MAHARSHI DAYANAND UNIVERSITY, ROHTAK
SCHEME OF STUDIES & EXAMINATIONS
B.E 4th YEAR MECHANICAL ENGINEERING, SEMESTER – VII
Modified 'E' Scheme effective from 2006-07

Course No.	Course Title	Teaching schedule				Marks for class work	Marks for Examination		Total Marks	Duration of Exam.
		L	T	P	Total		Theory	Practical		
ME-401 E	Automobile Engg.	3	1	-	4	50	100	-	150	3
ME-403 E	Ref. & Air-conditioning	3	1	-	4	50	100	-	150	3
ME-405 E	Operations Research	3	1	-	4	50	100	-	150	3
	Open Elective*	3	1	-	4	50	100	-	150	3
ME-407E	Mechanical Vibration	3	1	-	4	50	100	-	150	3
ME-409E	Automobile Engg. Lab	-	-	2	2	25	-	25	50	3
ME-411 E	R. A. C. Lab.	-	-	3	3	50	-	50	100	3
ME-413 E	Project	-	-	4	4	50	-	-	50	3
ME-415 E	Practical Training – II	-	-	2	2	-	-	-	-	-
	Total	15	5	11	31	375	500	75	950	

List of Open Electives

1	HUM-451-E	Language Skills for Engineers	8	CSE-451-E	Artificial Intelligence & Expert Systems
2	HUM-453-E	Human Resource Management	9	CSE-303-E	Computer Graphics
3	HUM-457-E	Business Communication	10	IC-455-E	Intelligent Instrumentation for Engineers
4	HUM-455-E	Entrepreneurship	11	IC-403-E	Embedded Systems
5	PHY-451-E	Nano technology	12	CH-453-E	Pollution & Control
6	PHY-453-E	Laser Technology	13	IT-471-E	Management Information System
7	ME-451-E	Mechatronics Systems	14	IT-204-E	Multimedia Technologies

Notes:

1. **Students will be permitted to opt for any one elective run by the other departments. However, the departments will offer only those electives for which they have expertise The choice of the students for any elective shall not be a binding for the department to offer, if the department does not have expertise.**

2. **Project load will be treated as 2 hrs. per week for Project co-ordinator and 1 hr. for each participating teacher. Project will commence in VIIth semester where the students will identify the Project problem, complete the design/procure the material/start the fabrication/complete the survey etc., depending upon the nature of the problem. Project will continue in VIIIth semester.**

3. **Assessment of Practical Training-II, carried out at the end of VI semester, will be based on seminar, viva-voce and project report of the student from the industry. According to performance, letter Grades A, B, C, F are to be awarded. A student who is awarded 'F' grade is required to repeat Practical Training.**

4. **Students will be allowed to use the non-programmable scientific calculator. However, sharing of calculator will not be permitted.**

ME- 401 E AUTOMOBILE ENGINEERING

L	T	P
3	1	-

Sessional : 50 Marks
Theory : 100 Marks
Total : 150 Marks
Duration of Exam : 3Hrs.

Unit I Introduction to Automobiles : Classification, Components, Requirements of Automobile Body; Vehicle Frame, Separate Body & Frame, Unitised Body, Car Body Styles, Bus Body & Commercial Vehicle Body Types; Front Engine Rear Drive & Front Engine Front Drive Vehicles, Four Wheel Drive Vehicles, Safety considerations; Safety features of latest vehicle; Future trends in automobiles.

Unit II Clutches : Requirement of Clutches – Principle of Friction Clutch – Wet Type & Dry Types; Cone Clutch, Single Plate Clutch, Diaphragm Spring Clutch, Multi plate Clutch, Centrifugal Clutches, Electromagnetic Clutch, Over Running Clutch; Clutch Linkages.

Unit III Power Transmission : Requirements of transmission system; General Arrangement of Power Transmission system; Object of the Gear Box; Different types of Gear Boxes; Sliding Mesh, Constant Mesh, Synchro- mesh Gear Boxes; Epi-cyclic Gear Box, Freewheel Unit. Overdrive unit-Principle of Overdrive, Advantage of Overdrive, Transaxle, Transfer cases.

Unit IV Drive Lines, Universal Joint, Differential and Drive Axles: Effect of driving thrust and torque reactions; Hotchkiss Drive, Torque Tube Drive and radius Rods; Propeller Shaft, Universal Joints, Slip Joint; Constant Velocity Universal Joints; Front Wheel Drive; Principle, Function, Construction & Operation of Differential; Rear Axles, Types of load coming on Rear Axles, Full Floating, Three quarter Floating and Semi Floating Rear Axles.

Unit V Suspension Systems : Need of Suspension System, Types of Suspension; factors influencing ride comfort, Suspension Spring; Constructional details and characteristics of leaf springs.

Unit VI Steering System : Front Wheel geometry & Wheel alignment viz. Caster, Camber, King pin Inclination, Toe-in/Toe-out; Conditions for true rolling motions of Wheels during steering; Different types of Steering Gear Boxes; Steering linkages and layout; Power steering – Rack & Pinion Power Steering Gear, Electronics steering.

Unit VII Automotive Brakes, Tyres & Wheels : Classification of Brakes; Principle and constructional details of Drum Brakes, Disc Brakes; Brake actuating systems; Mechanical, Hydraulic, Pneumatic Brakes; Factors affecting Brake performance, Power & Power Assisted Brakes; Tyres of Wheels; Types of Tyre & their constructional details, Wheel Balancing, Tyre Rotation; Types of Tyre wear & their causes.

Unit VIII Emission Control System & Automotive Electrical : Sources of Atmospheric Pollution from the automobile, Emission Control Systems – Construction and Operation of Positive Crank Case Ventilation (PVC) Systems, Evaporative Emission Control, Heated Air Intake System, Exhaust Gas Recirculation (ECR) Systems, Air Injection System and Catalytic Converters; Purpose construction & operation of lead acid Battery, Capacity

Rating & Maintenance of Batteries; Purpose and Operation of Charging Systems, Purpose and Operations of the Starting System; Vehicle Lighting System.

Text Books:

1. Automobile Engineering by Anil Chhikara, Satya Prakashan, New Delhi.
2. Automobile Engineering by Dr. Kirpal Singh, standard Publishers Distributors.

Reference Books:

1. Automotive Mechanics – Crouse / Anglin, TMH.
2. Automotive Technology – H.M. Sethi, TMH, New Delhi.
3. Automotive Mechanics – S.Srinivasan, TMH, New Delhi.
4. Automotive Mechanics – Joseph Heitner, EWP.
5. Motor Automotive Technology by Anthony E. Schwaller – Delmer Publishers, Inc.
6. The Motor Vehicle – Newton steeds Garrett, Butter Worths.

Note : In the semester examination, the examiner will set eight questions in all, at least one question from each unit & students will be required to attempt only 5 questions.

ME-403 E REFRIGERATION & AIR CONDITIONING

L	T	P		
3	1	-	Sessional	: 50 Marks
			Theory	:100Marks
			Total	:150 Marks
			Duration of Exam	: 3Hrs.

Unit I Introduction: Definition of refrigeration & air conditioning; Necessity; Methods of refrigeration; Unit of refrigeration; Coefficient of performance (COP), Fundamentals of air-conditioning system; Refrigerants- Definition, Classification, Nomenclature, Desirable properties, Comparative study, secondary refrigerants, Introduction to eco-friendly Refrigerants; Introduction to Cryogenics.

Unit II Air Refrigeration System: Carnot refrigeration cycle. Temperature. Limitations; Brayton refrigeration or the Bell Coleman air refrigeration cycle; Necessity of cooling the aero plane; Air craft refrigeration systems, Simple cooling and Simple evaporative types, Boot strap and Boot strap evaporative types, Regenerative type and Reduced Ambient type system, Comparison of different systems, problems.

Unit III Vapour Compression (VC) Refrigeration Systems: (A) Simple Vapour Compression (VC) Refrigeration systems-Limitations of Reversed Carnot cycle with vapour as the refrigerant; Analysis of VC cycle considering degrees of sub cooling and superheating; VC cycle on p-v, t-s and p-h diagrams; Effects of operating conditions on COP; Comparison of VC cycle with Air Refrigeration cycle.

(B) Multistage Ref. Systems- Necessity of compound compression, Compound VC cycle , Inter-cooling with liquid sub –cooling and / or water inter cooler: Multistage compression with flash inter-cooling and / or water inter-cooling; systems with individual or multiple expansion valves; Individual compression system with individual or multiple expansion valves; Individual compression systems with individual or multiple expansion valves but with and without intercoolers.

Unit IV Other Refrigeration Systems: (A) Vapour Absorption Refrigeration Systems – Basic Systems, Actual COP of the System, Performance, Relative merits and demerits; Properties of aqua ammonia; Electrolux Refrigeration; Problems.

(B) Steam Jet Refrigerating System- Introduction, Analysis, Relative merits and demerits, Performance Applications, Problems.

(C) Cascade Refrigerating Systems-Necessity Selection of Pairs of refrigerants for the system, Concept of cascade temperature, Analysis, Multistaging, Comparison with V.C. systems, Applications, Problems.

Unit V Psychrometry of Air & Air Conditioning Processes: Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temp., Thermodynamics wet bulb temp., Psychrometric chart; Psychrometry of air-conditioning processes, Mixing Process, Basic processes in conditioning of air; Psychrometric processes in air washer, Problems.

Unit VI Air- Conditioning Load Calculations: Outside and inside design conditions; Sources of heating load; Sources of cooling load; Heat transfer through structure, Solar radiation, Electrical applications, Infiltration and ventilation, Heat generation inside conditioned space; Apparatus selection; Comfort chart, Problems.

Unit VII Air Conditioning Systems with Controls & Accessories: Classifications, Layout of plants; Equipment selection; Air distribution system; Duct systems Design; Filters; Refrigerant piping; Design of summer air-conditioning and Winter air conditioning systems; Temperature sensors, Pressure sensors, Humidity sensors, Actuators, Safety controls; Accessories; Problems.

Unit VIII Refrigeration and Air Conditioning Equipments: Type of compressors and their performance curves; Types of Condensers, Heat transfer in condensers; Types of expansion devices; types of evaporators, Cooling and Dehumidifying coils, Problems**.**

Text Books :

1. Refrigeration & Air conditioning –R.C. Jordan and G.B. Priester, Prentice Hall of India.
2. Refrigeration & Air conditioning –C.P. Arora, TMH, New Delhi.

Reference Books:

1. A course in Refrigeration & Air Conditioning – Arora & Domkundwar, Dhanpat Rai & Sons.
2. Refrigeration & Air conditioning –W.F. Stocker and J.W. Jones, TMH, New Delhi.
3. Refrigeration & Air conditioning- Manohar Prasad Wiley Estern limited, New Delhi.

Note : In the semester examination the examiner will set eight questions in all one question from each unit. The students will be required to attempt only 5 questions.

ME- 405 E OPERATIONS RESEARCH

L	T	P
3	1	-

Sessional : 50 Marks
Theory : 100 Marks
Total : 150 Marks
Duration of Exam : 3 Hrs.

Unit I Introduction: Definition, role of operations research in decision-making, applications in industry. Concept on O.R. model building –Types & methods.

Unit II Linear Programming (LP): Programming definition, formulation, solution- graphical, simplex Gauss-Jordan reduction process in simplex methods, BIG-M methods computational, problems.

Unit III Deterministic Model: Transportation model-balanced & unbalanced, north west rule, Vogel's Method, least cost or matrix minimal, Stepperg stone method, MODI methods, degeneracy, assignment, traveling salesman, problems.

Unit IV Advanced Topic Of LP: Duality, PRIMAL-DUAL relations-its solution, shadow price, economic interpretation, dual-simplex, post-optimality & sensitivity analysis, problems.

Unit V Waiting Line Models: Introduction, queue parameters, M/M/1 queue, performance of queuing systems, applications in industries, problems.

Unit VI Project Line Models: Network diagram, event, activity, defects in network, PERT & CPM, float in network, variance and probability of completion time, project cost- direct, indirect, total, optimal project cost by crashing of network, resources leveling in project, problems.

Unit VII Simulation: Introduction, design of simulation, models & experiments, model validation, process generation, time flow mechanism, Monte Carlo methods- its applications in industries, problems.

Unit VIII Decision Theory: Decision process, SIMON model types of decision making environment- certainty, risk, uncertainty, decision making with utilities, problems.

Text Books:

1. Operation Research – TAHA, PHI, New Delhi.
2. Principle of Operations Research – Ackoff, Churchaman, arnoff, Oxford IBH, Delhi.

Reference Books :

1. Operation Research- Gupta & Sharma, National Publishers, New Delhi.
2. Quantitative Techniques- Vohra, TMH, New Delhi
3. Principles of operation Research (with Applications to Managerial Decisions) by H.M.Wagher, Prentice Hall of India, New Delhi.
4. Operation Research – Sharma, Gupta, Wiley Eastern, New Delhi.
5. Operation Research – Philips, Revindran, Solgeberg, Wiley ISE.

Note: Paper setter will set eight questions, at least one from each unit. Students are required to answer five questions.

ME 407- E MECHANICAL VIBRATIONS

L	T	P
3	1	-

Sessional : 50 Marks
Theory : 100 Marks
Total : 150 Marks
Duration of Exam: 3 Hrs.

Unit I Fundamentals : Importance of Study of Vibrations, Classifications of Vibrations, Free and Forced, Undamped and Damped, Linear and Non-linear, Deterministic and Random, Harmonic Motion, Vector and Complex Number Representations, Definitions and Terminology, Periodic Functions, Harmonic Analysis, Fourier Series Expansion.

Unit II Free and Damped Vibrations : Single Degree of Freedom system, D'Alemberts Principal, Energy Methods, Rayleighs Method, Application of these Methods, Damped Free Vibrations, Logarithmic Decrement, Under Damping, Critical and Over Damping, Coulomb Damping.

Unit III Harmonically Excited Vibrations : Forced Damped Harmonic Vibration of Single Degree of Freedom Systems, Rotating Unbalance, Rotor Unbalance, Critical Speeds and Whirling of Rotating Shafts, Support Motion, Vibration Isolation, Energy Dissipated by Damping, Equivalent, Viscous Camping, Structural Damping Sharpness of Resonance, Vibration Measuring Instruments.

Unit IV Transient Vibrations : Impulse Excitation, Arbitrary Excitation, Response to Step Excitions, Base Excitation Solution by Laplace Transforms, Response Spectrum, Runge-Kutta Method.

Unit V Two Degrees of Freedom Systems : Introduction to Multi-Degree of Freedom Systems, Normal Mode Vibrations, Coordinate Coupling, Principal Coordinates, Free Vibrations in Terms of Initial Conditions, Forced Harmonic Vibrations, Vibration Absorber, Centrifugal Vibration Absorber, Vibration Damper.

Unit VI Multi degrees of Freedom Systems and Numerical Methods Introduction, Influence Coefficients, Stiffness Matrix, Flexibility Matrix, Natural Frequencies and Normal Modes, Orthogonality of Normal Modes, Dunkerley's Equation, Method of Matrix Iteration, The Holzer Type Problem, Geared and Branched Systems, Beams.

Unit VII Normal Mode Vibration of Continuous System: Vibrating String, Longitudinal Vibrations of Rod, Torsional Vibrations of Rod, Lateral Vibrations of Beam.

Text Books :

1. Theory of Vibrations with Applications W.T. Thomson, Prentice Hall of India.
2. Mechanical Vibration : G.K. Grover and S.P. Nigam, Nem Chand and Sons

Reference Books :

1. Theory and Practice of Mechanical Vibrations J.S. Rao and K. Gupta, Wiley Eastern Ltd.
2. Mechanical Vibrations S.S. Rao, Addison – Wesely Publishing Company

Note : In the semester examination, the examiner will set eight questions in all, at least one question from each unit & students will be required to attempt only 5 questions**.**

ME- 409- E AUTOMOBILE ENGINEERING LAB

L	T	P
-	-	2

Sessional : 25 Marks
Practical : 25 Marks
Total : 50 Marks
Duration of Exam : 3Hrs.

List of Experiments :

1. To study and prepare report on the constructional details, working principles and operation of the following Automotive Engine Systems & Sub Systems.
   (a) Multi-cylinder : Diesel and Petrol Engines.
   (b) Engine cooling & lubricating Systems.
   (c) Engine starting Systems.
   (d) Contact Point & Electronic Ignition Systems.

2. To study and prepare report on the constructional details, working principles and operation of the following Fuels supply systems:
   (a) Carburetors
   (b) Diesel Fuel Injection Systems
   (c) Gasoline Fuel Injection Systems.

3.. To study and prepare report on the constructional details, working principles and operation of the following Automotive Clutches.
   (a) Coil-Spring Clutch
   (b) Diaphragm – Spring Clutch.
   (c) Double Disk Clutch.

4. To study and prepare report on the constructional details, working principles and operation of the following Automotive Transmission systems.
   (a) Synchromesh – Four speed Range.
   (b) Transaxle with Dual Speed Range.
   (c) Four Wheel Drive and Transfer Case.
   (d) Steering Column and Floor – Shift levers.

5. To study and prepare report on the constructional details, working principles and operation of the following Automotive Drive Lines & Differentials.
   (a) Rear Wheel Drive Line.
   (b) Front Wheel Drive Line.
   (c) Differentials, Drive Axles and Four Wheel Drive Line.

6. To study and prepare report on the constructional details, working principles and operation of the following Automotive Suspension Systems.
   (a) Front Suspension System.
   (b) Rear Suspension System.
7. To study and prepare report on the constructional details, working principles and operation of the following Automotive Steering Systems.

(a) Manual Steering Systems, e.g. Pitman –arm steering, Rack & Pinion steering.
(b) Power steering Systems, e.g. Rack and Pinion Power Steering System.
(c) Steering Wheels and Columns e.g. Tilt & Telescopic steering Wheels, Collapsible Steering Columns.

8. To study and prepare report on the constructional details, working principles and operation of the following Automotive Tyres & wheels.
   (a) Various Types of Bias & Radial Tyres.
   (b) Various Types of wheels.

9. To study and prepare report on the constructional details, working principles and operation of the Automotive Brake systems.
   (a) Hydraulic & Pneumatic Brake systems.
   (b) Drum Brake System.
   (c) Disk Brake System.
   (d) Antilock Brake System.
   (e) System Packing & Other Brakes.
10. To study and prepare report on the constructional details, working principles and operation of Automotive Emission / Pollution control systems.

11. Modeling of any two automotive systems on 3D CAD using educational softwares (eg. 3D modeling package/Pro Engineering/I-Deas/ Solid edge etc.)

12. Crash worthiness of the designed frame using Hypermesh and LS-Dyna solver or other software.

NOTE : 1. At least ten experiments are to be performed in the Semester.

2. At least seven experiments should be performed from the above list. Remaining three experiments may either be performed from the above list or as designed & set by the concerned institution as per the scope of the syllabus.

ME- 411- E REFRIGERATION & AIR CONDITIONING LAB.

L	T	P
-	-	3

Sessional : 50 Marks
Practical : 50 Marks
Total : 100 Marks
Duration of Exam : 3Hrs.

List of Experiments :

1. To study the vapour compression Refrigeration System and determine its C.O.P. and draw P-H and T-S diagrams.
2. To Study the Mechanical heat pump and find its C.O.P.
3. To study the Air and Water heat pump and find its C.O.P.
4. To study the cut- sectional models of Reciprocating and Rotary Refrigerant compressor.
5. To study the various controls used in Refrigerating & Air Conditioning systems.
6. To study the Ice- plant, its working cycle and determine its C.O.P and capacity.
7. To study the humidification, heating, cooling and dehumidification processes and plot them on Psychrometric charts.
8. To determine the By-pass factor of Heating & Cooling coils and plot them on Psychrometric charts on different inlet conditions.
9. To determine sensible heat factor of Air on re-circulated air-conditioning set up.
10. To study the chilling plant and its working cycle.

Note : 1. At least ten experiments are to be performed in the semester.

2. At least seven experiments should be performed form the above list. Remaining three experiments may either be performed from the above list or as designed & set by the concerned institute as per the scope of the syllabus.

ME- 413- E PROJECT

L	T	P
-	-	6

Sessional : 100 Marks
Practical : 100 Marks
Total : 200 Marks
Duration of Exam : 3Hrs.

Project involving design/ fabrication/ testing computer simulation/ case studies etc. which is commenced in VIIth Semester, will be completed in VIIIth Semester and will be evaluated through a panel of examiners consisting of HOD of the concerned department, project coordinator and one external examiner to be appointed by the University.

The student will be required to submit three copies of his/her project report to the office of the concerned department for record (one copy each for the deptt. Office, participating teacher and college library).

Project coordinator will be assigned the project load of 2 hrs., per week while the participating teachers will be assigned 1 hr. load for the same.

ME – 415- E PRACTICAL TRAINING – II

At the end of sixth semester each student would undergo six weeks Practical Training in an Industry/ Professional / Organization/ Research Laboratory with the prior approval of the Director-Principal/ Principal of the concerned college and submit a written typed report along with a certificate from the organization. The report will be a evaluated during VII Semester by a Board of Examiners to be appointed by the Director-Principal/ Principal of the concerned college who will award one of the following grades:

Excellent	:	A
Good	:	B
Satisfactory	:	C
Not satisfactory	:	F

A student who has been awarded ‘F’ grade will be required to repeat the practical training.

ME- 451 E FINITE ELEMENT METHODS

L	T	P
3	1	-

Sessional : 50 Marks
Theory : 100 Marks
Total : 150 Marks
Duration of Exam : 3 Hrs.

Unit I Fundamental Concepts : Introduction; Historical Background, Stresses and Equilibrium, Boundary Conditions, Strain-displacement, Relations, Stress- strain Relations, Temperature Effects, Potential Energy and Equilibrium; The Rayleigh-Ritz Method, Galerkin's method. Saint Venant's Principle, Matrix Algebra, Gaussian Elimination.

Unit II One-Dimensional Problems: Introduction; Finite Element Modeling, Coordinates and a Shape Functions, The Potential Energy Approach; The Galerkin Approach, Assembly of the Global Stiffness Matrix and Load Vector. Properties of Stiffness Matrix, The Finite Element Equations; Treatment of Boundary Conditions, Quadratic Shape Functions; Temperature effects.

Unit III Two-Dimensional Problems using Constant Strain Triangles: Introduction, Finite Element Modeling, Constant Strain Triangle, Problem Modeling and Boundary conditions; Axis Symmetric Solids subjected to Axis Symmetric Loading:- Introduction, Axis Symmetric Formulation, Finite Element Modeling; Triangular Element, Problem Modeling and Boundary conditions.

Unit IV Two Dimensional Isoparametric Elements and Numerical Integration: Introduction, The Four-Node quadrilateral, Numerical Integration Stress Calculations, High – Order Element; Nine-Node quadrilateral, Eight-Node Quadrilateral, Six-Node triangle, Comment on Midside Node; Problems.

Unit V Beams & Frames: Introduction, Finite Element formulation, Load Vector, Boundary considerations, Shear Force and Bending Moment, Beams on Elastic supports, Plane Frames, Simple Numerical.

Unit VI Three-Dimensional Problems in Stress Analysis: Introduction, Finite Element Formulation, Stress Calculations, Mesh Preparation, Hexahedral Elements and Higher-order Elements, Problem Modeling.

Unit VII Scalar Field Problems : Introduction, Steady-state Heat Transfer,: Introduction One-Dimensional Heat Conduction, Heat transfer in thin Fins, Two-dimensional steady-state Heat conduction, Potential Flow, Seepage, Fluid flow in Ducts.

Unit VIII Dynamic Considerations: Introduction, Formulation, Element Mass Matrices: Evaluation of Eigen values and Eigenvectors, Interfacing with previous Finite Element Programs and a program for determining critical speeds of Shafts.

Text Books :

1. Introduction to Finite Elements in Engineering Analysis by Tirupathi R. Chandruipatala and Ashok R. Belagundu. Prentice Hall
2. The Finite Element Method in Engineering by S.S.Rao, Peragamon Press, Oxford.

Reference Books:

1. Finite Element Procedures , by Klaus Jurgen Bathi, Prentice Hall.
2. Concepts and Applications of Finite Element Analysis, by Cook, Malkus and Plesha, John Wiley.
3. The Finite Element Method by Zienkiewicz published by Mc Graw Hill.
4. An Introduction to Finite Element Method by J.N. Reddy published by Mc Graw Hill.

Note : In the Semester examination, the examiner will set eight questions. At least one question from each unit. The students will be required to attempt only 5 questions.

ME– 453 E ENERGY MANAGEMENT PRINCIPLES

L	T	P
3	1	-

Sessional : 50 Marks
Theory : 100 Marks
Total : 150 Marks
Duration of Exam : 3 Hrs.

UNIT I Planning for Energy Management : Initiation phase, Audit and analysis phase; Implementation phase; General methodology for building and site energy audit; Site survey, Methodology; Site survey-Electrical system, Steam & water systems; Building survey methodology; Basic energy audit instrumentation; Measurements for building surveys.

UNIT II Management of Heating and Cooling General Principles : The requirements for human comfort; Description of typical systems-dual duct HVAC system, Multi zone HVAC systems, Variable an volume system, Terminal reheat system, Evaporative HVAC systems; Modeling of heating and cooling loads in buildings; Problems.

UNIT III Electrical load and Lighting Management : General principles; Illumination and human comfort; Basic principles of lighting system; Typical illumination system and equipment; Fundamentals of single phase and 3-phase A.C. circuits; Energy management opportunities for lighting systems, Motors and electrical heat; Electrical load analysis and their parameters; Peak, demand control; Problems.

UNIT IV Management of Process Energy : General Principles; Process heat; Combustion; Energy saving in condensate return, Steam generation & distribution, auto-motive fuel control, hot water and water pumping, direct & indirect fired furnaces over; Process electricity; Other process energy forms – compressed air & manufacturing processes; Problems.

UNIT V Economics of Efficient Energy Use : General Consideration Life Cycle Costing, Break Even Analysis, Cost of Money, Benefit / Cost Analysis, Pay Back Period Analysis, Present Worth Analysis, Equivalent Annual Cost Analysis, Capital Cost Analysis, Perspective Rate of Return. Problems.

UNIT VI Integrated Building System : General Principles; Environmental conformation; Passive design consideration; Building envelope design consideration; Integration of building system; Energy storage ; Problems.

UNIT VII Use of Computer for Energy Management : Energy management; Energy management principle involving computers, Basics of computer use; Analysis – Engineering & Economic calculations, Simulation, Forecast, CAD/CAM; Controls – Microprocessor & minicomputers, Building cycling & control, Peak demand limiting & control; Industrial Power management; Problems.

Text Books :

1. Energy management Principles by Craig B. Smith, Published by Pergamon Press.
2. Energy systems and developments – Jyoti Parikh, Oxford University Press.

Reference Books :

1. Energy – resources, demand and conservation with reference to India – Chaman Kashkari, TMH.
2. Integrated renewable energy for rural development– Proc. of natural solar energy convention, Calcutta.

NOTE : In the semester examination, the examiner will set Eight questions, at least one question from each unit. The students will be required to attempt only 5 questions.

ME- 455 E ENGINEERING DESIGN

L	T	P		
3	1	-	Sessional	: 50 Marks
			Theory	: 100 Marks
			Total	: 150 Marks
			Duration of Exam	: 3 Hrs.

Unit I Design Philosophy : Definition of Design, Difference between Science, Engineering and Technology, Morphology of Design, Definition of Product Design, Design by Evolution, Design by Innovation, Invention and Brainstorming.

Unit II Considerations Dictating Mechanical Design : Basic Considerations- Convenience of Use, Maintenance Cost and Appearance; Operational Considerations: Operational Requirements - Strength (Volume & Surface), Rigidity (proper and contact), Vibration, Thermal Resistance etc.; Design for Strength, Design for Rigidity. Design for Stability (buckling) with Illustrations; Functional Requirements – Conformiting (among various components), Concept of Synthesis and Assembly, Role of Fits, Tolerance and Process Capability.

Unit III Human Engineering : Human factors in Engineering Design, Man-machine Systems, Human Physical Activities and Human Control of Systems, Visual Displays of Static and Dynamic Information, Work Environment – Illumination, Atmospheric Conditions, Noise etc.

Unit IV Ingenuity in Design : Tips to increase Strength and Rigidity of m/c components, Concept of Standardization. Simplification (Preferred numbers or Renard series). Concept of Slim Design – Use of Reinforcement, Ribs, Corrugations, Laminations etc. – their Design Analysis; Designation of different types of Fits, Design of Interference Fit Joints, Cumulative Fatigue Failure & Minor's Equation.

Unit V Modeling, Analogy & Simulation : Types of Models and their uses with emphasis on Mathematical Modeling, Importance of Analogy in Design, Electrical – Mechanical Analogy, Membrane Analogy. Similitude and Scale Models.

Unit VI Material Selection: Spectrum of material properties: Performance Characteristics of materials, Evaluation Methods for material selection – Cost vs Performance Relations, Weighted- property Index, Value Analysis – Illustrations.

Unit VII Interactions of Materials, Processing and Design : Role of processing in design, Economics of Manufacturing, Design for Casting, Design for Machining, Design for Welding, Design for Powder Metallurgy, Design for Assembly.

Unit VIII Cost Analysis: Objectives, Costs Classification, Cost Estimate Methods, Labour Costs, Product Pricing.

Text Books :

1. Product Design and Manufacturing – A.Kale & R.C. Gupta, P H I, New Delhi.
2. Engineering Design–A material & Processing Approach – George Dietor, McGraw Hill

Reference Books :

1. Machine Elements - C.B. Rovoloky et.al., MIR Punleshan, Moscow.
3. Mechanical Engg. Design – Joseph Shigley Published by MGH.
4. Engineering Design Process : Yousef Haik, Books/Cole 2003.

Note: In the semester examination, the examiner will set eight questions, at least one question from each unit. The students will be required to attempt only 5 questions.

ME- 457 E COMPUTER INTEGRATED MANUFACTURING

L	T	P
3	1	-

Sessional	:	50 Marks
Theory	:	100 Marks
Total	:	150 Marks
Duration of Exam	:	3 Hrs

Unit I Introduction : CAD/CAM Definition, Computer Technology-central processing unit (CPU), types of memory, input/output, the binary number system, computer programming languages. Automation- Types of automation, CIM, reasons for automating, automation strategies.

Unit II Conventional Numerical Control: Basic components of NC system, the NC procedure, NC coordinate systems, NC motion control system, applications of numerical control, advantages and disadvantages of NC, computer controls in NC, problems with conventional NC, NC controller technology, computer numerical control, functions of CNC, advantages of CNC, Direct numerical control, components of a DNC system, functions of DNC, advantages of DNC.

Unit III NC Part Programming: Introduction, the punched tape in NC, tape coding and format, NC words, manual part programming, computer assisted part programming, the part programmer's job, the computer's job, NC part programming languages. The APT language: Geometry, statements, motion statements, post processor statements, auxiliary statements.

Unit IV Robotics Technology : Joints and links, common robot configurations, work volume, drive systems, types of robot control, accuracy and repeatability, end effectors, sensors in robotics, applications of robots.

Unit V Automated Material Handling & FMS: The material handling function, types of material handling equipment, conveyor systems, types of conveyors, automated guided vehicle systems, applications. FMS-Components, types of systems, applying FMS technology, FMS workstation, planning.

Unit VI Computer Aided Quality Control: Introduction, terminology in Quality Control, the computer in QC, contact and non-contact inspection methods-optical and non-optical, and computer aided testing.

Unit VII Computer Integrated Manufacturing Systems: Introduction, types, machine tools and related equipments, material handling systems, computer control systems, function of the computer in a CIMS, CIMS benefits.

Text Books:

1. Automation, Production Systems and Computer Integrated Manufacturing. Groover M.P, Prentice Hall of India.
2. CAD/CAM – Groover M.P, Zimmers E.W, Prentice Hall of India.

Reference Books:

1. Approach to Computer Integrated Design and Manufacturing Nanua Singh, John Wiley

Note : The paper setter will set 8 questions taking at least one question from each unit . Students will be required to answer only five.

ME 459 E MANUFACTURING MANAGEMENT

L	T	P
3	1	-

Sessional : 50 Marks
Theory : 100 Marks
Total : 150 Marks
Duration of Exam: 3 Hrs

Unit I Manufacturing Systems Designs: Definition, Systems, Subsystems, Systems Approach Fundamentals, Systems Approach for designing, Manufacturing Systems, Systematic Layout Planning (SLP),Computerized Plant Layout-CRAFT, ALDEP, CORELAP, Assembly Line balancing, Problems and solutions of assembly lines, Group Technology & Cellular Systems, Classification & Grouping, overview of FMS. Strategic consideration for comparison of various systems.

Unit II Manufacturing Systems Economics: Concept of time value of money, Preparation of time profile of project, Single payment, Equal Series payment, various machine and project selection & evaluation techniques: Payback period, Present worth, Equivalent annual cost, Cost- benefit ratio, Evaluation for both equal & unequal life. Depreciation concept various methods-straight line, declining balance, Sum of the digits, Sinking fund.

Unit III New Product Development (NPD): Product Development, Customer Need, Strategies for New Product Development, Product life cycle, Product status. Corporate Design Strategies, Japanese Approach to NPD. PUGH total Design approach, PAHL & BEITZ Approach, Project Approach, Cross functional Integration –Design, manufacturing, Marketing, Concurrent Engineering, Modular Design, Standardization Value Engineering & Analysis.

Unit IV Manufacturing Planning & Control Systems: Overview of Aggregate Planning Models, Linear Decision Rules, Management Coefficient, Direct Search Methods, Master Production Schedule, Modular Bill and Materials, Capacity planning & control, language, medium range, short range capacity planning, Just-in Time (JIT), Manufacturing –Philosophy, Elements, KANBAK, effects on layout, workers & vendors, optimized production technology (OPT).

Unit V Forecasting Methods: Forecasting Framework, Forecasting cost and accuracy, Forecasting Uses and Methods – Delphi, Exponential Smoothing, Forecasting Errors – MAD, Regression Methods _ Linear Model for single & multiple variables, Brief idea of computerized forecasting systems.

Unit VI Material Requirements Planning (MRP): Definition of MRP systems. MRP versus Order point, MRP Elements, Types of MRP – MRP I & II. Structured Bill of Materials. Regenerative & Net change MRP, Operating an MRP, Integration of Production & Inventory Control.

Unit VII Maintenance & Reliability: Concept of preventive & breakdown maintenance, maintenance cost, optimal preventive maintenance simple replacement models-individual and group replacement, MAPI - methods, reliability definitions, failure analysis and curve, systems reliability- series parallel, redundancy, methods of

improving reliability, MTBF, MTTR, Maintainability, availability, brief concept of tero-technology.

Text Books:

1. Operations Management – SCHOROEDER, MGH, New York.
2. Production Operations Management – CHARY, TMH, New Delhi.

Reference Books:

1. Production Operations Management – ADAM & EBERT, PHL, New Delhi
2. Operational Management –MONKS, McGraw Hill, Int.
3. Production & Operations Management – I. Hill, Prentice Hall, Int.
4. Production Planning & Inventory Control – NARASIMHAM etal, PHL, New Delhi
5. Production & Operation Management- Panneerselvam, PHI, New Delhi
6. Managing for total Quality-LOGOTHETIS, PHI, New Delhi
7. Concept of Reliability Engineering –L.S. Srinath, Affiliated East West.
8. Revolutionizing Product Development – WHEELWRIGHT & CLARK, Free Press.
9. Management in Engineering – FREEMAN-BALL & BALKWILL, PHI, New Delhi.
10. Production & Operations Management – MARTINICH, John Wiely SE, New Delhi.

Note :In the semester examination the examiner will set 8 questions, at least one question from each unit. Students will be required to attempt five questions.

ME- 461 E RELIABILITY ENGINEERING

L	T	P
3	1	-

Sessional : 50 Marks
Theory : 100 Marks
Total : 150 Marks
Duration of Exam : 3 Hrs.

Unit I Reliability: Definition; Probability Concept; Addition of Probabilities; Complimentary Events; Kolmogorov Axioms.

Unit II Failure Data Analysis: Introduction, Mean Failure Rate, Mean Time to Failure (MTTF), Mean Time between Failures (MTBF), Graphical Plots, MTTF in terms of Failure Density, MTTF in Integral Form.

Unit III Hazard Models: Introduction, Constant Hazard; Linearly Increasing Hazard, The Weibull Model, Density Function and Distribution Function, Reliability Analysis, Important Distributions and their Choice, Standard Deviation and Variance.

Unit IV Conditional Probability: Introduction, Multiplication Rule, Independent Events, Vernn Diagram, Hazard Rate as conditional probability, Bayes Theorem.

Unit V System Reliability: Series. Parallel and Mixed Configurations, Complex Systems, Logic Diagrams, Markov Models.

Unit VI Reliability Improvement & Repairable Systems: Redundancy, Element, Unit and standby Redundancy, Optimization; Reliability – cost trade- off, Introduction to Repairable Systems, Instantaneous Repair Rate, MTTR, Reliability and Availability Functions, Important Applications.

Unit VII Fault-Tree Analysis and Other Techniques: Fault-tree Construction, Calculation of Reliability, Tie- set and Minimal Tie-set.

Unit VIII Maintainability and Availability : Introduction, Maintenance Planning, Reliability and Maintainability trade – off.

Text Books:

2. Reliability Engineering, L.S. Srinath, Affiliated East-West Press, New Delhi.
3. Reliability Engineering, A.K.Govil, Tata Mc-Graw Hill, New Delhi.

Reference Books:

1. Reliability Engineering, L.Balagurusamy, Tata Mc-Graw Hill, New Delhi, 1984.
2. Reliability Based Design, S. Rao, Mc-Graw Hill, 1992.
3. Reliability in Engineering Design, K.C. Kapur and L.R. Lamberson, Wiley Publications.
4. Reliability Engineering, D.J. Smith, 1972, E.W. Publications.

Note: In the semester examination, the examiner will set eight questions, at least one question from each unit. The students will be required to attempt only 5 questions.

ME- 463 E SOLAR ENERGY ENGINEERING

L	T	P
3	1	-

Sessional : 50 Marks
Practical : 100 Marks
Total : 150 Marks
Duration of Exam : 3 Hrs.

Unit I Solar Radiation: Introduction, solar system – sun, earth and earth-sun angles, time, derived solar angles, estimation of solar radiation (direct and diffuse), measurement systems – phyrheliometers and other devices.

Unit II Effect of Solar radiation upon structures: Steady state heat transmission, solar radiation properties of surfaces, shading of surfaces, periodic heat transfer through walls and roofs.

Unit III Solar Collectors: Flat plate and concentrating – comparative study, design and materials, efficiency, selective coatings, heliostats.

Unit IV Heating Applications of Solar Energy: Air and Water heating systems, thermal storages, solar bonds, solar pumps, solar lighting systems, solar cookers, solar drying of grains.

Unit V Cooling Applications of Solar Systems: Continuous and Intermittent vapour absorption systems for cooling applications, absorbent – refrigerant combination, passive cooling systems.

Unit VI Solar Electric Conversion Systems: Photovoltaics, solar cells, satellite solar power systems.

Unit VII Effects on Environment, economic scenario, ozone layer depletion, green house effect, global warming, Remedial measures by international bodies.

Text Books:

1. Solar Energy – S P Sukhatme, Tata McGraw Hill
2. Solar Energy Process – Duffie and Bechman, John Wiley

Reference Books:

1. Applied Solar Energy – Maniel and Maniel, Addison Wiley
2. Solar Energy: Fundamentals and Applications – R P Garg and Jai Prakash, TMH.

Note: In the semester examination, the examiner will set eight questions, at least one question from each unit. The students will be required to attempt only 5 questions.

ME- 465 E DESIGN OF HEAT EXCHANGERS

L	T	P
3	1	-

Sessional : 50 Marks
Theory : 100 Marks
Total : 150 Marks
Duration of Exam: 3 Hrs.

UNIT I Classification of Heat exchangers: Introduction ; Recuperation and regeneration, Transfer processors, Geometry of construction–tubular heat exchangers, plate heat exchangers, extended surface heat exchanges, Heat transfer mechanisms, Flow arrangements, Selection of heat exchangers.

UNIT II Basic Design Methods of Heat Exchanges: Introduction, Arrangement of flow path in heat exchangers , Basic equations in design, Overall heat transfer coefficient , Log mean temperature difference method for heat exchanger analysis , The $\in$-NTU method for heat exchanger analysis, Heat exchanger design calculation, Variable overall heat transfer coefficient , Heat exchanger design methodology.

UNIT III Design Correlations for Condensers and Evaporators :Introduction, Condensation, Film condensation on a single horizontal tube-laminar film condensation, forced convection, Film condensation in tube bundles-effect of condensate inundation, effect of vapor shear, Combined effects of inundation and vapor shear, Condensation inside tubes-condensation in vertical tubes, Flow boiling-sub-cooled boiling, flow pattern, flow boiling correlations.

UNIT IV Shell and Tube Heat Exchangers: Introduction, Basic components-shell types, tube bundle types, tubes and tube passes, tube layout, baffle type and geometry, allocation of streams, Basic design procedure of a heat exchanger-preliminary estimation of unit size, rating of preliminary design, Shell-slide heat transfer and pressure drop-shell-side heat transfer coefficient, shell-side pressure drop, tube-side pressure drop, Bell-Delaware method.

UNIV V Compact Heat Exchangers: Introduction, Plate-fin heat exchangers, tube-fin heat exchangers, Heat transfer and pressure drop-heat transfer, pressure drop for finned-tube exchangers, pressure drop for plate-fin exchangers.

UNIT VI Gasketed Plate Heat Exchangers: Introduction, Mechanical features-plate pack and frame, plate types, Operational characteristics-main advantages, performance limits, Passes and flow arrangements, Application-corrosion, maintenance, Heat transfer and pressure drop calculations-heat transfer area, mean flow channel gap, channel equivalent diameter, heat transfer coefficient, channel pressure drop, port pressure drop, overall heat transfer coefficient, heat transfer surface area, performance analysis, Thermal performance.

UNIT VII Condensers and Evaporators: Introduction, Shell-and-tube condensers-horizontal shell-side condensers, vertical shell-side condensers, vertical tube-side condensers, horizontal in-tube condensers, Steam turbine exhaust condensers, Plate condensers, Air-cooled condensers, Direct contact condensers, Thermal design of shell-and-tube condensers, Design and operational considerations, Condensers for refrigeration and air-conditioning-water cooled condensers, air-cooled condensers, evaporative condensers, Evaporative for

refrigeration and air-conditioning-water-cooling evaporators (chillers), air-cooling evaporators (air coolers), Thermal analysis-shah correlation, Kandlikar correlation, Gungor and Winterton correlation, Standards for evaporators and condensers.

UNIT VIII Regenerators: Classifications-fixed bed regenerators, rotary regenerators, basic design method, Influence of fluid bypass carry-over, Pressure drop evaluation, The rating problem, surface geometrical properties, Pressure drop, Sizing problem.

Text Books:

1. Heat Exchangers, Sadik Kakac, Hongtan Hiu , CRC Press.
2. Principles of Heat Transfer, F.Krieth & M.S. Bohn, Asian Books Pvt. Ltd., Delhi.

Reference Books:

1. Heat exchangers, Design and Theory Source Book, N.H. Afgan and Schliinder MGH.
2. Compact Heat Exchanger, W.M. Kays & A.L. London, MGH.

Note: In the semester examination, the examiner will set eight questions, at least one question from each unit. The students will be required to attempt only 5 questions.

ME- 467 E VALUE ENGINEERIN

L	T	P			
3	1	-	Sessional marks	:	50
			Theory marks	:	100
			Total marks	:	150
			Duration of exam	:	3Hrs

PART- A

UNIT – I Introduction:
Value Engineering concepts, Advantages, Applications, Problem recognition, and role in productivity criteria for comparison, element of choice.

UNIT – II Organisation:
Level of VE in the organization, Size and skill of VE staff, small plant VE activity. Unique and quantitative evaluation of ideas.

PART- B

UNIT – III Analysis Of Function:
Anatomy of the function, Use esteem and exchange values, Basic vs secondary vs. unnecessary functions.

UNIT – IV Value Engineering Techniques:
Selecting products and operation for VE action, VE programmes, determining and evaluating function(s) assigning rupee equivalents, developing alternate means to required functions, decision making for optimum alternative, Use of decision matrix, Queuing theory and Monte Carlo method, make or buy, Measuring profits, Reporting results, Follow up, Use of advanced technique like FAST (Function Analysis System) Tech.

Reference and Text Books:

1. Techniques of Value analysis and engineering – Miles, Pub.- McGraw Hill.
2. Value Management – Heller Pub.- Addison Wesley.
3. Value Analysis and Value – Oughson, Pub.- Pitman.

Note: In the semester examination, the examiner will set eight questions in all, taking two questions from each unit. The students will be required to attempt 5 questions in all, taking at least two questions from each Part.