Category	Title	Code	Credits-4C			Theory Paper
DC(E)-3	Energy Conservation and Audit	ME-801(A)	L	T	P	Max.Marks-100
			3	1		Min.Marks-35
						Duration-3hrs.

UNIT-I Energy Management: Concept of energy management, energy demand and supply, economic analysis; Duties and responsibilities of energy managers.
Energy Conservation: Basic concept, energy conservation in Household, Transportation, Agricultural, service and Industrial sectors, Lighting, HAVC.

UNIT-II Energy Audit: Definition, need and types of energy audit; Energy management (Audit) approach: Understanding energy cost, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirement; Fuel & energy substitution; Energy audit instruments; Energy conservation Act; Duties and responsibilities of energy manager and auditors.

UNIT-III Material energy balance: Facility as an energy system; Method for preparing process flow; material and energy balance diagrams.
Energy Action Planning: Key elements, force field analysis; Energy policy purpose, perspective, content, formulation, rectification

UNIT-IV Monitoring and Targeting: Definition monitoring & targeting; Data and information analysis.
Electrical Energy Management: energy conservation in motors, pumps and fan systems; energy efficient motors.

UNIT-IV Thermal energy management: Energy conservation in boilers, steam turbine and industrial heating system; Application of FBC; Cogeneration and waste heat recovery; Thermal insulation; Heat exchangers and heat pump; Building Energy Management.

References:
1. Murphy & Mckay, Energy Management, BSP Books Pvt. Ltd.
2. Smith CB; Energy Management Principle, Pergamon Press, New York.
3. Rajan GG, Optimising Energy Efficiency in Industry, TMH.
4. Callaghan P O, Energy Management, McGraw-Hill Book Company.
5. Amit Kumar Tyagi, Handbook on Energy Audit and Management, Tata Energy Research Institute.
6. Bureau of Energy Efficiency, Study material for energy Managers and Auditors: Paper I to V.
7. Hamies; Energy Auditing and Conservation: Method, Measurement…, Hemisphere, Washington.
8. Witty, Larry C, Industrial Enegy Management Utilisation, Hemisphere Publishers, Washington
9. Kreith & Goswami, Energy Management and Conservation Handbook, CRC Press.

Category	Title	Code	Credits-4C			Theory Paper
DC(E)-3	Tool Engineering and Machine Tools	ME-801(B)	L	T	P	Max.Marks-100
			3	1		Min.Marks-35 Duration-3hrs.

Course Contents

Unit I Basic Features and Kinematics of Machine Tools: Features of basic machine tools; construction and operation, types of machine tools, machine tools motions, transmission-rotation in to rotation, rotation in to translation, kinematic-structures of machine tools: elementary, complex and compound structure, kinematic-features of gear shapers and gear hobbing machine.

Unit II Regulation of Speed: Design of gear boxes- need for variation of speed, selection of speed range, laws of stepped regulation, standardization of speeds, speed diagram, analysis of productivity loss, kinematic advantage of GP, structural diagrams, ray diagram and speed chart.
Gear Drives: Belt and cone pulley, slip gear type, north gear drive, draw key gear drive, clutch type, mechanical step less drives, electrical drives; hydraulic drive.

Unit III Design of Metal working Tools: Design of press working tools, shearing, piercing, blanking, dies, compound die design principles for forging dies, bending, forming drawing dies, tooling for forging-design principles for forging dies, drop forging, upset forging, design principles and practice for rolling, roll press design.

Unit IV Design of Jigs and Fixtures: Principles of location, locating method and devices, principles of clamping, clamping devices, drilling jigs, types, drill bushes, fixture and economics, types of fixture, milling, grinding, broaching, assembly fixtures indexing jig and fixtures, indexing devices.

Unit V Design of Gauges and Inspection Features: Design of gauges for tolerance for dimensions and form inspection; dies and mould design for Ppastics & rubber parts:
compression molding, transfer molding, blow molding.

References:
1. Mehta N.K.; Machine Tool Design and Numerical Control; TMH
2. Sen G.C, Bhattacharya A; Principles of Machine Tools; New Central Book Agency.
3. Donaldson; Tool Design T.M.H.
4. Jain KC and Chitale AK; Text Book Of Production Engineering; PHI Learning
5. Juneja, Sekhon and Seth; Fundamentals of Metal Cutting and Machine Tools; New Age.
6. Krar SF, Gill AR, Smid P; Technology of Machine Tools;TMH
7. Sharma P.C; Production Engineering; Chand S
8. Wilson; Fundamentals of Tool Design; ASTME
9. Paqwin J.R; Die Design Handbook; The Industrial Press-NY
10. ASTME; Die Design Hand Book; McGraw Hill
11. Archinov; Metal Cutting & Cutting Tool Design; MIR Publishers Moscow
12. Kempster M.H.A; Introduction to Jig and Tool Design; FLBS.

Course Contents

Category	Title	Code	Credits-4C			Theory Paper
DC(E)-3	Reliability and Maintenance	ME-801(C)	L	T	P	Max.Marks-100
			3	1	0	Min.Marks-35 Duration-3hrs.

Unit 1 Basic Concepts of Reliability: Probability distributions used in maintenance engineering-Binomial, Poisson, Exponential, Normal, Log-normal, Gamma and Weibull distribution; failure rate, hazard rate, failure modes, MTTR, MTBF, MTTF

Unit 2 System Reliability Models: System reliability–n-component series systems, m-component parallel systems and combined system; standby systems; K-out-of-m systems; redundancy techniques in system design; event space, decomposition (Key Stone), cut and tie sets, Markov analysis, reliability and quality, unreliability, maintainability, availability

Unit 3 Maintenance Concepts and Strategies: Introduction, maintenance functions and objectives, maintenance planning and scheduling, maintenance organization.
General Introduction to Maintenance Types: Breakdown, emergency, corrective, predictive, and preventive; maintenance prevention; design-out maintenance, productive maintenance, shutdown maintenance and scheduled maintenance.

Unit 4 Condition Based Maintenance: Principles of CBM, pillars of condition monitoring, CBM implementation and benefits; condition monitoring techniques- visual monitoring, vibration monitoring, wear debris monitoring, corrosion monitoring, performance monitoring

Unit 5 Reliability Centered Maintenance (RCM):– Concept, methodology, benefits;
Total Productive Maintenance: Evolution of TPM, TPM objectives, concept, pillars of TPM.
Failure Modes and Effects Analysis **(FMEA)/** Failure Modes, Effects and Criticality Analysis **(FMECA)**: Overview, elements of FMECA, applications and benefits, risk evaluation, risk priority numbers, criticality analysis, process FMEA, qualitative and quantitative approach to FMECA; design FMEA and steps for carrying out design FMEA

References:
1. Ebeling CE; An Introduction To Reliability & Maintainability Engg; TMH
2. Srinath L.S; Reliability Engineering; East West Press.
3. Naikan; Reliability engg and life testing; PHI
4. Kapur KC and Lamberson LR; Reliability in Engineering Design; Wiley India
5. Telang AD and Telang A; Comprehensive Maintanance Management; PHI
6. Mishra R.C; Reliability and Maintenance Engineering; New age International publisher.
7. Balaguruswamy; Reliability Engg; TMH
8. Dhillon; Engg Maitainability- How to design for Reliability and easy maintenance; PHI
9. Davidson John; The Reliability of mechanical system; Institution of Mech. Engineers, London
10. Patrick D.T and O.'Connor; Practical Reliability Engineerin; John Wiley and Sons
11. Modarre M; Reliability and Risk Analysis, Marcel Dekker Inc CRC Press

Course Contents

Category	Title	Code	Credits-4			Theory Paper
DC(E)-3	Simulation and Process Modeling	ME 801 (D)	L	T	P	Max. Marks-100
			3	1		Min. Marks-40 Duration: 3 hrs.

Unit 1: Introduction to modeling and simulation: Modeling and simulation methodology, system modeling, concept of simulation; gaming; static, continuous and discrete event simulation.

Unit 2: Basic concept of probability, generation and characteristics of random variables, continuous and discrete variables and their distributions; mapping uniform random variables to other variable distributions; linear, nonlinear and stochastic models

Unit 3; Introduction to Queuing Theory: Characteristics of queuing system, Poisson's formula, birth-death system, equilibrium of queuing system, analysis of M/M/1 queues. Introduction to multiple server Queue models M/M/c Application of queuing theory in manufacturing and computer system

Unit 4; System Dynamics modeling: Identification of problem situation, preparation of causal loop diagrams and flow diagrams, equation writing, level and rate relationship, Simulation of system dynamics models.

Unit 5: Verification and validation: Design of simulation experiments, validation of experimental models, testing and analysis. Simulation languages comparison and selection, study of simulation software – Arena, Pro-model, SIMULA, DYNAMO, STELLA, POWERSIM.

References:
1. Law AM and Kelton WD; Simulation Modeling and Analysis; TMH
2. Gordon G., System simulation, PHI Learningl
3. Banks J; Hand book of Simulation; John Wiley.
4. Taha H, Operations Research; PHI.
5. Hillier FS, Liberman GJ; Introduction to OR; TMH.
6. Deo N; System Simulation with Digital Computer; PHI Learning
7. Harrell C, Ghosh B, Bowden R; Simulation Using Promodel; MG Hill
8. Seila, Ceric and Tadikmalla; Applied Simulation Modeling, Cengage
9. Payer T., Introduction to system simulation, McGraw Hill.
10. Sushil, System Dynamics, Wiley Eastern Ltd.
11. Spriet JA; Computer Aided Modeling and Simulation, Academic Press INC; USA

Course Contents

Category	Title	Code	Credits-6C			Theory Paper
DC 21	Machine Design	ME-802	L	T	P	Max.Marks-100
			3	1	2	Min.Marks-35
						Duration-3hrs.

Note: PSG Design data book and/ or Mahadevan and Reddy's Mechanical design data book are to be provided/ permitted in exam hall (duly verified by authority)

Unit I Design of Belt, Rope and Chain Drives: Methods of power transmission, selection and design of flat belt and pulley; Selection of V-belts and sheave design; Design of chain drives, roller chain and its selection; Rope drives, design of rope drives, hoist ropes.

Unit II Spur and Helical Gears: Force analysis of gear tooth, modes of failure, beam strength, Lewis equation, form factor, formative gear and virtual number of teeth; Gear materials; Surface strength and wear of teeth; strength against wear; Design of straight tooth spur and Helical Gears.
Bevel Gears: Application of bevel, formative gear and virtual number of teeth; Force analysis; Lewis equation for bevel gears; Strength against wear; Design of bevel gear.

Unit III Design of I.C. Engine Components: General design considerations in I C engines; design of cylinder; design of piston and piston-rings; design of connecting rod; design of crankshaft.

Unit IV Design of Miscellaneous Components: design of Flanged coupling; Rigid coupling, Design of Pressure vessels subjects to internal pressure, external pressure, design of penetration, design of flanges, cone cylinder junctions ,Materials, Fabrication.

Unit V Optimization: Basic concept of optimization, classification of optimization, optimization techniques, engineering applications of optimization. Classical optimization techniques: unconstrained optimization single-variable optimization, multivariable optimization, solution by direct search method, solution by Lagrange-multipliers method.

References:

1. Shigley J.E.; Machine Design; TMH
2. BhandariVB; Design of Machine Elments; TMH
3. Sharma CS and Purohit K; Design of Machine Elements; PHI Learning.
4. Hall and Somani; Machine Design; Schaum Series; TMH
5. Wentzell TH; Machine Design; Cegage Learning
6. Sharma & Agrawal; Machine Design; Katson
7. Kulkarni SG; Machine Design; TMH
8. Abdul Mubeen; Machine Design; Khanna Publishers
9. Juvinall RC, Marshek KM; Fundamentals of Machine Component Design; Wiley
10. Norton R; Design Of Machinery; TMH

List of Experiment (Pl. expand it):
Designing and sketching of components contained in the syllabus

Course Contents

Category	Title	Code	Credits-6C			Theory Paper
			L	T	P	Max.Marks-100
DC 22	Refrigeration and Air Conditioning	AU/ ME-803	3	1	2	Min.Marks-35 Duration-3hrs.

Unit-I Introduction: Principles and methods of refrigeration, freezing; mixture cooling by gas reversible expansion, throttling, evaporation, Joule Thomson effect and reverse Carnot cycle; unit of refrigeration, coefficient of performance, vortex tube & thermoelectric refrigeration, adiabatic demagnetization; air refrigeration cycles- Joule's cycle Boot-strap cycle, reduced ambient cycle and regenerative cooling cycles.

Unit-II Vapour compression system: Vapor compression cycle, p-h and t-s diagrams, deviations from theoretical cycle, sub-cooling and super heating, effects of condenser and evaporator pressure on cop; multi-pressure system: removal of flash gas, multiple expansion & compression with flash inter cooling; low temperature refrigeration: production of low temperatures, cascade system, dry ice, production of dry ice, air liquefaction system,.

Unit-III (a) **Vapour absorption system**: Theoretical and practical systems such as aqua-ammonia, electrolux & other systems; (b) **Steam jet refrigeration**: Principles and working, simple cycle of operation, description and working of simple system, (c) **refrigerants:** nomenclature & classification, desirable properties, common refrigeration, comparative study, leak detection methods, environment friendly refrigerants and refrigerant mixtures, brine and its properties

Unit-IV Psychrometric: Calculation of psychrometric properties of air by table and charts; psychrometric processes: sensible heating and cooling, evaporative cooling, cooling and dehumidification, heating and humidification, mixing of air stream, sensible heat factor; principle of air conditioning, requirements of comfort air conditioning, ventilation standards, infiltrated air load, fresh air load human comfort, effective temperature & chart, heat production & regulation of human body,

Unit-V Air conditioning loads: calculation of summer & winter air conditioning load, bypass factor of coil, calculation of supply air rate & its condition, room sensible heat factor, grand sensible heat factor, effective sensible heat factor, dehumidified air quantity. Problems on cooling load calculation. Air distribution and ventilation systems

References:
1. Arora CP; Refrigeration and Air Conditioning; TMH
2. Sapali SN; Refrigeration and Air Conditioning; PHI
3. Ananthanarayan; Basic Refrigeration and Air conditioning; TMH
4. Manohar Prasad; Refrigeration and Air Conditioning; New Age Pub
5. Ameen; Refrigeration and Air Conditioning; PHI
6. Pita ; Air conditioning Principles and systems: an energy approach; PHI
7. Stoecker W.F, Jones J; Refrigeration and Air conditioning; McGH, Singapore
8. Jordan RC and Priester GB Refrigeration and Air Conditioning, PHI USA
9. Arora RC; Refrigeration and Air conditioning; PHI Learning

List of Experiments (Please Expand it):
Refrigeration and Air Conditioning AU/ ME 803

1. General Study of vapor compression refrigeration system.
2. General Study of Ice Plant
3. General Study and working of cold storage
4. General Study Trane Air Condition (Package Type).
5. General Study of Electrolux Refrigeration
6. General Study One tone Thermax refrigeration unit.
7. General Study of Water cooler
8. General Study of Psychrometers (Absorption type)
9. General Study of Leak Detectors (Halide Torch).
10. General Study and working of Gas charging Rig.
11. General Study of window Air Conditioner.
12. General Study and working of Vapor compression Air conditioning Test rig.
13. Experimentation on Cold Storage of Calculate COP & Heat Loss.
14. Experimentation on Vapor compression Air Conditioning test rig.
15. Changing of Refrigerant by using Gas Charging Kit.

Course Contents

Category	Title	Code	Credits-6C			Theory Paper
DC 23	CAD/CAM/CIM	ME-804	L	T	P	Max.Marks-100
			3	1	2	Min.Marks-35
						Duration-3hrs.

Unit 1 Introduction: Information requirements of mfg organizations; business forecasting and aggregate production plan; MPS, MRP and shop floor/ Production Activity Control (PAC); Mfg as a system, productivity and wealth creation; production processes on volume-variety axes; importance of batch and job shop production; CIM definition and CIM wheel, evolution and benefits; CIM as a subset of Product Life Cycle (PLC) mgt; design for mfg (DFM) and concurrent engg; product design in conventional and CIM environment; terms like CAD, CAE, CAM, CAP, CAPP, CATD and CAQ.

Unit 2 Graphics and standards: Raster scan, coordinate systems for model (M/ WCS) user and display; database for graphic modeling; PDM, PIM, EDM; define EDM, features of EDM; basic transformations of geometry- translation, scaling, rotation and mirror; introduction to modeling software; need for CAD data standardization; developments in drawing data exchange formats; GKS, PHIGS, CORE, IGES, DXF STEP DMIS AND VDI; ISO standard for exchange of Product Model data-STEP and major area application protocols.

Unit 3 Geometric Modeling: Its use in analysis and mfg; 2D and 3D line, surface and volume models; linear extrusion and rotational sweep; Constructive Solid Geometry (CSG); basics of boundary presentation- spline, Bezier, b-spline, and NURBS; sculpture surfaces, classification, basics of coons, Bezier, b-spline and ruled surfaces; tweaking, constraint based parametric modeling; wire-frame modeling, definition of point, line and circle; polynomial curve fitting; introduction to rapid prototyping.

Unit 4 Numeric control and part programming: Principles of NC machines, CNC, DNC; NC modes of point to point, -line and 2D, 3D contouring; NC part programming; ISO standard for coding, preparatory functions(G)- motion, dwell, unit, preset, cutter compensation, coordinate and plane selection groups; miscellaneous (M) codes; CLDATA and tool path simulation; ISO codes for turning tools and holders; ATC, modular work holding and pallets; time and power estimation in milling, drilling and turning; adaptive control, sequence control and PLC; simple part programming examples.

Unit 5 Group Technology: Importance of batch and job shop production; merits of converting zigzag process layout flow to smooth flow in cellular layout, Production Flow Analysis (PFA) and clustering methods; concept of part families and coding; hierarchical, attribute and hybrid coding; OPITZ, MICLASS and DCLASS coding; FMS; material handling; robots, AGV and their programming; agile mfg; Computer Aided Process Planning (CAPP), variant/ retrieval and generative approach

References:
1. S.Kant Vajpay; Principles of CIM; PHI
2. Rao PN; CAD/CAM;TMH
3. Groover MP; Automation, Production Systems & CIM; P.H.I.
4. Rao PN, Tiwari NK, Kundra TK; Computer Aided Manufacturing; TMH
5. Alavudeen A, Venkteshwarn N; Computer Integrated Mfg; PHI
6. Radhakrishnan P, Subramanian S and Raju V; CAD/CAM/CIM; New age Pub

List of Experiments (please expand it):
1. 2D and 3D modeling on CAD software
2. Use of CAM software for writing CNC programs
3. Study of automatic and semi automatic control system and writing the electrical analogy.
4. Production & layout for GT for group of jobs to be manufactured
5. A case study / tutorial using CAPP Software
6. Writing M & G codes for given operations.
7. Robot and AGV programming

Course Contents

Category	Title	Code	Credits 8C			Practical
DC 24	Major Project	ME 805	L	T	P	Max. Marks 100
			0	0	8	Min. Marks-50

Objectives of the course Minor/Major Project are:
- To provide students with a comprehensive experience for applying the knowledge gained so far by studying various courses.
- To develop an inquiring aptitude and build confidence among students by working on solutions of small industrial problems.
- To give students an opportunity to do some thing creative and to assimilate real life work situation in institution.
- To adapt students for latest development and to handle independently new situations.
- To develop good expressions power and presentation abilities in students.

The focus of the Major Project is on preparing a working system or some design or understanding of a complex system using system analysis tools and submit it the same in the form of a write up i.e. detail project report. The student should select some real life problems for their project and maintain proper documentation of different stages of project such as need analysis market analysis, concept evaluation, requirement specification, objectives, work plan, analysis, design, implementation and test plan. Each student is required to prepare a project report and present the same at the final examination with a demonstration of the working system (if any)

Working schedule   The faculty and student should work according to following schedule:
Each student undertakes substantial and individual project in an approved area of the subject and supervised by a member of staff.The student must submit outline and action plan for the project execution (time schedule) and the same be approved by the concerned faculty.

Action plan for Major Project work and its evaluation scheme #(Suggestive)

Task/Process	Week	Evaluation	Marks For Term Work#
Orientation of students by HOD/Project Guide	1st	-	-
Literature survey and resource collection	2nd	-	-
Selection and finalization of topic before a committee*	3rd	Seminar-I	10
Detailing and preparation of Project (Modeling, Analysis and Design of Project work)	4th to 5th	-	10
Development stage			
Testing, improvements, quality control of project	6th to 10th 11th	-	25
Acceptance testing	12th	-	10
Report Writing	13th to 15th	-	15
Presentation before a committee (including user manual, if any)	16th	- Seminar-II	30

* Committee comprises of HOD, all project supervisions including external guide from industry (if any)
# The above marking scheme is suggestive, it can be changed to alternative scheme depending on the type of project, but the alternative scheme should be prepared in advance while finalizing the topic of project before a committee and explained to the concerned student as well.
NOTE: At every stage of action plan, students must submit a write up to the concerned guide: