger) Deviation of actual vapour compression cycle with that of theoretical.

Air Refrigeration System

Reverse Carnot cycle, most efficient refrigerator, Bell-Colman cycle, advantages and disadvantages of air refrigeration system, necessity of cooling the auroplanes, simple cooling and simple evaporative type, Bootstrap and Bootstrap evaporative type, regenerative type, reduced ambient. Limitation, merits and comparison.

UNIT-II

Multi Temperature

Method of improving the COP, optimum inter state pressure for two stages refrigeration system, Multi stage or compound compression with flash inter cooler, single expansion valve and multi expansion valve. Multi evaporator system with single compressor, individual compressor with compound compression, single expansion valve and multi-expansion valve.

UNIT-III

Production of Low Temperature

Limitations of simple vapour compression system, multistage system, cascade system, production of solid carbon dioxide, Joule-Thomson effect, liquification of gases, hydrogen, helium, application of low temperature, Cryogenic insulation.

Steam Jet Refrigeration

Steam Jet Refrigerator, component of steam Jet refrigeration plant, advantages and limitations of steam jet refrigeration system, performance of the system

UNIT-IV

Vapour Absorption System

Simple vapour absorption system, Maximum co-efficient of performance, modification of simple vapour absorption system, acxtual vapour absorption cycle and its representation on Enthelpy –composition diagram, absorption system calculation. Richy and poor solution concentration. Lithium – Bromide water system.

Application

Manufacture and treatment of metal, industrial mideical, civil engineering, solar refrigeration and ice manufacturing. Properties of refrigerants and mixture of refrigerant. Design consideration of compressors, condensers, expansion devices, evaporators, ice manufacture, food presentation.

R**eference Books :**

1. Mechanical Refrigeration by Sporks and Diffio.
2. ASHARE Handbook (Fundamentals) by ASHARE.
3. Thermal Environment Engineering by Threlkeld.
4. Regrigeration and Air-conditioning by C.P. Arora.
5. Refrigeration and Air –conditioning by Stocker.

(PhD-ME-117) AIR-CONDITIONING

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D			
			Marks of Internal:		20
3	-	-	**Examination:**		80
Duration of Exam:	3 Hrs		**Total Marks:**		100

UNIT-I

Introduction and Human Comfort

Psychometric and psychometric properties, psychometric relations and processes, adiabatic temperature, psychometric chart, summer and winter air-conditioning system, year-round air-conditioning, factors influencing-human comfort, effective temperature, factors governing optimum effective temperature.

Cooling Load Calculations

Types of loads, building heat transmission, solar-radiation infiltration, occupants, electric lights, products load, other internal heat sources, fresh-air miscellaneous steams, design of air-conditioning systems.

UNIT-II

Air Conditioning Systems

Central station, unitary, distinct, self-contained direct expansion, all water, all air, air-water system, arrangement of components, air-cleaning and air filters, humidifiers, dehumidifiers air-washers, fan and blowers, grills and registers.

UNIT-III

Air Conditioning Control System

Heating and cooling coils, basic principles of control system, temperature humidity, pre-heating and humidification, cooling and dehumidification, reheat and all-year conditioning control systems. Elements of control, Deflective element (bimetallic, bulbs and below, electrical resistance, electro magnetic sensitive and pressure sensitive, controlling room conditions at partial load (ON-OFF control), by pass control, reheat control and volume control).

UNIT-IV

Miscellaneous

Evaporative cooling, heating system, ventilation and ventilation standards, thermal insulation duct design and air-distribution system, noise and noise control, solar air-conditioning. Transport air conditioning, air conditioning of special type of buildings, air conditioning of textile industry, photographic industry, theatre auditorium, hospitals etc.

Reference Books:

1. Refrigeration and air conditioning by C.P. Arora.
2. Refrigeration and air conditioning by Jordan and Priester
3. Refrigeration and air conditioning by William
4. ASHARAE Hand Book (Fundamentals) ASHARAE
5. Elementary Refrigeration and air conditioning Stoecjer McGraw Hill
6. Air Conditioning Engineering Jones Arnold.

(PhD-ME-118) RENEWABLE ENERGY & ENERGY MANAGEMENT

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D			
			Marks of Internal:	20
3	-	-	**Examination:**	80
Duration of Exam: 3 Hrs			**Total Marks:**	100

UNIT-I

Solar Energy

The sun as a perennial source of energy, direct solar energy utilization; solar thermal applications – water heating systems, space heating and cooling of buildings, solar cooking, solar ponds, solar green houses, solar thermal electric systems; solar photovoltaic power generation; solar production of hydrogen.

Energy from Oceans

Wave energy generation – energy from waves; wave energy conversion devices; advantages and disadvantages of wave energy; Tidal energy – basic principles; tidal power generation systems; estimation of energy and power; advantages and limitations of tidal power generation; ocean thermal energy conversion (OTEC); methods of ocean thermal electric power generation.

UNIT-II

Wind energy

Basic principles of wind energy conversion; design of windmills; wind data and energy estimation; site selection considerations.

Hydro power

Classification of small hydro power (SHP) stations; description of basic civil works design considerations; turbines and generators for SHP; advantages and limitations.

UNIT-III

Biomass and bio-fuels

Energy plantation; biogas generation; types of biogas plants; applications of biogas; energy from wastes.

Geothermal energy

Origin and nature of geothermal energy; classification of geothermal resources; schematic of geothermal power plants; operational and environments problems.

UNIT-IV

Energy conservation management

The relevance of energy management profesion; general principles of energy management and energy management planning; application of Pareto's model for energy management; obtaining management support; establishing energy data base; conducting energy audit; identifying, evaluating and implementing feasible enrgy conservation opportunities; energy audit report; monitoring, evaluating and following up energy saving measures/projects.

Reference Books:

1. 'Renewable energy resources'. John W Twidell and Anthony D Weir.
2. 'Renewable energy – power for sustainable future'. Edited by Godfrey Boyle. Oxford University Press in association with the Open University, 1996.
3. 'Renewable energy sources and their environmental impact'. S.A.Abbasi and Naseema Abbasi. Prentice-Hall of India, 2001.
4. 'Non-conventional sources of energy'. G.D. Rai. Khanna Publishers, 2000.
5. 'Solar energy utilization'. G.D. Rai. Khanna Publishers, 2000.
6. 'Renewable and novel energy sources'. S.L.Sah. M.I. Publications, 1995.
7. 'Energy Technology'. S.Rao and B.B. Parulekar. Khanna Publishers, 1999.

(PhD-ME-119) GAS TURBINE AND JET PROPULSION

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		
3	-	-	Marks of Internal:	20
			Examination:	80
Duration of Exam:	3 Hrs		Total Marks:	100

UNIT-I

Introduction
Introduction to simple gas turbine; open cycles considering heat exchanger; reheater; multispool arrangement; combined cycles and cogeneration scheme; closed cycle; industrial applications of gas turbine.

Power Cycles
Efficiencies & specific work output of heat exchanger cycles; reheat cycles; cycles with intercooled compression; various component loses.

UNIT-II

Combustion Systems
Combustion process; types of combustion systems; operational requirements; combustion chamber performance.

Turbine
Axial Flow Turbine- Elementary theory of axial flow turbine; swirl angle; total to total stage efficiency; flow coefficient; floe coefficient; loss coefficient for the nozzle blades; methods of blade cooling.

Radial flow turbine- specific work output; various efficiencies

UNIT-III

Jet Propulsion & Turbojet Engine:
Introduction; net thrust; propulsion efficiency; intake & propelling nozzle efficiency; turbojet engine -actual cycle analysis ; typical engine performance; corrected engine performances; thrust augmentation.

Turboprop & Ramjet Engine:
Turboprop Engine process & cycle analysis; engine performances; Ramjet engine; jet expansion; overall process and performance

UNIT-IV

Rocket Engine
Solid and liquid propellant rocket motor cooling; propellant section; performance and design.

Reference Books:
1. Gas turbine theory by H. Cohen & GFC Rogers
2. Jet propulsion and gas turbine theory gy Zucrow, John Wiley
3. Jet propulsion by Hesse, Pitman
4. Theory and design of gas turbine & jet engine by Vincent, Mcgraw Hill

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		Marks of Internal:	20
3	-	-		Examination:	80
Duration of Exam:	3 Hrs			Total Marks:	100

UNIT-I

General

Functions of production planning and control, preplanning planning, control, plant layout, simplification and standardization, time and motion study.

Product Development and Design

Effect of competition on design, Long-range Planning, Company policy, product analysis, marketing aspects, the product characteristics, functional aspect, operational aspect, durability and dependability, Aesthetic aspect; Economic analysis, Profit and competitiveness, The three S's:- Standardization, Simplification and Specialization. Break Even Analysis.

UNIT-II

Inventory Control

Definition, classification, objectives of inventory control, functions, economic order quantity various inventory models. Numericals on inventory control. Inventory carrying costs, factors affecting inventory costs. V.E.D. analysis, S-D-E analysis, F-S-N analysis H-M-L analysis and ABC analysis. Safety stocks, their objectives safety stocks and service levels.

UNIT-III

Evaluation of Material and Processes

Introduction, value analysis, consideration of new techniques and materials, value analysis tests, material utilization of a product or assembly. Numerical problems on material utilization of a product. Value engineering job plan and various phases of job plan in systematic value engineering approach.

UNIT-IV

Routing, Loading and Scheduling

Introduction, Scheduling Procedure, Master Schedule, its objectives, Order scheduling, Loading by scheduled period, Dispatching, Job card, Job order. Commercial Loading & Scheduling Devices.

Reference Books:
1. Production Planning and control: Samuel Eilon
2. Production Planning and Control: K.C. Aggarwal & K.C. Jain
3. Industrial Engg. & Operation Management by S.K. Sharma & Savita Sharma.
4. Production Planning and Control: King J.R.
5. Production Planning and Control: Sharma, Hari Rraghu Rama.
6. Production Planning and Control: Narasimhan Seetha-rama L.

(PhD-ME-121) MECHATRONICS

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D			
3	-	-			

Marks of Internal:	20
Examination:	80
Total Marks:	100

Duration of Exam: 3 Hrs

UNIT-I

Introduction:
Definitions, trends, control systems, microprocessor / micro controller based controllers, PC based controllers, applications: SPM, robot, CNC machine, FMS, CIM.

Sensor Technology:
Sensor and transducers, terminology, displacement, position, proximity – encoders, velocity – tachogenerators, force - strain gauges, pressure, temperature – thermocouples, RTDs, thermistors, light sensors – photoelectric sensors, IR sensors, sensor selection.

Signal Conditioning:
Introduction, the operational amplifier, protection, filtering, Wheatstone bridge, digital signals, multiplexers, data acquisition, digital signal processing, pulse – modulation.

UNIT-II

Precision Mechanical Actuation:
Pneumatic actuation systems, electro-pneumatic actuation systems, hydraulic actuation systems, electro-hydraulic actuation systems, mechanical systems, types of motion, kinematics, inverse kinematics, timing belts, ball screw and nut, linear motion guides, linear bearings, harmonic transmission, bearings, motor / drive selection.

Electronic Devices and Circuits:
Semiconductor devices, diodes and LEDS, zener diodes and voltage regulator, inductive kick, bandwidth, frequency %& response of a measurement system, bipolar transistor circuits, amplifiers.

UNIT-III

Electromechanical Drives:
Relays and solenoids, stepper motors, DC brushed and brushless motors, DC servo motors, AC / DC motors for non-servo motion drives, braking methods, pulse width modulated, Bipolar driver, Mosfet drives, SCR drives, variable frequency drives.

Digital Electronics:
Digital logic, number systems, logic gates, Boolean algebra, Karnaugh maps, sequential logic.

UNIT-IV

Microprocessors:
Control, microcomputerstructure, microcontrollers, digital interfacing, analog interfacting, DAC, ADC, applications.

Input / Output Systems:
Interfacing, input / output ports, interface requirements, peripheral interface adapters, serial communication interface, direct memory access.

Control System:
System transfer function, Laplace transformation and its applications, continuous and discrete processes, proportional control, integral control, differential control, PID control, digital controllers, control system performance, controller tuning, adaptive control, frequency response, PLC, PMC, introduction to fuzzy logic and neural networks.

Reference Books:
1. Understanding Electro-Mechanical Engineering – An Introduction to Mechatronics by Kamm, Prentice-Hall of India.

(PhD-ME-122)MATERIALS MANAGEMENT

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		Marks of Internal:	20
3	-	-		Examination:	80
Duration of Exam:	3 Hrs			Total Marks:	100

UNIT-I

Integrated approach to materials management:
Introduction, materials productivity and role of materials management techniques in improved materials productivity. Cost reduction and value improvement, value analysis for right choice and rationalization of materials.

Purchasing function:
Objectives, purchase requisitions, types of specification, centralized versus decentralized purchasing, timing of purchases. Purchasing research, identification of right sources of supplies. Make or buy decisions, vender selection and vender rating. Negotiations, purchase price analysis and price determination. Purchasing organization, procedures, forms, records and reports. Purchasing as a dynamic profession, transition to supply management.

UNIT-II

Inventory management:
Inventory concepts, reasons for holding inventory, types of inventory, inventory reduction tactics. Inventory turnover ratio. Selective Inventory management: ABC, VED, and FSN analysis etc., identifying critical items with selective inventory management.

Operating policies:
continuous review system, periodic review system, comparative advantages and disadvantages of continuous and periodic review systems, hybrid systems. Inventory management across the organization.

UNIT-III

Optimising Inventory:
Assumptions for Wilson's lot size model, inventory costs, hidden costs, composition of costs, estimation of inventory related costs, lead time, stock out point, number of time periods, calculating Economic Order Quantity (EOQ), sensitivity analysis of EOQ model.

Special inventory models:
Finite replenishment rate model, lot size models with planned backlogging, generalized model with uniform replenishment rate, inventory model with lost sales, quantity discount model, one period decisions. Determination of safety stock, service level and uncertainty in demand. Information systems for inventory management.

UNIT-IV

Stores management
Introduction, stores functions, stores organization, stores systems and procedures, stores accounting and verification systems, stores address systems, stores location and layout, store equipment.

Standardization and codification:
Classification of materials. Codification, objectives of codification, essential features of codification system, Brisch and Kodak systems, colour coding systems. Standardisation and variety reduction.

Reference Books:
1. Arnold and Chapman "*Introduction to Materials Management*", Pearson Education Asia, Fourth Edition, (2001)
2. Narsimhan, Mcleavey & Billington, "*Production Planning & Inventory Control*", Prentice Hall of India, Second Edition (2003)
3. Dobler Donald W., Burt David N., "*Purchasing and Supply Management*", Tata McGraw Hill, Sixth Edition (2001)
4. Menon K S, "*Purchasing and Inventory Control*", Wheeler Publishing New Delhi, Third Edition (1997)

<div align="center">(**PhD-ME-123**) **OPERATIONS MANAGEMENT**</div>

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D			
3	**-**	**-**		**Marks of Internal:**	**20**
				Examination:	**80**
Duration of Exam: 3 Hrs				**Total Marks:**	**100**

UNIT-I

Basics of Production Management:
Types of production, life cycle approach to production system, Productivity and Productivity measures, types of productivity index, productivity improvement, production scheduling, MRP v/s JIT, requirements and problems in implementing JIT, Benefits of JIT, Introduction to JIT purchasing and JIT quality management

UNIT-II

Supply chain management, its importance, objectives and applications. Tenabled supply chain supply chain drives concepts of stockless, VRM and CRM.

Business Process:
Re-engineering-characteristics, organizational support, responsibility of re-engineering, re-engineering opportunities, choosing the process to re-engineer, success factors and advantages.

UNIT-III

ERP:
Evolution of ERP, Characteristics, approaches, methodology for implementation, Success factors.

UNIT-IV

Waste Management:
Introduction, classification of waste, systematic approach to waste reduction, waste disposal.

Reference Books:
1. Operation Research by D. S. Hira & P. K. Gupta,
2. Introduction to Operation Research by Hiller & Liebeman
3. Production and Operations Management by S.A.Chunawalla and D.R.Patel

(PhD-ME-124)   STRATEGIC ENTREPRENEURSHIP

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		Marks of Internal:	20
3	-	-		Examination:	80
Duration of Exam:	3 Hrs			Total Marks:	100

UNIT-I

Small Scale Industries

Definition and types of SSI's ; Role, scope and performance in national economy; Problems of small scale industries.

Industrial Sickness

Definition; Causes of sickness; Indian scenario, Government help; Management strategies; Need for trained entrepreneurs

UNIT-II

Entrepreneurship Development Programmes

Introductioin, Origin of EDP's , Organizations involved in EDP's, Objectives of EDPs, Implementation of EDP's, Short comings of EDP's, Role in entrepreneruship development.

STEP

Inroduction, Origin, Status in India, Success and failure factors, Govt. polices and incentives, future prospects in India.

UNIT-III

Business Incubation

Introduction, Origin and development of business incubators in India and other countries, types of incubators, success parameters for a business incubator, Benefits to industries, institutes, government and society; future prospects. A few case studies (at least 2

Special Aspects of Entrepreneurship

Intrapreneurship, Social entrepreneurship, International entrepreneurship, Rural entrepreneurship, Community Development, Women entrepreneurship.

UNIT-IV

Network Marketing

Introduction, E-business, E-commerce, E-auction, A basic internet e-business architecture, A multi tier e-business architecture.

Reference Books:
1. Strategic Entrepreneurship by P.K. Gupta, (Everest Publishing House)
2. Project Management – Strategic Design and Implementation by David Cleland (McGraw Hill)
3. Entrepreneurship-New Venture Creation by David H Holl (Prentice Hall of India)
4. Sustainable Strategic Management by Steed & Steed (Prentice Hall of India)
5. Marketing Management by Kotler (Prentice Hall of India)
6. Management of Technology by Tarek Khalil (McGraw Hill)
7. Engineering Economic Principles by Henry Steiner (McGraw Hill)

<div align="center">(**PhD-ME-125**) **MACHINE VISION**</div>

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	**T**	**P/D**		
			Marks of Internal:	**20**
3	**-**	**-**	**Examination:**	**80**
Duration of Exam:	**3 Hrs**		**Total Marks:**	**100**

UNIT-I

Introduction
Machine vision, Elements of machine vision system, Basic relationship between pixels (Neighbors of a pixel, Connectivity, Labeling of connected components, Distance measures).

UNIT-II

Image Processing
Digitization, Noise, Introduction to spatial domain and frequency domain, Spatial filters (mean, median, gaussian smoothing filters, high pass filters), Image enhancement techniques (LUT, Histogram Equalization, Histogram specification, contrast stretching, intensity transformations)

UNIT-III

Image Analysis
Segmentation of images, Techniques for detecting point, line, edges (Roberts, Prewitt, Sobel, Laplacian operators), Edge linking and boundary detection, Thresholding, Region oriented segmentation (Region growing by pixel aggregation, Region splitting and merging

UNIT-IV

Description
Boundary Descriptors (Chain code, Signatures, Polygon approximation, Shape numbers, Fourier descriptors) Regional descriptors-simple descriptors (Perimeter, area, minimum and maximum radii, no. Of holes, corner, bending energy, compactness), Moment based descriptors (center of mass, bounding rectangle, Best fit ellipse, Eccentricity, moment invariants), Texture

. **Pattern Recognition**
Artificial Neural network (Perceptron, Hebb net, Feed forward back-propagation net), Template matching.

Reference Books:
1. Digital image processing by Rafael C. Gonzalez and Richard E. Woods
2. Fundamentals of Digital image processing by Anil K. Jain
3. Digital image processing–Concepts, Algorithms and Scientific Applications by Bernd Jahne
4. Machine vision by Ramesh Jain, Rangachar Kasturi, Brian G. Schunck

(PhD-ME-126) PRODUCTIVITY MANAGEMENT

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D			
			Marks of Internal:	20	
3	-	-	**Examination:**	80	
Duration of Exam:	3 Hrs		**Total Marks:**	100	

UNIT-I

Introduction: Productivity Basics

Concern and the Significance of Productivity Management, the Rationale of Productivity Measurement, Productivity: Some Perspectives, Productivity Measurement: A Case for Re-appraisal

Productivity Measurement: A Conceptual Framework

Objectives of Productivity Measurement, Management by Objectives (MBO) and Productivity Measurement, Systems Approach to Productivity Measurement, Performance Objectives – Productivity (PO-P) : The Concept, PO-P: The Model, PO-P: The Methodology.

UNIT-II

Productivity Measurements in Manufacturing Sector

Productivity Measurement in Manufacturing Sector, Productivity Measurement in a Medium Sized Organisation, Productivity Measurement in a Large Sized Organisation.

UNIT-III

PO-P Application : Productivity Measurement in Service Sector

Need for measuring Productivity in Service Sector, Difficulties in measuring productivity, Productivity of an R&D System, Productivity of an Educational Institution.

Productivity Management : The Role of External Environment

External Environment and Organisation, Impact of external Environment, External Environment: Its Sub-systems, Approaches to measure Impact of External Environment.

UNIT-IV

Productivity Management and Implementation Strategies

Productivity Management System, Productivity Policy, Productivity: Organisation & Planning, Productivity Measurement, Productivity Measurement Evaluation, Productivity Improvement Strategies, Productivity Audit and Control

Reference Books:
1. Productivity Management by Prem Vrat, G.D.Sardana and B.S.Sahai
2. Production and Operations Management by S.A.Chunawalla and D.R.Patel

(PhD-ME-127) ERGONOMICS

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		
3	-	-	Marks of Internal:	20
			Examination:	80
Duration of Exam: 3 Hrs			Total Marks:	100

UNIT-I

Introduction, history of development, Domains of Ergonomics Physical ergonomics Cognitive ergonomics Macro ergonomics Organizational ergonomics Engineering psychology,man-machine system and its components.

UNIT-II

Introduction to structure of the body- features of the human body, stress and strain, metabolism, measure of physiological functions- workload and energy consumption, biomechanics, types of movements of body members, strength and endurance, speed of movements. Applied anthropometry - types, use, principles in application,

UNIT-III

Ergonomics in the workplace, design of work surfaces and seat design. Visual displays for static information, visual displays of dynamic information, auditory, tactual and olfactory displays and controls. Effect of vibration, noise, temperature and illumination on performance,

UNIT-IV

Work-Related Musculoskeletal Disorders, Properties of Musculoskeletal Disorders, Work Factors of Musculoskeletal Disorders, Back injury, Carpal tunnel syndrome, Cognitive load, Industrial Design ,Environmental design, Human factors, Human computer interaction, Industrial hygiene ,Industrial noise, Light ergonomics ,Occupational therapy, Participatory Ergonomics and Ergonomics Change Teams.

Reference Books:
1. Sanders Mark S and McCormick Ernert J, "Human Factors in Engineering and Design", McGraw-Hill Inc., 1993.
2. Salvendy, Gavriel. Handbook of Industrial Engineering: Technology and Operations Management. New York, NY: John Wiley & Son Inc, 2001.
3. Hendrick, Hal W., and Brian M. Kleiner. Marcoergonomics: Theory, Methods, and Applications. 1st ed. Mahwah, NJ: Lawrence Erlbaum Associates, Inc., Publishers, 2002.
4. Brookhuis, K., Hedge, A., Hendrick, H., Salas, E., and Stanton, N. (2005). Handbook of Human Factors and Ergonomics Models. Florida: CRC Press.

(PhD-ME-128) ADVANCED MANUFACTURING TECHNIQUES

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		Marks of Internal:	20
3	-	-		Examination:	80
Duration of Exam:	3 Hrs			Total Marks:	100

UNIT-I

Different Techniques:
Manufacturing Change in manufacturing system, manufacturing strategies, Advanced manufacturing Technologies for Indian Industries, Robust design methodology for Quality Engineering and management

UNIT-II

Six Sigma, Taguchi concepts, Quality function deployment, Rapid proto typing: Technology and challenges, Introduction and concepts of JIT, CAPP, MRP, CIMS, FMS, SCM, TPM, Kaizan,

UNIT-III

Agile manufacturing, Lean Manufacturing, Virtual manufacturing system, kanban, Theory of constrains, synchronous manufacturing, concurrent Engineering

UNIT-IV

Advanced Techniques:
Manufacturing and Environmental issues, Advanced materials and their application in manufacturing, Abrasive flow machining , Advanced welding processes (New Solid state Welding, Arc welding and Radiation welding Processes).

Reference Books:
1. Modern Machining Processes, P.C. Pandey and H.S. Shan, TMH
2. Machining Science, Ghosh and Mallik, AEW
3. Non-Traditional Manufacturing Processes by G.F. Benedit, Marcel Dekker.
4. Advanced Machining Processes by V.K. Jain, Allied Puiblishers.

(PhD-ME-129)   COMPUTER AIDED MANUFACTURING

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	**T**	**P/D**		
3	**-**	**-**		

Marks of Internal: 20
Examination: 80
Duration of Exam: 3 Hrs **Total Marks: 100**

UNIT-I

Introduction to Manufacturing
Basic definitions, design activities for manufacturing systems, Planning and control activates for manufacturing system, Manufacturing control, Types of production – low, Medium and high quantity production.

Group Technology and Cellular Manufacturing
Part families, parts classifications and coding, Production flow Analysis, cellular Manufacturing- composite part concept, machine cell design, applications of group technology, Grouping parts and machines by Rank order clustering technique, Arranging machines in a G.T. cell.

UNIT-II

Process Planning
Introduction, Manual process planning, Computer aided process planning – variount, generative, Decision logic- decision tables, decision trees, Introduction to Artificial intelligence.

UNIT-III

Flexible Manufacturing
Introduction, FMS components, Flexibility in Manufacturing – machine, Product, Routing, Operation, types of FMS, FMS layouts, FMS planning and control issues, deadlock in FMS, FMS benefits and applications.

UNIT-IV

CNC Basics and Part Programming
Introduction, Principle of CNC, Classification of CNC/NC – point to point and continuous path, positioning system- fixed zero and floating zero, Dimensioning- absolute and incremental, Coordinate system, Basic requirements of CNC machine control, CNC/NC words, Manual part programming, (G&M codes only) canned cycles, tool length and radius compensation.

Reference Books:
1. Automation, Productions systems and Computer-Integrated Manufacturing by M.P. Groover, Prentice – Hall
2. Computer Aided Manufacturing by Chang, Wang & WySK
3. Numerical Control and Computer – Aided Manufacturing by Kubdra, Rao and Tiwari, Tata Mc Graw Hill.
4. International Journal of Production Research
5. International Journal of Flexible Manufacturing system.

(PhD-ME-130) NON-CONVENTIONAL MACHINING

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		Marks of Internal:	20
3	-	-		Examination:	80
Duration of Exam: 3 Hrs				Total Marks:	100

UNIT-I

Introduction: Need for advanced machining processes; An Overview of Modern machining processes

UNIT-II

Mechanical processes: Abrasive Jet Machining; Ultrasonic Machining; Abrasive Flow Finishing; Magnetic Abrasive Finishing; Abrasive Water Jet Machining

UNIT-III

Thermoelectric advanced machining processes: EDM; EleGtric Discharge Diamond Grinding; Wire EDM; Laser beam Machining; Plasma Arc Machining; Electron Beam Machining

UNIT-IV

Electrochemical and Chemical Processes: ECM; ECG; Electro stream Drilling; Electrochemical Deburring; Chemical Machining

Reference Books:
1. Advanced Machining Processes by V.K. Jain. Allied Publishers Pvt Ltd
2. Model:n Machining Processes by P.C. Pandey and H.S. Shan. Tata McGraw- Hill

(PhD-ME-131) EXPERIMENTAL DESIGNS

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		Marks of Internal:	20
3	-	-		Examination:	80
Duration of Exam:	3 Hrs			Total Marks:	100

UNIT-I

Introduction: Objectives for experimental designs. 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

UNIT-II

Full Factorial Designs with Two Levels: Nature of Factorial Designs. Deleterious Effects of Interactions. Effect Estimates. The 2^3 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

UNIT-III

Designs with more than two levels: 3^k Designs; Conditional Effects; 3"-P Designs; Orthogonal Arrays with mixed levels

UNIT-IV

Robust Designs: 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

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

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		Marks of Internal:	20
3	-	-		Examination:	80
Duration of Exam: 3 Hrs				Total Marks:	100

UNIT-I

Classification:
Arc welding processes: carbon arc welding; shielded metal arc welding; submerged arc welding; gas tungsten arc welding; gas metal arc welding; plasma are welding; atomic hydrogen welding; stud welding; electoslag welding; electrogas welding. Resistance welding Processes: various techniques used in Industry; Friction welding ultrasonic welding; diffusion welding; electron beam welding; laser welding; thermit welding; pressure and non-pressure type.

Arc Welding Power Sources:
Requirements for an arc welding power source; constant current characteristics; constant voltage characteristics, duty cycle. A.C. welding power source D.C. welding power sources.

UNIT-II

Welding Electrodes:
Types of welding eldctrodes, electrode details, non non-consumable or refactory electrodes, consumable electrodes, light, medium and heavy coated electrodes, categories of coated electrodes, electrode coating ingredients and their functions, selection of electrodes.

Weldability and Welding of Various Metals:
Weldability of metals, effect of alloying element on weldability. Welding of cast iron, welding of carbon steels, welding of stainless steel, welding of aluminum and its alloys.

UNIT-III

Foundry Mechanization:
Definition, advantages and disadvantages. Moulding machines, functions, advantages and disadvantages. Various types of moulding machines.

Principle of Gating:
Gating system, requiremenmts, functions of gating system, pouring cups and basins, sprues, gates their characteristics and different types, design of gating system, defects occurring due to improper design of gating system.

UNIT-IV

Principle of Risering:
Functions of riser, types of risers, riser and directional solidification, design, general principle riser shape and size, riser location and riser feeding distance.

Defects in Castings & Special Casting Techniques:
Classification of defects, main types, their causes and remedies. Techniques of die casting centrifugal casting, investment casting their limitations advantages and disadvantages.

Reference Books:
1. Principle of Foundry Technology by P.L. Jain
2. Fundamentals of Metal Casting by P.C. Mukherjee.
3. Foundry Engineering by Tayloir Howard F.
4. Welding and its applications by Rossi, B.E
5. Metallurgy of Welding by Lancaster J.F
6. Modern Welding Technology by Cary Howard B.,
7. Welding Processes and Technology by R.S. Parmar.

(PhD-ME-133) QUALITY & RELIABILITY MANAGEMENT

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		
			Marks of Internal:	**20**
3	-	-	**Examination:**	**80**
Duration of Exam:	3 Hrs		**Total Marks:**	**100**

UNIT-I

Introduction:
Concept of quality, Need, Factor influencing quality, Types of quality, Quality control, Cost of quality control, Quality assurance, Benefits, Modern concept, Inspection and quality control, Quality characteristics, Quality circles.

Statistical Concepts and Control Charts:
Review of fundamental statistical concept, Frequency distribution, Central tendency, measures of dispersion, Probability distributions, statistical quality control, Theory of control charts, Control charts for variables and attributes ($\bar{x}$, R, P, np and C chart), their advantages and disadvantages, Applications.

UNIT-II

Acceptance Sampling:
Introduction, Advantages and Disadvantages, Operating Characteristics curve, Producer's and consumer's risk, Quality indices for acceptance sampling plans, Types of sampling Plans-single double sequential sampling plan, Sampling plan for variables, continuous sampling plans, Skip lot sampling plans, Chain sampling plan.

UNIT-III

Total Quality Management:
Introduction, Concept of Total quality, Quality function, Deployment tools for continuous quality improvement, The ISO 9000 family of standards, Six Sigma and other extensions of TQM.

UNIT-IV

Reliability:
Introduction, Factor effecting Reliability, Failure and its types, Failure curve, Majors of reliability, MTBF, MTTF, Relationship b/w reliability failure rate and MTBF and its characteristics, System reliability (components in series and parallel) System reliability with stand by components, Redundancy, Operating characteristics curve, Reliability and life testing plans, Types of test, Maintainability, Availability.

Reference Books:
1. Statistical Quality control by C. Gupta.
2. Modern Methods for Quality Control and Improvement by Harrism M. Wadsworth.
3. Statistical Quality control by E.L. Grant.
4. Reliability Mathematics by B.L.Ams Tadter.
5. Fundamental of Quality Control and Improvement by Amitava Mitra.

(PhD-ME-134) ADVANCED INTERNAL COMBUSTION ENGINES

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		Marks of Internal:	20
3	-	-		Examination:	80
Duration of Exam:	3 Hrs			Total Marks:	100

UNIT-I

Cycle Analysis

Thermodynamic properties of gases and combustion products, combustion charts, Fuel-air cycle, calculations for Otto, Diesel and dual cycles, Losses due to dissociation, burning time and heat flow. Combustion processes for SI and CI engines; flame propagation and spray burning processes; energy release calculations; actual Vs fuel air cycle, effects of various operating conditions, two and four stroke engine cycles.

UNIT-II

Heat Transfer

Instantaneous heat transfer calculations, engine heat transfer equations, overall heat loss-radiative and convective heat transfers.

Gas Exchange

Generalised equations for in-flow and outflow processes; filling and emptying methods and wave action calculations; two stroke engines, gas exchange processes; types and phases of scavenging, Kadney effect. Super charging of SI 7 CI engines; super charger and turbocharger systems, matching of atomization and spray formation; pump characteristics.

UNIT-III

Fuel Injection

Fuel injection: fuel line hydraulics; compressibility effects; wave and nozzle ends; mechanism of atomization and spray formation; pump characteristics.

UNIT-IV

Flow Processes

Characterisation of flow in the cylinder, Swirl, Squish and turbulence calculations.

Fuels

Petroleum fuels, Gasoline grades, desirable properties of SI & CI engines fuels, rating of fuels.

Reference Books:

1. I.C. Engine Vol. 1 & II by Taylor.
2. Thermodynamics and Gas Dynamic of I.C. Engine, Vol. I & II by Horlock and Winterbone.
3. I.C. Engine , Vol. I & II by Benson and Whitehouse.
4. Thermodynamic Analysis of Combustion Engines, by Campbell.

(PhD-ME-135) DIRECT ENERGY CONVERSION

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		
3	-	-	Marks of Internal:	20
			Examination:	80
Duration of Exam: 3 Hrs			Total Marks:	100

UNIT-I

General

Conversion of energy from one form to another, Direct energy conversion, Application of direct energy conversion.

M.H.D. Generator

Introduction, Principle of working, Different types of M.H.D. generators, M.H.D. materials, M.H.D. power generation systems, Economic aspects of M.H.D. generation.

UNIT-II

Solar Energy

An introduction to solar energy, Heat transfer through solar energy, Solar radiation analysis, Solar energy measuring instruments, Solar collectors, Flat plate collectors, Focussing type collectors, Advantages of focusing type collectors over flat plate type collectors.

Photo-voltaic Power Generation

Introduction, Photo-voltaic effect, Different types of photo-voltaic cells, Cell fabrication, Solar batteries and systems, Solar energy applications, Economic aspects of solar energy utilization.

UNIT-III

Thrmoelectric Generators

Introduction, Thermoelectric effects, Thermoelectric generator, Types of thermoelectric generators, Economic aspects of thermoelectric generation.

UNIT-IV

Fuel Cells

Introduction, Principle of fuel cells, Thermodynamic analysis of fuel cells, Types of fuel cells, Fuel cell batteries, Applications of fuel cells.

Reference Books:

1. Renewable Energy Sources and Conversion Technology by N.K.Bansal, M.Kleeman and M. Mieles.
2. Direct Energy Conversion by G.W.Sutton.
3. Energy Conversion by S.S.L.Chang
4. Fuel Cells for Electric Utility Power generation
5. Advances in Energy Systems and Technology, Vol. 5 by A.P.Fickett

(PhD-ME-136) GAS DYNAMICS

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Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D		
3	-	-	**Marks of Internal:**	20
			Examination:	80
Duration of Exam: 3 Hrs			**Total Marks:**	100

UNIT-I

Introduction
General differential equations of continuity; momentum and energy applied to compressible inviscid fluids; sonic velocity.

UNIT-II

Mach number and propagation of disturbance in a fluid flow; isentropic flow and stagnation properties; flow through nozzles and diffusers; Fanno, Rayleigh and isothermal flows through pipes.

UNIT-III

Shock Waves
Normal and oblique shocks; supersonic expansion by turning; Prandtle-Mayer function, Reflection, refraction and intersection of oblique sock waves; detached shocks.

UNIT-IV

Supersonic and Subsonic Flow
Linearisation and small pertuburation theory; general solutions of supersonic flow; elements of supersonic thin airfoil theory; method of characteristics for solving non-linear equations; Hodograph method for mixed subsonic and supersonic flow. Wind tunnel and its instrumentation.

Reference Books:

1. Gas Dynamics by E. Rathakrishnan
2. Fundamentals of Gas Dynamics by S.M. Yahya
3. Gas Dynamics by Cambell and Jennings
4. Gas Dynamics by Becker
5. Fundamentals of Gas Dynamics by R.D.Zucker
6. Fluid Mechanics by A.K. Mohanty

(PhD-ME-137) CRYOGENICS

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	**T**	**P/D**		**Marks of Internal:**	**20**
3	**-**	**-**		**Examination:**	**80**
Duration of Exam: 3 Hrs				**Total Marks:**	**100**

UNIT-I

Gas liquefaction systems, thermodynamically ideal systems, Joule Thomson effect, adiabatic expansion; liquefaction system for air, Neon, hydrogen and helium, effect of component efficiencies on system performance.

UNIT-II

Gas separation and purification – principles, plant calculation, air, hydrogen, and helium separation systems.

UNIT-III

Cryogenic refrigeration systems, ideal and practical systems, cryogenic temperature measurement; cryogenic fluid storage and transfer systems, storage vessels and insulation, two-phase flow in cryogenics transfer systems, cool down process.

UNIT-IV

Introduction to vacuum technology, low temperature properties of materials, pump down time, application of cryogenic systems, super-conductive devices, rocket and space simulation, cryogenics in biology and medicine, cryopumping.

Reference Books:
1. Barron, R., Cryogenic Systems, McGraw-Hill, 1966.
2. Timmerhaus, K. D. and Flynn, T. M., Cryogenic Process Engineering, Plenum Press, 1989.
3. Scott, R. B., Cryogenic Engineering, D'Van-Nostrand, 1962.
4. Vance, R. W. and Duke, W. M., Applied Cryogenic Engineering, John Wiley, 1962.
5. Sitting, M. Cryogenic, D' Van-Nostrand, 1963.

(PhD-ME-138) NUCLEAR ENGINEERING

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	T	P/D			
			Marks of Internal:		20
3	-	-	**Examination:**		80
Duration of Exam:		3 Hrs	**Total Marks:**		100

UNIT-I

Concepts of Nuclear Physics

The atom, structure, the nucleus, nuclear structure, atomic transmutation of elements, detection of radio-activity, particle accelerator, decay, natural of elements, nucleus interactions, decay rates, half-life, transuranic elements.

Neutorn Interaction

Advantages of using neutron, neutron moderation, fission chain reaction, thermalisation of neutrons, fast neutrons, prompt and delayed neutrons, fission products.

UNIT-II

Energy Release

Mass energy equivalence, mass defect, binding energy, energy release in fission & fusion,thermonuclear reasction, fusion bomb.

Reactor Materials

Fissile & fertile materials, cladding & shielding materials, moderators, coolants.

UNIT-III

Reactor Technology

Basic principles, fuel assembly, neutron balance, reactor kinetics, reactor coefficients, reactor stability, excess reactivity, Xenon poisoning, burnable absorbers, reactivity control, heat balance, production& transfer of heat to the coolant, structural considerations.

Nuclear Reactors

Types of nuclear reactors, pressurized water reactors, boiling water reactors, CANDU type reactors, gas cooled & liquid metal cooled reactors, fast breeder reactors.

UNIT-IV

Safety Considerations & Waste Disposal

Hazards, plant site selection, safety measures incorporated in; plant design, accident control, disposal of nuclear waste.

Health Physics & Radio-isotopes

Radiation: units, hazards, prevention, preparation of radio-isotopes & their use in medicine, agriculture & industry.

Reference Books:
1. Nuclear Power Engineering by M.M. El-Wakel
2. Nuclear Power Plant by Taylor
3. Introduction to Nuclear Engineering by Stephenson.

(PhD-ME-139) SOLAR ENERGY

Note: Total 9 questions are to be set by the examiner/teacher covering the entire syllabus uniformly. A candidate is required to attempt any five questions at least one question from each unit. Question no. 1 is Compulsory. All questions shall carry equal marks.

L	**T**	**P/D**		**Marks of Internal:**	**20**
3	**-**	**-**		**Examination:**	**80**
Duration of Exam:	**3 Hrs**			**Total Marks:**	**100**

UNIT-I

Solar Radiation
Characteristics, Earth-sun relation, Estimation on horizontal and tilted surfaces, Radiation characteristics of opaque and transparent material.

Flat Plate Collectors
Description, theory, Heat capacity effects, Time constant, Measurement of thermal performance, Air heaters.

UNIT-II

Evacuated Tubular Collectors
One axis, Two axis, Solar tracking, Cylinderical, Spherical and Parabolic and Paraboloid concentrators. Composite collectors, Central receiver collectors.

Heat Storage
Sensible and latent heat storage, Chemical energy system, performance calculations.

UNIT-III

Flow Systems
Natural and forced flow systems, Water heating systems for domestic, industrial and space heating requirements, Solar distillation.

Solar Heating and Cooling
Direct, indirect and isolated heating concepts, Cooling concepts, Load calculation methods, Performance evaluation methods.

UNIT-IV

Solar Thermal Power Generation
Introduction, Paraboloidal concentrating systems, Cylinderical concentrating systems, Central receiver system.

Solar Refrigeration and Air Conditioning Systems
Introduction, Solar refrigeration and air conditioning systems, Solar desiccant cooling

Reference Books:

1.   Solar Thermal Engineering Process by Duffie and Beckman.
2.   Advanced Solar Energy Technology by H.P. Garg.
3.   Solar Energy by S.P. Sukhatme.
4.   Solar Energy by J.S. Hsieh.
5.   Solar Thermal Engineering by P.J. Lunde.