DEPARTMENT OF
MECHANICAL ENGINEERING

Scheme of Instruction
and Syllabi of

B.E. IV YEAR
MECHANICAL ENGINEERING

With effect from 2014-2015

UNIVERSITY COLLEGE OF ENGINEERING
(AUTONOMOUS)
Osmania University,
Hyderabad–500 007. (Telangana)

UNIVERSITY COLLEGE OF ENGINEERING, OSMANIA UNIVERSITY

VISION OF THE INSTITUTE

The Vision of the Institute is to generate and disseminate knowledge through a harmonious blending of Science, Engineering and Technology. To serve the society by developing a modern technology in students' heightened intellectual, cultural, ethical and humane sensitivities, fostering a scientific temper and promoting professional and technological expertise.

MISSION OF THE INSTITUTE

- To achieve excellence in Teaching and Research.
- To generate, disseminate and preserve knowledge.
- To enable empowerment through knowledge and information.
- Advancement of knowledge in Engineering, Science and Technology.
- Promote learning in free thinking and innovative environment.
- Cultivate skills, attitudes to promote knowledge creation.
- Rendering socially relevant technical services for the community.
- To impart new skills of technology development.
- To inculcate entrepreneurial talents and technology appreciation programmes.
- Technology transfer and incubation.

DEPARTMENT OF MECHANICAL ENGINEERING

VISION OF THE DEPARTMENT

To generate and disseminate knowledge in Mechanical Engineering and nurture professional, technical and scientific temper for serving the needs of the industry, research organizations and society.

MISSION OF THE DEPARTMENT

- Create technically competent mechanical engineers to suit the changing needs of global industry and society.
- To cultivate skills, attitudes to promote knowledge creation and technology development.
- Interact with prominent educational institutions and R&D organizations for enhancing teaching, research and consultancy services.

DEPARTMENT OF MECHANICAL ENGINEERING

B.E (Mechanical Engineering)

PROGRAM EDUCATIONAL OBJECTIVES

PEO 1	To provide the requisite fundamentals of varied subjects related to Mechanical Engineering to conceive, plan, model, design, construct, maintain and improve systems to enhance human comfort.
PEO 2	To provide knowledge of experimental, computational, analytical, simulation tools and techniques require to address the challenges in Mechanical Engineering and other allied fields.
PEO 3	To provide knowledge to apply Mechanical Engineering Fundamentals to design and implement cost effective systems in manufacturing.
PEO 4	To provide effective communication skills, creative methods, ethics and continuous learning techniques to fulfill their professional requirements and societal needs.

PROGRAM ARTICULATION MATRIX

S.No.	PEO Statement	M1	M2	M3
PEO 1	To provide the requisite fundamentals of varied subjects related to Mechanical Engineering to conceive, plan, model, design, construct, maintain and improve systems to enhance human comfort.	3	3	3
PEO 2	To provide knowledge of experimental, computational, analytical, simulation tools and techniques require to address the challenges in Mechanical Engineering and other allied fields.	3	3	3
PEO 3	To provide knowledge to apply Mechanical Engineering Fundamentals to design and implement cost effective systems in manufacturing.	3	3	3
PEO 4	To provide effective communication skills, creative methods, ethics and continuous learning techniques to fulfill their professional requirements and societal needs.	2	2	2

PROGRAM OUTCOMES (POs):

At the end of the program, the student will be able to:

POs	
PO1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an mechanical engineering to the solution of complex engineering problems.
PO2	**Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems related to mechanical engineering and allied fields reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the Mechanical engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the Mechanical engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the mechanical engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the mechanical engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Lifelong learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.
Program Specific Outcomes	
PS01	Apply the principles of collaborative and multi disciplinary approach for solving problems
PS02	Able to interact with industry and R&D institutions leading to start-ups/ budding entrepreneurs.

SCHEME OF INSTRUCTION & EXAMINATION
B.E. IV-YEAR (MECHANICAL ENGINEERING)

SEMESTER-I

Sl. No.	Syllabus Ref. No.	Subject	Scheme of Instruction		SCHEME OF EXAMINATION			Credits
			Periods / week		Duration in hrs.	Max. Marks		
			L + T	D / P		Univ. Exam	Sessional Marks	
THEORY								
1.	ME 401 UE	Production and Operations Management	4	-	3	75	25	4
2.	ME 402 UE	Thermal Turbomachines	4	-	3	75	25	4
3.	ME 403 UE	CAD/CAM	4	-	3	75	25	4
4.	ME 404 UE	Control Systems Theory	4	-	3	75	25	4
5.	CM 221 UE	Managerial Economics & Accountancy	4	-	3	75	25	4
6.		Elective-II	4	-	3	75	25	4
PRACTICALS								
1.	ME 431 UE	Thermal Engineering Lab.	-	3	3	50	25	2
2.	ME 432 UE	CAD/CAM Lab.	-	3	3	50	25	2
3.	ME 433 UE	Project Seminar	-	3	-	-	25	-
4.	SI 400 UE	Summer Internship	-	-	-	-	*Grade	-
		TOTAL:	24	9	24	550	225	28

** S / A / B / C / D / F*

Note: Summer Internship (6-Weeks) is after III/IV II-Semester. Grade will be awarded in IV/IV I-Semester.

ELECTIVE-II

1. ME 406 UE Design of Solar Energy Systems
2. ME 407 UE Non-conventional Methods of Machining & Forming
3. ME 408 UE Additive Manufacturing Technologies
4. ME 409 UE Entrepreneurship
5. ME 410 UE Aerodynamic Design of Thermal Turbines
6. ME 411 UE Materials Handling
7. ME 412 UE Finite Element Analysis
8. ME 413 UE Numerical Methods in Engineering
9. CS 408 UE Database Systems

SCHEME OF INSTRUCTION & EXAMINATION

B.E. IV-YEAR

SERVICE COURSES OFFERED TO OTHER DEPARTMENTS

SEMESTER-I

Sl. No.	Syllabus Ref. No.	Subject	Scheme of Instruction		SCHEME OF EXAMINATION			Credits
			Periods / week		Duration in hrs.	Max. Marks		
			L + T	D / P		Univ. Exam	Sessional Marks	
THEORY								
1.	ME 409 UE CE/CSE/ ECE/EEE/ BME	Entrepreneurship	4	-	3	75	25	4
2.	ME 412 UE (CSE/BME)	Finite Element Analysis	4	-	3	75	25	4
		TOTAL:	8	-	6	150	50	8

SCHEME OF INSTRUCTION & EXAMINATION
B.E. IV-YEAR (MECHANICAL ENGINEERING)

SEMESTER-II

Sl. No.	Syllabus Ref. No.	Subject	Scheme of Instruction		SCHEME OF EXAMINATION			Credits
			Periods / week		Duration in hrs.	Max. Marks		
			L + T	D / P		Univ. Exam	Sessional Marks	
THEORY								
1.	ME 451 UE	Management and Information Systems	4	-	3	75	25	4
2.		Elective-III	4	-	3	75	25	4
3.		Elective-IV	4	-	3	75	25	4
PRACTICALS								
1.	ME 481 UE	Seminar.	-	3	-	-	25	-
2.	ME 482 UE	Project	-	6	Viva-Voce	*Grade	50	12
TOTAL:			12	9	9	225	150	24
							* S / A / B / C / D / F	

ELECTIVE-III

1. ME 454 UE Waste Heat Recovery & Co-Generation
2. ME 455 UE Composite Materials
3. ME 456 UE Machine Tool Engineering & Design
4. ME 466 UE Advanced Propulsion & Space Science
5. EC 465 UE Embedded System Design
6. EC 466 UE Microprocessor Applications
7. CS 459 UE Information Security (New elctive)
8. EE 451 UE Reliability Engineering

ELECTIVE-IV

1. ME 460 UE Robotics
2. ME 461 UE Energy Conservation & Management
3. ME 462 UE Tool Design
4. ME 465 UE Non-Destructive Testing
5. CS 458 UE Data Mining
6. LA 454 UE Intellectual Property Rights
7. BM 454 UE Bio-Electricity
8. CE 461 UE Disaster Management (Newelective)

SCHEME OF INSTRUCTION & EXAMINATION

B.E. IV-YEAR

SERVICE COURSES OFFERED TO OTHER DEPARTMENTS

SEMESTER-II

Sl. No.	Syllabus Ref. No.	Subject	Scheme of Instruction		SCHEME OF EXAMINATION			Credits
			Periods / week		Duration in hrs.	Max. Marks		
			L + T	D / P		Univ. Exam	Sessional Marks	
THEORY								
1.	ME 460 UE CE/CSE/E CE/EEE/ BME	Robotics	4	-	3	75	25	4
2.	ME 471 UE EEE/ECE	Industrial and Financial management	4	-	3	75	25	4
		TOTAL:	8	-	6	150	50	8

ME 401 UE

PRODUCTION AND OPERATION MANAGEMENT

Instruction (Periods per week)	4
Duration of University Examination	: 3 Hours
University Examination	: 75 Marks
Sessional	: 25 Marks.
Credits	4

Objectives:

* *To understand the concept of scientific management, classify various types of manufacturing processes and importance of plant layout and the role of scheduling function in optimizing the utilization of resources*
* *To understand the importance of quality, inventory control and concepts like MRP I and MRP II*
* *To know the emerging management concepts like TQC, Kanban, Lean and Agile Manufacturing.*

UNIT-I

Scientific Management by Taylor and Henri Fayol. Functions of Management, Types of Business firms and organizational structures, Designing Products, Services and Processes: New product design and development. Product life cycle: phasing multiple products. Types of Manufacturing processes: Product, job shop, batch, assembly line and continuous process technology: Flexible manufacturing systems.

UNIT-II

Locating production and services facilities, effects of location and costs and revenues, factor rating simple median model (linear programming). Layout planning: process layout; product layout- Assembly lines; line balancing manufacturing cellular layout. Scheduling system and aggregate planning for production and services; loading assignment algorithm; priority sequencing and other criteria. Work study, Work measurement techniques; predetermined time study; Work sampling

UNIT-III

Quality planning and control; basic concepts, definitions and history of quality control. Quality function, Quality policy and objectives. Economics of quality and measures of the cost of quality. Quality consideration in design, Use of statistical process control charts for variables and attributes. Acceptance sampling; single double and multiple sampling, operating characteristic Curve- calculation of producers risk and consumer's risk.

UNIT-IV

Inventory Control: Definition of Inventory and Inventory Control, Types of Inventory, Objectives & Benefits of Inventory Control, Terminology, Cost Trade-off, Inventory Models: Deterministic and Stochastic inventory models: variable demand: lead time, specific service level, perishable products and service. Selective Control of Inventory: ABC, VED and SDE Analysis. Inventory control procedures; Fixed Order Quantity System (Q-System) versus Fixed Period Quantity systems (P-System); Material requirement planning(MRP); MRP as a scheduling and ordering system; MRP system components; MRP computational procedure, MRP –limitations and Advantages. Detailed Capacity Planning: Capacity planning decision, measuring capacity: estimating future capacity needs, Manufacturing Resource Planning (MRP-II).

UNIT V

Emerging Management Concepts: Japanese management overview, value added manufacturing, Japanese manufacturing techniques; total quality control - Deming contribution to TQC, quality circles; fishbone diagram, Taguchi method of quality control, push or pull system, Kanban system, Juran's Triology, Quality Loss Function and Calculations. Introduction to Lean and Agile Manufacturing Concepts.

Suggested Readings:

1. Everett, E. Adam. Jr and Ronald. J. Ebert - "Production and operations management – concepts, models and behaviour" - Prentice – Hall (India) Pvt. Ltd., New Delhi, 5th ed. 1998, New Delhi.
2. Lee J. Krajewski, Larry. P. Ritzman, "Operations Management: Strategy and Analysis" - Addison Wesley Longman (Singapore) Pvt Ltd., India Branch, 5th ed., 2000 year.
3. Richard B. 8hase, Nicholas, J. Aquilano and F. Robert Jacobs. "Production and operations management - manufacturing and services"- Irvin McGraw - Hill; New Delhi, 5th ed. 1998.
4. J.M.Juran & Frank M.Gryna, "Quality Planning and Analysis", Tata McGraw Hills

ME 402 UE

THERMAL TURBOMACHINES

Instruction (periods per week)	:	4
Duration of University Examination	:	3 Hours
University Examination	:	75 Marks
Sessional	:	25 Marks
Credits	:	4

Course Objectives:

* *To learn about formulation of governing equations for compressible fluid flows*
* *To understand the design concepts of mechanical devices handling compressible fluids*
* *To learn about the functioning of turbomachines and related performance parameters.*

Unit-I

Introduction to compressible flows: bulk modulus and coefficient of compressibility, acoustic velocity, mach number, pressure field created by a point disturbance, mach cone and mach angle.

Isentropic flow through variable area devices: Energy equation for flow through nozzles and diffusers, Relations connecting stagnation and static properties-enthalpy, temperature, pressure and density. Various regimes of flow-adiabatic steady flc.v ellipse. Effect of back pressure on nozzle performance.

Unit-II

Flow through constant area ducts with friction (Fanno flow): Governing equation, Fanno line, Fanno relations for perfect gas, maximum length of a duct.

Flow through constant area ducts with heat transfer (Rayleigh flow): Governing equation, Rayleigh line, Rayleigh relations for perfect gas, choking due to heat transfer.

Types of shocks-normal, oblique and expansion.
Normal shock waves : Governing equations, Prandtl-Meyer equation, Rankine-Hugoniot relations.
Oblique shock waves: Relation between deflection angle and wave angle.

Unit-III

Definition and classification of turbo machines, Euler's equation for energy transfer.

Rotodynamic compressors : General classification, comparison with positive displacement compressors. Concept of shape number-selection of impeller.

Axial flow compressors: Stage velocity triangles, enthalpy-entropy diagram, Euler's work input, flow coefficient, blade loading coefficient, relations for static pressure rise in rotor, stator and stage. Stage and polytropic efficiency. Factors affecting stage pressure ratio. Degree of reaction. Surging, stalling and choking.

Centrifugal compressors: Elements of a centrifugal stage, stage velocity triangles, performance of different types of impellers- forward, radial and backward swept blades. Enthalpy-entropy diagram, degree of reaction. Slip factor, actual work and stage and polytropic efficiency.

Unit-IV

Steam Turbines: Classification, flow over blades, impulse and reaction turbines, Pressure and velocity compounding of steam turbines.

Impulse steam turbines: Velocity triangles-single and multistage De Laval turbine, effect of blade friction, axial thrust, effect of blade speed ratio on stage and blade efficiency. Partial Admission, height of turbine blades.

Parson's reaction turbine: Reaction stage analysis, degree of reaction, maximum blade efficiency, representation on enthalpy-entropy diagram. Height of turbine blades.

Unit-V

Gas turbines : Classification and comparison of open and closed cycles. Thermodynamic Analysis of Brayton /Joule cycle. Methods to improve thermal efficiency of gas turbine cycles: inter cooling, reheat and regeneration.

Jet Propulsion : Aircraft propulsion turbo engines: Turbo jet, turboprop, turbofan, ramjet and pulse jet engines. Propulsion performance parameters: Thrust force, thrust power and thrust specific fuel consumption. Thrust, propulsion, transmission and overall efficiencies

Rocket Propulsion: Working principle, propulsion efficiency.
Types of Rocket engines: Solid propellant and liquid propellant engines.

Suggested Reading

1. Yahya S M, " Fundamentals of compressible flow", Wiley eastern Ltd., 2003.
2. Balachnadran P, "Fundamentals of Compressible fluid dynamics", Prentice Hall of India, New Delhi, 2006.
3. Rathakrishnan E, "Gas Dynamics", Prentice Hall of India, New Delhi, 2003.
4. Mathur M L & Mehta F S, " Thermal Engineering", Jain Brothers(New Delhi), 1996.
5. Gopalakrishnan G, Prithvi Raj D, "A treatise on Turbomachines", Scitech Publications, Chennai, 2002.

ME 403 UE

CAD/CAM

Instruction (periods per week)	:	4
Duration of University Examination	:	3 Hours
University Examination	:	75 Marks
Sessional	:	25 Marks
Credits	: 4	

Course Objectives:

- To help the students in understanding the functioning of computer numerical control machine tools and also in writing programs for operating this machines.
- To help the student in understanding advanced manufacturing concepts like Group technology, flexible manufacturing systems, Computer aided Process Planning, Computer aided quality control, Artificial Intelligence etc.

Outcomes:

- Understand the fundamental applications of computer in design, manufacturing and geometric transformation techniques in CAD
- Develop mathematical Model for curves, surfaces, solid models and understand the fundamental concepts of Finite Element Analysis
- Write CNC Part program for manufacturing components
- Understand the concepts of Machining Centres, adaptive control and as well as fundamentals knowledge of robotics
- Understand the working of various components of an modern manufacturing systems

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	1	2	1	-	-	-	-	-	1	-	-
CO2	3	2	1	2	3	1	--	--	--	--	--	1	-	-
CO3	2	2	1	2	3	1	-	-	-	-	-	1	-	-
CO4	2	2	1	2	3	2	-	-	-	-	-	1	-	-
CO5	2	2	1	2	3	2	-	-	-	-	-	1	-	-

Unit-I

CAD Fundamentals: Classification and basic elements of CAD work station hardware, Hardware integration and networking. CAD Software: Definitions of system software and application software. Graphic Standards and Exchange Formats. CAD database and structure.

Automatic 2-D facilities such as Fillets, Chamfers, Hatching, Dimensioning, Editing, Windowing & Zooming. 2-D & 3-D Geometric Transformations.

Unit-II

Geometric modeling: 3-D wire frame modeling: wire frame entities and their definitions, Interpolation and approximation of curves, synthetic curves and curve fitting. Definitions of cubic, Bezier, and B-spline curves.

Surface modeling: Definitions of basic surfaces, surface of revolution, blends, intersection, and Cubic, Bezier, B-spline surfaces.

Solid Modeling: Solid entities, Boolean operations, B-rep and C-rep approaches. Feature based modeling: Concepts and applications, Assembly modeling.

Finite element modeling: Introduction, modeling, Meshing, Characteristics of different elements, different solvers and post processing.

Unit-III

Numerical Control of machine Tools: Features and elements of NC. Positional, paraxial and contouring types. Definitions of axes, punched type, formats of tape preparation. Definitions of interpolation, post-processor, preparatory and miscellaneous functions, canned cycles, tool length and cutter radius compensation. Manual and computer aided part programming (APT) for simple components. Programming with MACROS.

Unit-IV

Computer Control in NC and Robots: Machining centers, CMC, DNC and adaptive control systems. Their types, typical configurations and relative features.

Industrial Robots: Classification based on manipulator configurations, relative characteristics, Online and offline programming methods, controls and drives, applications.

Unit-V

Group Technology: Organization, G.T. layout, part classification and coding, CAPP: Variant and Generative approaches and their relative features.

Computer Aided Quality Control: Computer in quality control, Contact and non contact inspection, optical and non optical computer aided testing.

Others: Basic concepts of FMS, Experts systems. Artificial intelligence, Typical Applications of computer in manufacturing viz. management, in-process measurement, CAD/CAM integration.

Suggested Reading

1. Ibrahim Zeid, "CAD/CAM, theory and practice", McGraw Hill Inc, N.Y.1991.
2. Grover, MP and Zimmers E.W., "CAD/CAM", Prenctice Hall of India 1989.
3. Rao P.N., Tiwari N.K., Kundra T.K., "Computer Aided Manufacturing", Tata McGraw Hill, New Delhi, 1993.
4. Radhakrishnan. P, Subramanyan. S, Raju. V, "CAD/CAM/CIM", New Age international (P) Ltd., 2nd Edn., 2004.

ME 404 UE

CONTROL SYSTEMS THEORY

Instruction (periods per week)	:	4
Duration of University Examination	:	3 Hours
University Examination	:	75 Marks
Sessional	:	25 Marks
Credits	:	4

Course Objectives:

- To introduce students to the fundamental of feedback control system theory and use of analytical design methods in designing, analyzing various physical systems and to apply the gained knowledge in developing solutions for real world systems.
- To develop the ability of formulating mathematical models and designing feedback control systems.
- To provide students with necessary tools to analyze linear feedback control systems.
- To introduce the students to the concepts of digital control and modern control.

Outcomes:

- Differentiate open and closed loop systems and develop mathematical models of various systems like mechanical, electrical, electro- mechanical systems.
- Evaluate the effects of transient and steady state responses and apply these models to real time systems.
- Application of time response and frequency response methods to determine the stability of the system.
- Apply the concepts of discrete time control systems.
- Analyse and design multi input, multi output systems by state space analysis.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	1				1			1	2	2
CO2	3	2	3	2	1				1			1	2	1
CO3	3	2	3	2	1							1	1	1
CO4	2	2	2	2	1							1	1	1
CO5	3	2	3	2	1							1	1	1

Unit-I

Introduction: Classification of control systems. Examples of control systems with applications in Mechanical Engineering. Basic laws: Mechanical, Electrical, Fluid, Thermal. Relationships of components and analogies. Performance characteristics of control system components. Hydraulic and pneumatic control systems. Methods of analysis using standard input functions. Laplace transformation, use of transfer functions.

Derivation of system equations: The simultaneous equation method. Block diagram method and Laplace transform approach.

Error sensing devices: Potentiometer, synchros, and AC-DC servomotors, Encoders, Decoders.

Unit-II

Time Response: Response characteristics of systems Types of input. Transient response of first and second order system for step input. Time domain specification. Types of system, static error coefficients, error series, Routh-Hurwitz criterion of stability.

Root Locus Techniques: Typical systems analyzed by Root Locus Techniques. Effect of location of roots on the system response.

Unit-III

Frequency response analysis: The frequency response of a second order system, effect of numerator factors, zero factors in a transfer function. Bode plots, Gain-Phase plot, Nyquist criterion for stability, Gain Margin and Phase Margin, compensation techniques.

Unit-IV

Discrete Control Analysis: The Z-transformation, digital control, advantages and disadvantages, Digital control system architecture. The discrete transfer function. Z-domain stability. Stability tests. Jury's stability criteria.

Unit-V

State space representation: Concept of state. State variable, state models of linear time invariant systems, derivation of state model from transfer functions and differential equations. State transition matrix, solution of state equations by time domain method.

Suggested Reading

1. Ogata, 'modern control engineering', prentice hall, 5th edition, India, 2010
2. Norman S Nise, control system engineering', Wiley publications, 6th edition, 2010
3. Francis Raven H. "Automatic Control Engineering", Tata McGraw Hill, 5* Edition, 1995.
4. Peter Dransfield, "Engineering Systems and Automatic Control", Prentice Hall of India, 1974.
5. Gene F. Franklin, J. David Powell, Abbas Emamin Naini, "Feedback control of Dynamic Systems", Pearson Education Pvt. Ltd., 4* Edition, 2004.
6. Benjamin kuo, 'automatic control systems ', 9th edition, wiley, india, 2010

MANAGERIAL ECONOMICS AND ACCOUNTANCY

Instruction (periods per week)	4
Duration of University Examination	: 3 Hours
University Examination	: 75 Marks
Sessional	: 25 Marks
Credits	4

Outcomes:

- Understand the responsibilities of a manager of a business undertaking
- Able to Forecast & compute the future sales level
- Outline the features, steps, merits, uses & limitations of Pay Back, ARR, NPV, PI & IRR methods of Capital Budgeting
- Assess various factors influencing demand elasticity and determine Break Even Point (BEP) of an enterprise
- Understands the principles of accounting and prepare Journal, Ledger, Trial Balance, Manufacturing A/c, Trading A/c., Profit & Loss A/c. and Balance Sheet of an enterprise.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1					1	1	2	1	1	1	1	1	
CO2	1	1			1	1	1				1	1	1	
CO3	1	1			1	1		2			1	1	1	
CO4	1	1				1					1	1	1	
CO5	1	1			2	1					1	1	1	

UNIT -I

Introduction to economics and its evolution: Managerial Economics its Scope, Importance and relation to other sciences, its usefulness to engineers-Basic concepts of Managerial Economics.

UNIT-II

Demands: Analysis-concept of demand, determinants, law of demand, its assumptions, elasticity of demand, price, income and cross elasticity, demand forecasting-markets competitive structure, price-output determination under perfect competition and Monopoly. (Theory questions and small numerical problems can be asked).

UNIT-Ill

Theory of Production: Firm and industry-production function-input-output relations-laws of returns-internal and external economics of scale. Cost analysis-Cost concepts-fixed and variable costs-explicitly and implicitly costs-out pocket of costs and imputed costs-opportunity cost-cost output relationship-break even analysis. (Theory and Problems).

UNIT -IV

Capital management: Significance, determinates and estimation of fixed and working capital requirements, sources of capital. Introduction to capital budgeting, methods of payback and discounted cash flow methods with problems.

(Theory questions and numerical problems on estimating working capital requirements and evaluation of capital budgeting opportunities can be asked)

UNIT-V

Book-keeping: Principles and significance of double entry book keeping, journal, subsidiary books, ledger accounts, trial balance concepts and preparation of final accounts with simple adjustments-analysis and interpretation of financial statements through ratios.

(Theory questions and numerical problems on preparation of final accounts, cash book, petty cash book, bank reconciliation statement, calculation of some ratios)

SUGGESTED READING:

1. Varshney RL and KI Maheswari, Managerial Economics, Sultan Chand.
2. JC Pappas and EF Grigham, Managerial Economics.
3. Grawal T.S. Introduction to Accountancv.
4. Maheswari S.N. Introduction to Accountancy.
5. Panday I.M. Financial Management.

ME 431 UE

THERMAL ENGINEERING LAB

Instruction (periods per week)	:	3
Duration of University Examination	:	3 Hours
University Examination	:	50 Marks
Sessional	:	25 Marks
Credits	:	2

Course Objectives:

- To understand working principles of heat transfer equipment
- To understand the flow phenomena on cascade blades.

Outcomes:

- Understand the fundamental applications of measuring instruments in equipment
- Able to find the performance of compressors, blowers
- Understand the working and determine the performance various turbines
- Able to estimate the heat transfer in various types of heat exchangers
- Able to find out conductivity of solids and liquids and convection in liquids

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	1	2						1	1		1
CO2	2	2	2	1	1						1	1		1
CO3	2	2	2	1	1						1	1		1
CO4	2	2	2	1	1						1	1		1
CO5	2	2	1	1	1						1	1		1

A representative list of experiments to be conducted is as follows:

1. Determination of static pressure distribution on a turbine blade surface at midspan on low speed wind tunnel.
2. Study on downstream wake profile of a turbine cascade at midspan on low speed wind tunnel.
3. Study on downstream wake profile of a compressor cascade at midspan on low speed wind tunnel.
4. Study of Double pipe Heat Exchanger: Determination of Overall heat transfer coefficient in Parallel and counter flow modes of operation.
5. Study of Finned Tube Heat Exchanger: Determination of Overall heat transfer coefficient in Parallel and counter flow modes of operation.
6. Study of Shell and Tube Heat Exchanger: Determination of Overall heat transfer coefficient in Parallel and counter flow modes of operation.
7. Study of Cross flow Heat Exchanger: Determination of Overall heat transfer coefficient.
8. Study on Thermal conductivity of metal rod.
9. Study on Thermal conductivity of liquid.
10. Study on Thermal conductivity of insulating powder
11. Study on performance of Centrifugal blower with forward swept blades.
12. Study on performance of Centrifugal blower with backward swept blades.
13. Heat transfer in Forced Convection.

14. Heat transfer in Natural Convection.
15. Critical Heat flux apparatus (Boiling Heat Transfer)
16. Unsteady State of Heat Transfer.
17. Study on heat pipe demonstrator
18. Study on Stefan Boltzmann apparatus
19. Pressure distribution in convergent air nozzle

ME 432 U E

CAD/CAM LAB

Instruction (Periods per week)	3
Duration of University Examination	: 3 Hours
University Examination	: 50 Marks
Sessional	: 25 Marks.
Credits	2

Course Objectives:

- To understand the various features of geometric modeling packages like Creo(Pro-E) /CATIA/Solid Works like 2d-Sketching, Part Modeling and Assembly
- To understand the application of Finite Element Analysis packages like ANSYS/ NASTRAN/ADINA in solving structural and thermal problems
- To develop NC part program, simulate and manufacture components on CNCmachine

Outcomes:

- Understand the Various Features of Geometric Modeling Package Creo(Pro-E) like 2d-Sketching, Extrude, revolve, sweep, surface of revolution, blend etc.
- Apply the knowledge of Finite Element analysis in solving structural and thermal problems using Ansys software.
- Write NC Part program, simulate and manufacture components on CNC machine

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	--	2	--	--	---	---	2	1	1	---	---
CO2	2	2	2	1	2	--	---	----	----	1	---	1	--	--
CO3	--	1	--	2	1	--	---	--	1	---	1	---	--	--
CO4														
CO5														

Computer Aided Design

1. Introduction to various features of geometric modeling packages like: Creo (Pro-E) /CATIA/Solid Works.

2. Practicing problems on 2D-Sketching.

3. Practicing problems on Part Modeling

4. Practicing problems on Assembly Modeling.

5. Static Structural Analysis using 2D truss/beam/etc. for different types of loads using ANSYS/NASTRAN/ADINA etc.

6. Steady state heat transfer and transient heat transfer analysis.

Computer Aided Manufacturing

7. Development of CNC part program for turning, facing, step turning, taper turning etc with and without canned or fixed cycle.

8. Tool path simulation using any CAM software

9. Demonstration of manufacturing of simple parts on CNC machine

10. Programming for simulation of integrating various machines, robots and material handling equipment using plant layout simulation software like FlexSim/Arena/Promodel etc.

ME 433 UE

PROJECT SEMINAR

Instruction : 3 Periods per week
Sessional : 25 Marks

Objective of the project seminar is to actively involve the students in preparation of the final year project with regard to following components:

- Problem definition and specification
- Literature survey, familiarity with research journals
- Broad knowledge of available techniques to solve a particular problem.
- Planning of the work, preparation of graphs, bar (activity) charts and analyzing the results.
- Presentation - oral and written.

Outcomes:

- Able to define Problem with specifications
- Relevant Literature survey, familiarity with research journals
- Critically evaluate various available techniques to solve a particular problem
- Able to Plan the work, prepare required graphs, bar (activity) charts and analyse the results and arrive at a solution
- Prepare and present results in a scientific manner (Presentation - oral and written)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1				1	2			1	2	2	2	1		
CO2				1	2			1	2	2	2	1		
CO3				1	2			1	2	2	2	1	1	1
CO4				1	3			1	2	2	2	1	1	1
CO5				1	3			1	2	2	2	1	1	1

The department can initiate the project allotment procedure at the end of III year 2nd semester and finalise it in the first two weeks of IV year 1st semester.

First 4 weeks of IV year 1st semester will be spent on special lectures by faculty members, research scholars, post graduate students of the department and invited lectures by engineers from industries and R & D institutions. The objective of these preliminary talks will be to expose the students to real life practical problems and methodology to solve the technical problems.

Seminar schedule will be prepared by the co-ordinator for all the students from 5th week to the last week of the semester which should be strictly adhered to.

Each student will be required to:

1. Submit a one-page synopsis before the seminar for display on notice board.
2. Give a 20 minutes presentation followed by 10 minutes discussion.
3. Submit a technical write-up on the talk.

At least two teachers will be associated with the Project Seminar to evaluate students for the award of sessional marks which will be on the basis of performance in all the 3 items stated above.

ELECTIVE-II

ME 406 UE

DESIGN OF SOLAR ENERGY SYSTEMS

Instruction (periods per week)	:	4
Duration of University Examination	:	3 Hours
University Examination	:	75 Marks
Sessional	:	25 Marks
Credits	:	4

Course Objectives:

- To learn concepts of solar energy conversion
- To understand the design principles of solar energy systems, their utilization and performance evaluation
- To understand the applications of solar photovoltaic systems

Outcomes:

- Understand the basic principle and Estimation solar radiation
- Analyze the coversion of solar radiation into heat also methods of reducing heat loss
- Design and analyze the solar energy systems
- Study the methods of performance and testing of solar collector
- Study the design and applications of Solar Photovoltaic Systems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	-	-	-	2	-	-	-	2	2	-	-
CO2	3	3	3	2	2	2	-	-	-	-	2	-	-	-
CO3	3	3	3	1	-	-	-	-	-	-	2	2	-	-
CO4	3	3	1	3	2	-	-	-	-	-	2	-	-	-
CO5	3	2	3	1	2	-	2	-	-	-	2	2	-	-

Unit-I

Hour angle, Sun's declination, Determination of Solar time, Solar angle, Day length. Energy measuring equipment - Pyrheliometers, Pyranometers. Sunshine recorder, Estimation of Average Solar radiation, Direct & diffused radiation. Ratio of beam and total radiation on horizontal and titled surfaces.

Unit-II

Principles of Solar Energy Utilization:

Principles of conversion of solar radiation into heat. Conduction, Convection and Radiation heat transfer. Heat exchanger. Methods of reducing heat loss. Energy storage - sensible and latent heat. Water storage and pebble bed storage.

Unit-III

Design of Solar Energy Systems:

Equipment to collect solar energy - Flat plate, liquid collectors, Air heating collectors, Focusing type collectors - Solar disc, theoretical solar image, solar concentrators, Receiver geometries. Orientation and Sun tracking system. Evaluation of overall heat transfer coefficient. Thermal analysis - Natural and forced convection heat transfer.

Unit-IV

Performance Testing of Solar Collectors:

Governing equations for evaluation of performance. Methods of testing, testing procedures, testing of liquid and air flat plate collectors. Cylindrical, parabolic concentrators. Overall performance of heating panels. Selection of materials - Absorbing heat transfer fluids.

Unit-V

Design and Application of Solar Photovoltaic Systems:

Solar photovoltaics - Photovoltaic conversion, Photon energy, p-n junction, Solar cells, efficiency of solar cells, Silicone crystal cells, Photovoltaic applications for refrigeration, street lights, water pumps and power generation.

Suggested Reading

1. Sukhatme S.P.," Solar Energy", 2 Edition, Tata McGraw Hill Publishing Co. Ltd., 2nd ed, 1996.
2. Garg H.P. and Prakash J., "Solar Energy", Tata McGraw Hill Publishing Co. Ltd., 1997.
3. Magal B.S. "Solar Power Engineering", Tata McGraw Hill Publishing Co. Ltd., 1994.

ME 407 UE

NON-CONVENTIONAL METHODS OF MACHINING AND FORMING

Instruction (periods per week)	:	4
Duration of University Examination	:	3 Hours
University Examination	:	75 Marks
Sessional	:	25 Marks
Credits	:	4

Course Objectives:

* *To learn about various unconventional machining processes, the various process parameters and their influence on performance and their applications*
* *To understand the basics of various forming operations and machining techniques.*

Unit-I

Ultrasonic Machining (USM): Process description, abrasive slurry, Abrasive materials and their characteristics. Functions of liquid medium in slurry. Types of Transducers, effect of process parameters, applications and limitations.

Abrasive Jet Machining (AJM): Principle of operation, process details, process variables and their effect on MRR and accuracy. Equation for MRR. Advantages, disadvantages and applications.

Water Jet Machining (WJM): Schematic diagram, equipment used, advantages and applications.

Unit-II

Electro Discharge Machining (EDM): Process description with schematic diagram, process parameters, functions and characteristics of dielectric medium, dielectric fluids, over cut and side taper Flushing, Mechanism of metal removal, crater volume, types of power supply circuits, mathematical analysis of metal removal rate (MRR), characteristics of spark eroded surfaces, advantages, disadvantages and applications, wire electro-discharge machining principles and description.

Electro-Chemical Machining (ECM): Schematic of the process, process parameters, function and characteristics of electrolyte, chemistry of the process. Equation for specific MRR and electrode feed rate, advantages, limitations and applications.

Rotary Machining, Hot machining, high speed machining, description of each process, process parameters, advantages and applications.

Unit-III

LASER Beam Machining (LBM): Principle of LASER Beam production, materials used, thermal analysis of the process, process parameters, equations for power density and machining rate, advantages, limitations and applications.

Plasma Arc Machining (RAM): Equipment used, process description and parameters, types of plasma arc: Transferred arc and non-transferred arc and process applications.

Electron Beam Machining (EBM): Schematic of the process, process parameters, principle of production of Electron beam, equipment used, Advantages, disadvantages and applications. ION Etching: Process description and applications.

Hybrid Machining Processes: Principle and applications of Electro chemical discharge machining, electro chemical abrasive finishing, electro discharge abrasive grinding.

Unit-IV

Rubber Pad Forming: Principle of the process, process details, process variants - Guerin, wheelon, Marforming and Hydro forming processes and applications.

High Energy Rate Forming (HERF): Advantages of high energy rate forming, Explosive forming: Explosive materials, standoff operation and contact operation, advantages and applications.

Electro-Hydraulic Forming (EHF): Schematic of the process, description and its applications. Electro-Magnetic Forming (EMF): Process details and parameters, materials used and applications. HERF hammers.

Unit-V

Stretch Forming: Introduction, types of stretch forming: stretch draw forming, rotary stretch forming or stretch wrapping, compression forming, radial draw forming. Stretch forming equipment and accessories, accuracy and surface finish, process variables and limitations.

Tube spinning: Introduction, methods of tube spinning, Backward spinning, Forward spinning, machines and tools used. Machine variables, speeds and feeds, effect of tube spinning on work metal properties and applications.

Hydrostatic Forming: Process principle description and applications.

Water Hammer Forming (WHF): Schematic diagram of the process, principle of operation, process variable, work materials, process limitations and applications.

Suggested Reading

1. Pandey PC. and Shan H.S., *"Modern Machining Process",* Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1980
2. Bhattacharya A., *"New Technology"*, The Institution of Engineers, India, 1984.
3. Davies and Austin, *"Developments in High Speed Metal Forming"*. The Machinery Publishing Co. Ltd., 1985
4. Mikell. P. Groover *"Fundamentals of Modern Manufacturing"*. Prentice Hall Inc., NewJerry

ME 408 UE

ADDITIVE MANUFACTURING TECHNOLOGIES

Instruction	4 Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessional	25Marks
Credits	4

Course Objectives:

- To understand the fundamental concepts of Additive Manufacturing (i.e. Rapid Prototyping) and 3-D printing, its advantages and limitations.
- To classify various types of Additive Manufacturing Processes and know their working principle, advantages, limitations etc.
- To have a holistic view of various applications of these technologies in relevant fields such as mechanical, Bio-medical, Aerospace, electronics etc.

Outcomes:

- Comprehend the importance, historical background and fundamentals of additive manufacturing(AM)
- Build the prototypes using AM technologies like Stereo Lithography Apparatus (SLA), Solid Ground Curing (SGC), Laminated Object Manufacturing (LOM), and Fused Deposition Modelling (FDM)
- Construct prototypes using powder based AM technologies like Selective Laser Sintering (SLS), Three Dimensional Printing (3DP), and classify, evaluate Rapid Tooling Processes
- Preparation of CAD data, evaluation of STL file problems and features of various AM software
- Apply AM processes for Mechanical, Bio-medical, Aerospace, Automotive, Medical etc. industries

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	1							1		
CO2	2	2	2	2	2							1		
CO3	2	2	2	2	2							1		
CO4	2	2	2	2	3							1		
CO5	2	2	2	2	3							1		

UNIT-I

Introduction: Prototyping fundamentals, Historical development, Fundamentals of Rapid Prototyping, Advantages and Limitations of Rapid Prototyping, Commonly used Terms, Classification of RPprocess, Rapid Prototyping Process Chain: Fundamental Automated Processes, Process Chain.

UNIT-II

Liquid-based Rapid Prototyping Systems: Stereo lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Solid ground curing (SGC): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies Solid-based Rapid Prototyping Systems: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

UNIT-III

Powder Based Rapid Prototyping Systems: Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Three dimensional Printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT. Rapid Tooling Classification; Indirect Rapid Tooling Methods: Spray Metal Deposition, RTV Epoxy Tools, Ceramic tools, Investment

Casting, Spin Casting, Die casting, Sand Casting, 3D Keltool process. Direct Rapid

Tooling : Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP

UNIT-IV

Rapid Prototyping Data Formats: STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. Rapid Prototyping Software's: Features of various RP software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor.

UNIT-V

RP Applications : Application - Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Biomolecules.

Suggested Reading:

1.Chua C.K., Leong K.F. and LIM C.S, Rapid prototyping; Principles and Applications, World Scientific Publications , Third Edition, 2010.
2.D.T. Pham and S.S. Dimov, Rapid Manufacturing, Springer, 2001.
3.TerryWohlers, Wholers Report 2000, Wohlers Associates, 2000.
4.PaulF.Jacobs, Rapid Prototyping & Manufacturing ASME Press, 1996.

ME 409 UE

ENTERPRENEURSHIP

Instruction (periods per week)	:	4
Duration of University Examination	:	3 Hours
University Examination	:	75 Marks
Sessional	:	25 Marks
Credits	:	4

Course Objectives:

* *To motivate students to take up entrepreneurship in future*
* *To learn nuances of starting an enterprise & project management*
* *To understand the design principles of solar energy systems, their utilization and performance evaluation*
* *To understand the behavioral aspects of entrepreneurs and time management*

Unit-I

Indian Industrial Environment – Competence; Opportunities and Challenges, Entrepreneurship and Economic growth, Small Scale Industry in India, Objectives, Linkage among small, medium and heavy industries. Types of enterprises.

Unit –II

Identification and characteristics of entrepreneurs, Emergence of First generation entrepreneurs, environmental influence and women entrepreneurs. Conception and evaluation of ideas, their sources and decision making. Choice of Technology – Collaborative interaction for Technology development.

Unit-III

Project formulation, analysis of marked demand, demand supply gap, financial and profitability analysis, technical analysis and risk analysis. Project financing in India.

Unit-IV

Project Management during construction phase, project organization, project planning and control using CPM-PERT techniques. Humana aspects of project management. Assessment of tax burden.

Unit-V

Behavioral aspects of entrepreneurs: Personality – determinats, attributes and models, leadership concepts and models. Values and attitudes. Motivation aspects, change behavior. Corporate social responsibility.
Time Management: Various approaches of time management, their strengths and weaknesses. The urgency addiction and time management matrix.

Suggested Reading

1. Vasant Desai, “Dynamics of Entrepreneurial Development and Management”, Himalaya Publishing House, 1997.
2. Prasanna Chandra, “Project – Planning , Analysis, Selection, Implementation and Review”, Tata McGraw-Hill Publishing Company Ltd., 1995.
3. B. Badhai, “Entrepreneurship for Engineers”, Dhanpath Rai & Co., Delhi, 2001.
4. Stephen R. Covey and A. Roger Merrill, “First Things First”, Simon and Schuster, 2002.
5. Robert D. Hisrich and Michael P.Peters, “ Entrepreneurship”, Tata McGRaw Hill Edition, 2002.

ME 410 UE

AERODYNAMIC DESIGN OF THERMAL TURBINES

Instruction (periods per week)	:	4
Duration of University Examination	:	3 Hours
University Examination	:	75 Marks
Sessional	:	25 Marks
Credits	:	4

Course Objectives:

- To learn design concepts of thermal turbines
- To understand the analysis of flow past a turbine cascade
- To understand turbine blade design methods

Outcomes:

- The Students are expected to be explain the Euler's Turbine equations application and Concepts of 1D 2D and 3D Flows in Turbines
- The Students are expected to be able to understand Aerodynamics of flow over turbine cascades and relevant performance parameters,
- The Students are expected to be use 1D and 2D Blade Design Methods and solve problems on Axial turbine stages cascades.
- The Students are expected to understand 3D Blading design methods and use Radial equilibrium and Actuated Disc theories of Axial flow turbine cascades.
- The Students are expected to understand the performance maps of Axial turbines and estimate losses in turbine cascades. They are also expected to understand wind tunnel experimental test procedures and related instrumentation.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	1				1	1	1	1		1
CO2	3	3	3	2	2	1					1	1	1	1
CO3	3	3	3	3	3	2	1			1	1	1	1	1
CO4	3	3	3	2	2	1					1	1	1	1
CO5	3	3	3	3	3	1					2	2	1	1

Unit-I

Introduction: Definition of a turbine stage. Enthalpy - Entropy diagram for a Turbine stage. Definition of Euler work, specific work and isentropic work. Euler's trubine equation and Energy transfer equation. Definitions of shape No, stage efficiency, stage reaction, work done factor, utilization factor and coupling power.

Concepts of ID, 2D and 3D flows; Vortices; Circulation; Potential and Viscous flow theories. Definitions of subsonic, transonic and supersonic flows. Single Aerofoil theory and its limitations. Boundary layer parameters and flow separation.

Unit-II

Aerodynamics of turbine cascades: Definition of a cascade. Classification of turbine Cascades. Blade and cascade geometric parameters. Blade and cascade angles and relation ships. Flow parameters and their significance. Cascade flow model for turbines. Wake flow NACA and other cascade blade data specification methods.

1 D Analysis: Cascade aerofoil blade forces. Force coefficients Lift and Drag Coefficients. Equations for blade forces with cascade blade parameters and angles. Stagnation pressure loss for a turbine cascade. Cascade efficiency.

Unit-III

1 D and 2D Blade Design Methods:

1 D methods: Pitch-line design method. Velocity diagrams at hub, tip and mean radii. Definition of mean flow terms. Kulta condition and Zweifel's criterion for axial turbine cascade design. Problems on axial turbine stage cascades.

2 D methods: Concepts of singularities, simple relations. Schlichting Method - equations for induced velocity, Camber line and thickness distribution for an arbitrary aerofoil shape - Direct and indirect design problems. Channel flow approach - Stanitz I and I approximation methods.

Unit-IV

3D Blading Design Methods:

Radial Equilibrium theory: Fundamental equation and approaches for the vortex design of axial turbine cascades; Simple problems on Radial equilibrium theory.

Actuator Disc theory: Concept and application to simple design problems on axial flow turbine cascades.

Unit-V

Performance Evaluation:

Dimensionless groups and performance maps for axial turbines. Distribution of static pressure over a blade profile losses in turbine cascades. Profile, Annulus, Secondary, Tip clearance and over all loss estimation - Soderberg and Ainley - Malhieson methods. Loss model for a turbine cascade.

Description of wind tunnel test rig for experimental investigations of turbine cascades. Types of pressure probes, Hotwire anemometer, LDV principles and their calibration techniques. Concepts of flow visualization and its sinificance.

Suggested Reading

1. J.P. Gostelow, " Cascade Aerodynamics" -, Pergamoa Press, USA.
2. S.M. Yahya, " Fans, Turbines and Compressors", Tata Mc-Graw Hill Pub; Delhi.
3. S.L. Dixon, "Fluid Mechanics and Thermodynamics of Turbomachinary" Pergamon Press, USA.
4. Gopalakrishnan G, Prithvi Raj D, "A treatise on Turboniachincs[?'], Scitech Publications. Chennai, 2002

ME 411 UE

MATERIAL HANDLING

Instruction (periods per week)	:	4
Duration of University Examination	:	3 Hours
University Examination	:	75 Marks
Sessional	:	25 Marks
Credits	:	4

Course Objectives:

- To know about the working principle of various material handling equipments
- To understand the Material handling relates to the loading, unloading and movement of all types of materials
- To understand the estimation of storage space and maintenance of material handling equipments

Outcomes:

- Importance of individual components of a material handling system
- Classify various conveying systems that are available in industry
- Compare and contrast various bulk solid handling systems and their design features
- Evaluate various modern material handling systems and their integration
- Calculate number of MH systems required, storage space, cost and maintenance

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2								1		
CO2	2	2	2	2								1		
CO3	2	2	2	2								1		
CO4	2	2	2	2								1		
CO5	2	2	2	2								1		

UNTT-I

Mechanical Handling Systems: Belt Conveyors and Desing, Bucket Elevators, Package conveyors, Chain and Flight Conveyors, Screw Conveyors, Vibratory Conveyors, Cranes and Hoists.

UNTT-II

Pneumatic and Hydraulic Conveying Systems: Modes of Conveying and High pressure conveying systems, Low Velocity Conveying System. Components of Pneumatic Conveying Systems: General Requirements, Fans and Blowers, Boots-Type Blowers, Sliding-Vane Rotary Compressors, Screw Compressors, Reciprocating Compressors, Vacuum Pumps.

UNIT-III

Bulk Solids Handling: Particle and Bulk Properties. Adhesion, Cohesion and Moisture Content. Gravity Flow of Bulk Solids: Static and Dynamic Pressure Distribution in Bulk Solids. Modes of Flow: Mass Flow, Funnel Flow and Expanded Flow from Hoppers, Bins and Silos.

UNTT-IV

Modern Material Handling Systems: Constructional features of (i) AGV (ii) Automated storage and retrieval systems. Sensors used in AGVs and ASRS.

Bar code systems and RFID systems: Fundamentals and their integration with computer-based information systems.

UNTT-V

Total MH Throughput: Calculation for no. of MH systems; storage space estimation based on no of aisles. Maintenance of MH equipment, spare parts management, cost of materials handling, cost per unit load computations.

Suggested Reading

1. Dr. Mahesh Varma, "Construction Equipment and its Planning & Application", Metropolitan Book Co.(P) Ltd., New Delhi, India 1997.
2. James M. Apple, "Material Handling Systems Design", The Ronald Press Company, New York, USA, 1972.
3. Woodcock CR. and Mason J.S., "Bulk Solids Handling: An Introduction to Practice Technology", Leonard Hill USA, Chapman and Hall, New York.
4. M P Groover etal, "Industrial Robotics", Me Graw Hill, 1999.

ME 412 UE

FINITE ELEMENT ANALYSIS

Instruction (periods per week)	:	4
Duration of University Examination	:	3 Hours
University Examination	:	75 Marks
Sessional	:	25 Marks
Credits	:	4

Course Objectives

* *To understand the theory and application of the finite element method for analyzing structural systems.*
* *To learn Approximation theory for structural problems as the basis for finite element methods*
* *To learn formulations for a variety of elements in one, two, and three dimensions. Implementations of element formulations will be examined using Matlab.*
* *To understand modeling and analysis of structures using planar, solid, and plate elements*

Unit-I

Introduction to Finite Element Method, solution method using FEM, descretisation, Boundary conditions, load application, types of elements comparison, Stress and Equilibrium, Boundary conditions. Strain-Displacement relations. Stress-strain relations.

One Dimensionla problems: Finite element modeling, coordinates and shape functions.

Potential Energy approach: Assembly of Gloabal stiffness matrix and load vector. Finite elemtn equations, Treatment of boundary conditions. Quadratic shape functions.

Unit-II

Analysis of trusses and frames: Element stiffness matrix for a truss member. Analysis of plane truss with number of unknowns not exceeding two at each node. Analysis of frames with two translations and a rotational degree of freedom at each node.

Analysis of Beams: Element stiffness matrix for two nodded, two degrees of freedom per node beam element.

Unit-III

Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions.

Finite element modeling of Axisymmetirc solids subjected to Axisymmetric loading with triangular elements.

Unit-IV

Two dimensional four nodded isoprarametric elements and numerical integration.

Steady state heat transfer analysis: Ond dimensional analysis of a find and two dimensional analysis of thin palate. Analysis of uniform shaft subjected to torsion.

Unit-V

Dynamic Analysis: Formulation of finite element mode, element matrices, evaluation of Eigen values and Eigen vectors for a stepped bar and a beam.

Time dependent field problems: Application to one dimensional heat flow in a rod. Finite element formation to three dimensional problems in stress analysis. Types of elements used.

Convergence requirements and geometric isotropy. Local, natural and global coordinates. Introduction to Finite Element Analysis Software.

Suggested Reading

1. Tirupathi R. Chandraputla and Ashok, D. Belgundu" Introduction to Finite Elements in Engineering", pearson Education, 2002, 3rd Edition.
2. Rao S.S., "The Finite Element Methods in Engineering", pergamon Press, 1989.
3. Segerlind, L.J. "Applied Finite Element Analysis", Wiley Publication, 1984.
4. Reddy J.N., "An Introduction to Finite Element Method", McGraw-Hill Company, 1984.

ME 413 UE

NUMERICAL METHODS IN ENGINEERING

Instruction	: 4 Periods/ week
Duration of University Examination	: 3 Hrs
University Examination	: 75 Marks
Sessional	: 25 marks
Credits	4

Course Objectives:

* *To understand application of numerical methods in solving sets of equations*
* *To understand interpolation & polynomial approximation using numerical methods*
* *To understand numerical differentiation & integration methods*

UNIT I:
Solving linear sets of equations
Formation of solution matrix, Matrix Inversion, Gauss Elimination, LU Decomposition, Scalar Tridiagonal Matrix, Thomas Algorithm, Gauss Seidel Method.
Unit II:
Solving nonlinear sets of equations
Minimization of function, Newton's Method, Steepest Descent Method, Eigen Values & Vectors, Norms, Power Method
UNIT III:
Interpolation & Polynomial Approximation
Least Squares Method, Langrage Interpolation, Hermite Interpolation, Cubic Spline interpolation, Chebeshev Polynomials & Series
UNIT IV:
Numerical Differentiation & Integration
Numerical Differentiation, Richardson's Extrapolation, Definite & Indefinites Integrals, Simpson's Rule, Trapezoid Rule, Gaussian Quadrature
UNIT V:
Ordinary Differential Equations
First and Higher Order Taylor Series, First order Runge-kutta Method, Fourth order Runge-kutta method, Errors, Convergence Criteria

Suggested Reading:

1. Cheney E. Ward, Kincaid D. R., Numerical Methods and Applications, 2008, Cengage Learning
2. Gerald C.F., Wheatley p. o., Applied Numerical Analysis, 7th Ed, Pearson Education.
3. Burden R.L., Faires J.D., Numerical Analysis: Theory and Applications, 2005, Cengage Learning
4. Chapra S.C., Canale R.P., Numerical Methods for Engineers, 4th Ed, Tata McGraw Hill.
5. Mathews J.H., Fink K.D., Numerical Methods using MATLAB, 4TH Ed, Pearson Education.
6. Press W.H., Taukolsky S.A., Vetterling W.T., Flannery B.P., Numerical Recipes in C++, 2nd Ed, Cambridge University Press.

CS 408 UE

DATABASE SYSTEMS
(Service Course)

Instruction	4 Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessional	25 marks
Credits	4

Course Objectives:

- Understand the mathematical foundations on which RDBMS are built
- Model a set of requirements using the Extended Entity Relationship Model (EER), transform an EER model into a relational model ,and refine the relational model using theory of Normalization
- Develop Database application using SQL and Embedded SQL
- Use the knowledge of file organization and indexing to improve database application performance
- Evaluate working of concurrency control and recovery mechanisms in RDBMS

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2								1		
CO2	2	2	2	2								1		
CO3	2	2	2	2								1		
CO4	2	2	2	2								1		
CO5	2	2	2	2								1		

UNIT-I

Data and Data Management: Role of Data and Databases
Database and Database Management System: Key Database concepts-Basic Database Models-Database Components
DataModeling: Database Design-Relational Database Models- Relationships-Comparing Data Models

UNIT-II

SQL language: SQL features- command basics-SELECT Fundamentals-Operators and Functions-DDL Commands-DML Commands.
Data Access and Manipulation: SELECT statement Advanced Syntax-Joins and Sub Queries.
SQL Procedures: SQL procedures and Functions-Triggers.

UNIT-III

Designing a Database: Designing Relational Tables-Comparing Relational Designs-Normalizing Data.
Implementing a Database: Physical Design and Implementation- Adjusting Design to the Real World-Implementing Database Objects.

UNIT-IV

Improving Data Access: Performance Rollbacks-Using Indexes and Views-Using Programmable objects.
Database Administration**:** Need for Administration-Administration Responsibilities-Management Task.

UNIT-V

Transactions and Locking: Transaction Basics-Managing Concurrency control-SQL server transaction management.
Database Access and Security: Database Connections-Managing Access Control-Protecting data.

Suggested Reading:

1. Mark L.Gillenson, Paulraj Ponniah..., "*Introduction to Database Management*", John Wiley & Sons Ltd, 2008.
2. Lee Chao, *"Database Development and Management"*, Auerbach Publications, 2006.
3. Rob Coronel, *"Database Systems: Design, Implementation & Management"* Thomson Course Technology, 2000.

ME 451 UE

MANAGEMENT AND INFORMATION SYSTEMS

Instruction (Periods per week) 4
Duration of University Examination : 3 Hours
University Examination : 75 Marks
Sessional : 25 Marks.
Credits 4

Course Objectives:

- To understand the concept of motion study, ergonomics , forecasting and their role of management
- understand the concept of forecasting and its types using different techniques along with cost analysis
- To understand the marketing concepts and strategies with financial and time management
- To understand maintenance management and cost associated evaluation of life testing of products using reliability testings
- to understand the role of information systems and in implementing modern management concepts

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		1		1	3	1	1			2		2	1	2
CO2		2	1	1	2		2		1	2	3	2	1	
CO3	1	1			1			1		1	2	1	1	2
CO4	1	1	2	1				1			1	1	2	
CO5		2	2		2					2	2	2	1	2

UNIT-I

Method Study: Introduction and Definition, Objectives of Method Study, Steps involved in method study, Selection of the job for method study, Recording Techniques, Micro-Motion Study, Memo Motion Study, Cycle Graph and Chronocycle Graph, Principles of Motion Economy.

Ergonomics: Introduction and Definition, Objectives of Human Engineering, Ergonomics as Multidisciplinary, Ergonomic Productivity and Working Environment, Study of Human Engineering Areas, Man-Machine Systems, Three Aspects of a Man-Machine Systems, Display Design, Design of Controls, Environmental Factors, Anthropometry, Manual Material Handling, Physiological Aspects of Muscular Work, Workplace Design.

UNIT-II

Forecasting : Introduction, Need for forecasting, Long-term and Short-term forecasts, Classification of Forecasting Methods, Judgment Techniques, Time-Series Analysis: Least Square Method of Forecasting (Regression Analysis), Moving Average Forecasting, Exponential Smoothing Method, Casual Forecasting Method, Forecast Error, Costs and Accuracy of Forecasts.

UNIT-III

Marketing Management; Marketing concepts -4P components of marketing mix management, product life cycle and its forecasting strategies. Marketing Research Techniques and different sales promotion methods.

Financial Management: Elements of cost – establishing selling price of a product of a product, overheads and its distribution. Nature of financial management. Time value of money, Techniques of capital budgeting.

UNIT-IV

Maintenance management : Introduction, Objectives, Maintenance Costs, Benefits and Limitations of Failure Statistics, Types of Maintenance, Preventive Maintenance System, Break down Maintenance, Condition Based Maintenance System.

Reliability. Introduction, Reliability in terms of hazard rate, failure density function. Bath tub curve. Reliability calculation for series, parallel and parallel- series systems. Relationship between reliability, maintainability and availability. Introduction to life testing and estimation of parameters for exponential distribution.

UNIT- V

Information System: Definition of Information System (IS), Organizational Need for Information System, Impact of IT on Organization Structure, Operating Elements of an IS, Main Functions of IS, Information Flows in organization, Information users and their information needs, Characteristics of the information systems, Information System at operational, tactical and strategic levels, Model of an information system, strategic uses of information technology. Categories of computers, input/ output devices, primary and secondary storage, introduction to operating system.

Suggested Readings

1. Everett E.ADAM, Jr and Ronald J. Ebert, Production and Operation Management- concepts, models and behavior", 5 ed. 1988, (EEE), Prentice- Hall of India (P) LTD., New Delhi.
2. Robert Schultheis, Mary Sumner, "Management Information System": Irvin Mc Graw Hill,1998
3. S.K. Hazara Chowdary, "Production Management", Media Promoters & Publishers LTD., Calcutta.
4. Harold Amrine, "Manufacturing Organization & Management", Eastern Economy Edition.
5. Martand Telsang, "Industrial Engineering and Production Management", S.Chand & Company Ltd., 1998.
6. S.A.Kelkar, "Management Information Systems- A Concise Study", PHI, New Delhi- 2008.

ME 481 UE

SEMINAR

Instruction of University	3 Periods per week
Sessional	25 Marks

Oral presentation is an important aspect of engineering education. The objective of the Seminar Course is to motivate a student to do a systematic and independent study of state-of-art topics in a broad area of his/her interest.

Seminar topics may be chosen by the student with the suggestions from the faculty members. Students are to be exposed to following aspects of seminar presentation.

- Literature survey
- Organization of material to be presented
- Preparation of OHP/ Slides/PC Presentation
- Technical writing.

Each student is required to

1. Submit one page synopsis of the seminar talk for display on notice board of the department.
2. Give a 20 minutes presentation with the aids of an OHP/PC/Slide Projector, followed by a 10 minutes discussion.
3. Submit the report on the seminar topic presented along with list of reference and slides/ transparencies used.

Seminars are scheduled from the 3rd week to the last week of the semester and any change in schedule is discouraged.

Sessional marks will be awarded jointly or independently by at least two faculty members. The awards be on the basis of the oral presentation made, written materials submitted, active participation of the student in the proceedings as well as involvements in the discussions.

ME 482 UE

PROJECT

Instruction	:	6 Periods per week
Duration of University Examination	:	Viva voce
University Examination	:	Grade*
Sessional	:	50 Marks
Credits	:	12

OUTCOMES

- Able to define Problem with specifications
- Relevant Literature survey, familiarity with research journals
- Critically evaluate various available techniques to solve a particular problem
- Able to Plan the work, prepare required graphs, bar (activity) charts and analyse the results and arrive at a solution
- Prepare and present results in a scientific manner (Presentation - oral and written)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1				1	2			1	2	2	2	1		
CO2				1	2			1	2	2	2	1		
CO3				1	2			1	2	2	2	1	1	1
CO4				1	3			1	2	2	2	1	1	1
CO5				1	3			1	2	2	2	1	1	1

Solving a real life problem' should be the focus of U.G. projects. Faculty members should propose the project briefs (scope and references) well in advance which should be made available to the students at the departmental library. The project could be classified as experimentation, theoretical calculation, computational analysis, Mathematical modeling. It should involve one or many elements of techniques such as analysis, design, simulation and synthesis.

The Department will appoint a project coordinator who will coordinate the following.

- Grouping of students (max. 3 in a group).
- Allotment of Projects and project guides Project monitoring at regular intervals

All projects allotment is completed by the 2nd week of 4th year 1st semester, so that students get sufficient time for completion of the project.

All projects will be monitored at least twice in a semester through students presentation. Sessional marks are to be based on the Grades/Marks, awarded by a monitoring committee comprising of faculty members in the presence of the supervisor.

Efforts should be made that some of the projects are carried out in Industries with the help of industry coordinators.

Common norms will be established for final documentation of the project report by the respective departments.

** S / A / B / C / D / F*

ELECTIVE - III

ME 454 UE

WASTE HEAT RECOVERY AND CO-GENERATION

Instruction (periods per week)	:	4
Duration of University Examination	:	3 Hours
University Examination	:	75 Marks
Sessional	:	25 Marks
Credits	:	4

Course Objectives:

- Understand the concept of waste heat recovery
- Distinguish heat exchangers and recuperators
- Acquire knowledge about various cogeneration methods
- Understand the cogeneration concept and thermodynamic advantages
- Understand the source of waste heat and methods of utilization

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2								1	1	
CO2	2	2	2	2								2	1	
CO3	1	1	1	1								1	1	
CO4	2	2	2	1								1	1	
CO5	1	1	1									1	1	

Unit-I

Definition, Sources, Quantity and quality of waste heat. Technologies for waste heat recovery and utilization. Need of storage systems for waste heat.

Utilization of Waste Heat - Continuous and Intermittent. Energy requirements of industry. Various forms of waste heat available.

Unit-II

Overview of heat exchangers. Gas to gas. Gas to liquid and liquid to liquid heat exchangers. Calculation of effectiveness and design of heat exchanger for number of tubes. Pressure drop considerations LMTD and effectiveness -NTU methods.

Unit-III

First and Second law of thermodynamics, and it's effect on design of recuperators. Recuperators-Ceramic, metallic and reradiant recuperators, high temperature recuperators. Concept of porosity, Peclet number superficial velocity, pressure drop, and selection of material for heat storage and recovery.

Unit-IV

Cogeneration - Definition, Two basic cogeneration concepts, thermodynamic advantage, Cogeneration efficiency, potential benefits and costs of cogeneration. Cogeneration-Over view, Industrial application of cogeneration.

Unit-V

Source of waste heat and methods of utilization. Application of Cogeneration to a steam power plant. Identifying the possibilities of extracting energy to run a gas turbine. Integration of Steam turbine and Gas turbine - Power calculations, various types and their applications towards power generation. Quality of steam and its effect on performance. Legislation - Power plant and Industrial fuel use act (FUA) Potential nation wide benefits of Cogeneration, Impact of Cogeneration on fuel use patterns. Legislative, Environment and Institutional Constraints for use of waste heat.

Suggested Reading

1. Donald Q. Kern, "Process Heat Transfer", McGraw Hill International Editions, Chemical Engineering Series, 1965.
2. Wylen V. and Sonntag, "Fundamentals of Classical Thermodynamics" - SI Version, Wiley Eastern Ltd., 1993.
3. David Hu S., "Handbook of Industrial Energy Conservation", Van Nostrand Reinhold Co., 1983.

ME 455 UE

COMPOSITE MATERIALS

Instruction (periods per week)	:	4
Duration of University Examination	:	3 Hours
University Examination	:	75 Marks
Sessional	:	25 Marks
Credits	:	4

Course Objectives:

- Understand the concept of composites its advantages and applications
- Compare and contrast different manufacturing methods of composites
- Analysis and evaluation of laminate composites using micromechanics
- Analysis and evaluation of laminate composites using macromechanics
- Estimate the properties of composites using micormechnics and macromechanics.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	1							1	1	
CO2	2	2	2	2	2							1	1	
CO3	2	2	2	2	2							1	1	
CO4	2	2	2	2	2							1	1	
CO5	2	2	2	2	2							1	1	

Unit-I

Introduction: Fibres, Matrix materials, interfaces, polymer matrix composites, metal matrix composites, ceramic matrix composites, carbon fibre composites.

Unit-II

Micromechanics of Composites:

Mechanical properties: Production of Elastic constant, micromechanical approach, Halpin-Tsal equations, Transverse stresses.

Thermal properties: Hygrothermal stresses, mechanics of load transfer from matrix to fibre.

Unit-III

Macromechanics of Composites:

Elastic constants of a lamina, relations between engineering constants and reduced stiffness and compliances, variation of lamina properties with orientation, analysis of laminated composites, stresses and strains with orientation.

Unit-IV

Inter-laminar stresses and edge effects. Simplified composite beam solutions. Bending of laminated beams. Tensile and compressive strength of unidirectional fibre composites, fracture modes in composites: Single and multiple fracture, de-bonding, fibre pullout and de-lamination failure, fatigue of laminate composite. Effect of variability of fibre strength.

Unit-V

Strength of an orthotropic lamina: Maximum stress theory, maximum strain criteria, maximum work (Tsai-Hill) criterion, quadratic interaction criteria. Designing with composite materials. Measurement of constituent material properties: Fibre tests, Matrix tests. Measurement of basic composite properties: Tensile test, compressive test, a plane shear test, interlaminar shear test, flexure test.

Suggested Reading

2. Jones, R.M., "Mechanics of Composite Materials", McGraw Hill Co., 1967.
3. Ronald F. Gibson, "Principles of Composite Materials Mechanics", McGraw-Hill, Inc., 1994.
4. Krishan, K. Chewla, "Composite Material", Springer - verlag, 1987.
5. Carl. T. Herakovich, "Mechanics of Fibrous Composites", John Wiley Sons Inc., 1998.

ME 456 UE

MACHINE TOOL ENGINEERING AND DESIGN

Instruction (periods per week)	:	4
Duration of University	:	3 Hours
Examination University	:	75 Marks
Examination Sessional	:	25 Marks
Credits	:	4

Course Objectives:

- Understand the basic working principles of different machine tools with kinematic mechanisms.
- Distinguish the functional and operational requirements of different machine tools
- Design speed and feed gear boxes for a particular configuration.
- Design machine tool structures for strength and rigidity
- Understand various controls used in machine tools

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2		1		2	1	1	1		1		1	2	
CO2	2		2	3		2	1		1	1			2	
CO3	3	3	3	2	3		1	1	2		2	1	3	3
CO4	2	2	2	1	2		1	1	2	1		1	2	2
CO5	2	2	1	1	1	1	1			1	1	1	2	2

Unit-I

Basic features: Classification of machine tools-Basic features of construction and fundamental kinematic mechanisms of general purpose, special purpose machine tools, transfer machines, Automatic and N.C. machines. Mechanisms used for converting rotary to linear motion: Mechanisms for intermittent motion.

Unit-II

Kinematics, Drives of Machine tools: Selection of range of speeds and feeds. Layout in G.P., A.P. and Logarithmic progression, standardization of speeds and feeds. Productivity loss. Selection of highest and lowest speeds, range ratio. Design of ray diagram" and structural diagrams for machine tool gear boxes. Sliding, clustered and clutched drives, Rupport drive.

Unit-III

Feed gear boxes: Norton and Meander drives pre-selection of speed, stepped and stepless regulation. Strength, rigidity and design analysis: Analysis of beds, frames, columns. Materials for structures. Methods to improve the rigidity of structures. Types of Guide ways-overall compliance of machine tool. Thermal effects-functional accuracy of machine tool.

Unit-IV

Spindle units: Spindle units of lathe, drilling, milling and grinding machines, materials for spindles. Spindle design. Effect of clearance on the rigidity of spindle. Hydrodynamic, hydrostatic, rolling bearings. Selection of bearings.

Unit-V

Hydraulic controls: Various controls used in machine tools. Hydraulic and pneumatic systems used in machine tools-positive displacement pumps - properties of fluids — relief valves, check valves, flow control valves, multi-position valves, filters, accumulators. Hydraulic circuit for surface grinding machine, hydro-copying system.

Suggested Reading

1. Sen G.S., & Battacharya, "Principles of Machine Tools", New Central Book Agency, Calcutta, 1986.
2. Basu S.K., "Design of Machine Tools", Allied Publishers, 1980.
3. Russe W. Henke, "Introduction to Fluid Power Circuits and Systems", Addison Wesley, 1970.
4. Mehta, "Machine Tool Design", Central Publishers, 2004.

ME 466 UE

ADVANCED PROPULSION AND SPACE SCIENCE

Instruction (periods per week)	:	4
Duration of University Examination	:	3 Hours
University Examination	:	75 Marks
Sessional	:	25 Marks
Credits	:	4

Course Objectives:

* *To learn about gas dynamic concepts of rocket propulsion system*
* *To understand rocket engine system.*
* *To understand celestial sphere and its parameters*
* *To learn about Satellites & Remote Sensing*

Unit-I

Advanced Gas Dynamics: Normal shock waves, pitot tubes, moving shock waves, oblique shock waves, reflected shock waves, conical shock waves, hypersonic flow, Newtonian theory, high temperature flows, low density flows.

Unit-II

Advanced Propulsion: Rocket engines - Operation and performance of rocket engines, design and operating parameters - total impulse, thrust, energy and efficiencies, Typical performance values, overview of monopropellant, bipropellant liquid, solid and hybrid rocket propulsion systems, combined cycle propulsion, Electric / Ion propulsion.

Unit-III

Rocket Technology: Flight mechanics, application thrust profiles. Acceleration -staging of rockets, feed systems, injectors and expansion nozzles, typical nozzle designs (cone, bell, plug). Rocket heat transfer and ablative cooling. Testing and Instrumentation. Nuclear thermal rockets, pulsed detonation engines, Solar sails.

Unit-IV

Celestial Sphere: Spherical trigonometry, celestial coordinate systems, Astronomical triangle, Time-Sidereal, apparent and mean solar time. Equation of Time.

Two Body Problem: Formulation, relative motion and solution, Kepler's equation, motions of rockets and artificial satellites, transfer orbits, minimum energy interplanetary transfer orbits, use of parking orbits, Perturbations of artificial satellites due to atmospheric drag and flattening of earth.

Unit-V

Nuclear Processes in the Sun, Solar wind, interaction of solar Wind and Earth's magnetic field, Van Allen radiation belts.

Satellites & Remote Sensing: Orbits, earth segment, space segment, earth station, satellite subsystems, working details of communication and navigational satellites - components, operation and maintenance, meteorological satellites. Principles of remote sensing.

Suggested Reading

1. Shapiro, "The dynamics and thermodynamics of compressible flow", 1953.
2. Thomas, D. Daman, "Introduction to space: The Science of space flight", Orbit book Co., 3rd ed., Malabar, FL, 2001.
3. K.D. Abhyankar, "Astrophysics of the solar systems", University Press (India) Ltd., 1999.
4. Timothy Pratt and Charles, W. Bostian, "Satellite Communications", John Wiley, 1986.

EC 402 UE

EMBEDDED SYSTEM DESIGN

Instruction	: 4 Periods per week
Duration of university examination	: 3 hours
University examination	: 75marks
Sessional	: 25marks
Credits	4

Course Objectives:

- acquire an overview of what an embedded system implies
- understand the architecture of a microprocessor and microcontroller to enable to design embedded applications using them
- apply theoretical learning to practical real time problems for automation.
- understand how to build and debug an embedded system application.
- analyze and design real world applications and interface peripheral devices to the microprocessor.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	2							1	1	
CO2	2	2	2	2	2							1	1	
CO3	2	2	2	2	2							1	1	
CO4	2	2	2	2	2							1	1	
CO5	2	2	2	2	2							1	1	

Unit I

Introduction To Embedded Systems: The Embedded Design Life Cycle: Product Specification, Hardware/Software Partitioning, Iteration And Implementation, Detailed Hardware And Software Design, Hardware/Software Integration, Product Testing And Release: Maintenance And Upgradation.

Unit II

The Selection Process: Choosing The Right Processor: Packaging The Silicon: Silicon Economics, System-On-Silicon; Adequate Performance: Performance Measuring Tools, Meaningful Benchmarking;

Unit III

RTOSAvailability : Language/Microprocessor Support, Tool Compatibility, Device Drivers, Services: Tool Chain Availability: Compilers, Hardware And Software Debugging Tools: Other Issues In Selection Process.

Unit IV

Embedded Software Development Tools: Host And Target Machines: Cross Compilers, Cross Assemblers, Tool Chains; Linkers/Locators For Embedded Software: Address Resolution, Locator Maps: Getting Embedded Software Into Target System: In Circuit- Emulators, Monitors: Testing On Your Host Machine: Calling Interrupt Routines: Instruction _Set Simulators; Logic Analyzers; Software-Only Monitors.

UnitV

The Role Of FPGAs In Embedded System Design: FPGAs Vs. Custom VLSI; FPGA Based System Design: HierarchicalDesign, DesignAbstractions, Methodologies: FPGAArchitecture: Generic Structure, Interconnect, Configuration: SRAM-Based FPGAs,Xilinx FPGA. ActelFPGA; Permanently Programmed FPGA:Chip I/O:Logic Element Parameters: InterconnectArchitecture:Pin out.

Suggested Books:

1. Arnold Berger; Embedded System Design- An Instruction To Process, Tools And Techniques; 1st South Asian Edition 2005, CMP Books.
2. David E.Simon: An Embedded Software Primer: Pearson Education Asia.
3. Wayne Wolf: FPGA Based System Design, Pearson Education, 2005 Edition.

EC 466 UE

MICROPROCESSORS APPLICATIONS

(Elective for ME)

Instruction:	4 Periods per week
Duration of University Examination:	3 Hours
University Examination:	75 Marks
Sessional:	25 Marks
Credits	4

Course Objectives:

* To Understand The Basic Building Blocks Of The Digital Circuits.
* To Gain Knowledge About Stored Program Computer Concept.
* To Understand Different Peripherals.

Unit I

Introduction to digital systems, number systems and architecture, Boolean algebra and logic gates – AND,OR,NOT,NAND,NOR, EXCLUSIVE- OR, Combinational logic circuits, binary adder, binary subtracter, BCD adder and BCD subtracter.

UnitII

Functional Aspect Of Decoder, Multiplexer, Demultiplexer, Encoder, Flip-Flops, Binary Counter, Bcd Counter, Shift Register, Octal Tristate Latch, Octal Bidirectional Buffer, Read Only Memory, Random Access Memory (Read/ Write), Digital To Analog (D/A)Converter, Analog To Digital (A/D)Converter.

UnitIII

Introduction To A Microcomputer(Stored Program Computer Concept),Flow Charts, CPU Architecture & Bus Structure, Intel 8085 Microprocessor & Architecture, Instruction Set. Instruction Cycle, Flow Charts, Simple 8085 Assembly Language And Machine Code Programmers, Simple Loops, Multiple Precision Binary Addition And Subtraction, Lookup Tables, Stack Operations, SubRoutines.

UnitIV

Memory Interfacing: ROM And Static ROM Chips, I/O Interfacing, Simple I/O Ports(Intel 8282), Programmable Peripheral Interface & Chip (8255). Programmable Communication Interface Chip (8251),RS232C Interface.

Unit V

Peripherals Interfacing Using Toggle Switches, Keyboard, LEDs, Seven-Segment LEDs, ADC, DAC, Centronic Parallel Printer, CRT Data Terminals, Interrupts, DMA Data Transfer.

Suggested Reading:

1. Gaur R.K. Digital Electronics And Microcomputers, DhanpatRai& Sons, 3rd Edition,1993
2.Goankar R.S. Microprocessor Architecture, Programming And Application with the 8085 Penram International,1997.
3. Ram Fundamentals Microprocessor And Microcomputers, DhanpatRai& Sons,1989.

CS 459 UE

INFORMATION SECURITY

Instruction	4 Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	4

Course Objectives:

- Describe the steps in Security Systems development life cycle(SecSDLC)
- Understand the common threats and attack to information systems
- Understand the legal and ethical issues of information technology
- Identify security needs using risk management and choose the appropriate risk control strategy based on business needs
- Use the basic knowledge of security frameworks in preparing security blue print for the organization

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	1	1									
CO2	2	2	2	2	1									
CO3	2	2	2	2	1									
CO4	2	2	2	2	1									
CO5	2	2	2	2	1									

UNIT-I

Introduction: Characteristics of Information, Components of Information Systems, Securing components, balancing Security and Access The Security System Development Life Cycle, Security Professionals and the organization.Security Investigation Phase; Need for security, Threats, Attacks.

UNIT-II

Legal, Ethical, and Professional Issues in Information Security Ethical Component in Information System, Codes of Ethics, Certification Security Analysis: Risk Management, Identifying and assessing risk, Controlling Risk.

UNIT-III

Logical Design: Blue print for security. Security Policy, standards and Practices.Design of Security Architecture, Physical Design: Security Technology, Physical Design of Security SDLC Firewalls, Dialup Protection, Intrusion Detection Systems, Scanning and analysis tools, Content filters.

UNIT-IV

Cryptography: The basic elements of cryptography: symmetric (Symmetric Key-DES, IDEA, and AES), and public key cryptography (Public Key Encryptions-RSA).

UNIT-V

Message digest (MD-5, SHA), digital signatures. SSL and SET: SSL and SET protocols, Internet transactions using both SSL and SET.

Suggested Reading:

1. Michael E. Whitman and Herbert J. Mattord, “Principles of Information Security”, Thomson, 2003.
2. William Stallings, “Cryptography and Network Security”, Pearson Education, 2000.
3. Nina Godbole, “Information System Security”, Wiley India Pvt. Ltd.

EE 451 UE

RELIABILITY ENGINEERING

Instruction (periods per week) : 4
Duration of University Examination : 3 Hours
University Examination : 75 Marks
Sessional : 25 Marks
Credits

OUTCOMES

- Understand the importance of various probability density functions
- Classify the various failures and and their causes
- Develop reliability block diagrams and evaluate failure rate
- Analyse various markov models for single and multi components
- Determine the frequency of failure and cumulative failure using makov and other models

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2								1		
CO2	2	2	2	2								1		
CO3	2	2	2	2								1		
CO4	2	2	2	2								1		
CO5	2	2	2	2								1		

UNIT- I

Discrete and continuous random variables. Probability density function and Cumulative distribution function. Mean and variance. Binomial, Poisson, Exponential and Weibull distributions.

UNIT -II

Failure and causes of failure. Failure rate and failure density. Reliability function and MTTF. Bath tub curve for different systems. Parametric methods for above distributions. Non-parametric methods from field data.

UNIT- III

Reliability block diagram. Series and parallel systems. Net work reduction technique, Examples. Evaluation of failure rate, MTTF and reliability, Active and Stand by Redundancy, r out of n configuration. Non-series - parallel systems. Path based and cut set methods

UNIT- IV

Availability, MTTR and MTBF Markov models and State transition matrices. Reliability models for single component, two component. Load sharing and standby systems. Reliability and availability models of two unit parallel system with repair and standby system with repair.

UNIT- V

Repairable Systems, Maintainability, Preventive maintenance. Evaluation of reliability and MTTF. Overhauling and replacement. Optimum maintenance policy. Markov model of a power plant with identical units and non-identical units. Capacity outage probability table. Frequency of failures and Cumulative frequency.

Suggested Reading

1. Charles E. Ebeling, Reliability and Maintainability Engineering , McGraw Hill International Edition,1997.
2. Balaguruswamy, Reliability Engineering, Tata McGraw Hill Publishing company Ltd, 1984
3. R.N. Allan, Reliability Evaluation of Engineering Systems - Pitman, Publishing - 1996
4. Endrenyi, Reliability Modeling in Electric Power Systems, John Wiley & Sons, 1978.

ELECTIVE – IV

ME 460 UE

ROBOTICS

Instruction (periods per week)	:	4
Duration of University Examination	:	3 Hours
University Examination	:	75 Marks
Sessional	:	25 Marks
Credits	:	4

Course Objectives:

- To provide student the fundamental knowledge of the various sub-disciplines in serial robots such as kinematics, dynamics, control & manipulation, and computer based acquisition etc.
- To provide adequate background in both analysis and design of serial robots.

OUTCOMES:

- Capable to relate mechanical structures of industrial robots and their operational workspace characteristics and have an understanding of the functionality and limitations of robot actuators and sensors
- Apply spatial transformation to obtain forward/Inverse kinematics
- equation of robot manipulators using analytical/numerical/simulation tools
- Apply robot vision techniques to get the required information from input images
- Design and develop a industrial robot for a given purpose economically
- Appreciate the current state and potential for robotics in new application areas

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	1							1	2	
CO2	2	2	2	2	2							1	2	
CO3	2	2	2	2	2							1	2	
CO4	2	2	2	2	1							1	2	
CO5	2	2	2	2	1							1	2	

UNIT-I

Introduction to Robotics Basic structure of Robots. Degree of freedom of Robots. Work envelope. Classification of Robots based on drive Technology, Work-Envelope and motion control methods. Application of Robots in Industry. Specification of requirement of motion and force for different application. Repeatability, Precision and Accuracy as applied to Robots.

UNIT-II

Rotation matrix. Homogeneous transformation matrix. Denavit and Hartenberg representation. Euler angles and RPY representation. Representation of absolute position and orientation in terms of joint parameters, Kinematic equation for manipulators. Inverse kinematics of Robot arm for position and orientation. Redundancy in Robots.

UNIT-III

Jacobian for direct and inverse kinematics. Trajectory planning for Robots. Trajectory control based on incremental inverse kinematics of kinematic equations, Static force analysis, stiffness.

UNIT-IV

Newton - Euler formulation of dynamic equation. Lagrangian formulation. Inertia tensor. Control schemes, individual joint control and disadvantages. Control through computed torques.

UNTT-V

Position and velocity measurement. Optical encoders. Different types of End effectors for industrial Robots. Range and Proximity sensing. Tactile sensors. Force and Torque sensors. Drives used in industrial Robots. Introduction to techniques used in Robot vision. Image acquisition and processing. Introduction to Robot programming.

ME 460 UE

Suggested Reading

1. Fu. K.S., Gon Zalez R.C., Lee C.S.G. "Robotics, Control-sensing vision and Intelligence", McGraw Hill, Int. Ed., 1987.
2. Asada and Sllotine , ‘robot analysis and intelligence’ BS Publications , India.
3. Spong and Vidyasagar, "Robot Dynamics & Control", John Wiley and Sons, Ed., 1990.
4. Groover M P, "Industrial Robotics", McGraw Hill Publications, 1999.
5. Mittal and Nagrath, "Industrial Robotics", Tata McGraw Hill Publications, 2004.
6. Saha & Subir kumar saha, ‘robotics’, tmh, india.

ME 461 UE

ENERGY CONSERVATION AND MANAGEMENT

Instruction (periods per week)	:	4
Duration of University Examination	:	3 Hours
University Examination	:	75 Marks
Sessional	:	25 Marks
Credits	:	4

Course Objectives:

* *To learn about energy conservation*
* *To understand sources of loss of power in energy conversion*
* *To understand Procedure for Comprehensive Energy Conservation Planning*
* *To understand Industrial energy conservation methods*

OUTCOMES:

- Student will able to understand different forms of energy
- Student will be able to calculate the amount of heat energy available
- Students able to understand the industry energy conservation modeling
- Students able to understand methodology for forecasting industrial energy supply and demand.
- Understand the energy storage techniques

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	1							1	1	1	
CO2	2	2	1	1							1	1	1	
CO3	1	2	2	1	1						1	1	1	
CO4	1	2	1	1	1						1	1	1	
CO5	2	1	1								1	1	1	

UNTT-I

Definition, Principles of Energy Conservation - Maximum Thermodynamic efficiency. Maximum Cost - effectiveness in energy use. Various forms of energy - Heat Mechanical. Electrical energy and Chemical energy. Identification of potential sources of energy losses - Transportion, operation and conversion from one from to another.

UNIT-II

Heat energy and storage - Media of transport of heat energy - steam, oil and flue gases. Calculation of steam quality. Calculation of amount of heat energy available. Recuperators. Constructional details, Selection of materials to store heat energy. Concept of power. Modes of mechanical energy transport - Gears, pulleys, belts, shafts etc., Calculation of power. Sources of loss of power in energy conversion into electricity, potential energy (i.e., pumps).

UNIT-III

Chemical energy - combustion of fuels - petrol, diesel and coal. Loss due to quality of fuel, conversion into other form of energy - boilers, I.C. engines. Calculation related to losses. Electrical energy - Working principle of motors and generators. Calculation of efficiency of generators. Losses during transmission and energy conversion - into mechanical energy, thermal energy. Calculation of effecting parameters.

UNTT-IV

Procedure for Comprehensive Energy Conservation Planning (CECP) -Specifying targets, identifying energy in-efficient facilities. Synthesize evaluation and optimization of alternative conservation measures in view of organization costs. Flow chart of organization's functions. Collection of accountable data. Application of CECP method. An example.

ME 461 UE

UNTT-V

Industrial energy conservation modeling - Methodology - Definition of production system - A primary copper production system, Model construction - Mathematical Programming. Market penetration, Structure of energy conservation model. Data preparation - coefficients needed in a model, Unit production cost and unit energy requirements. Model exercise, verification and validation. Methodology for forecasting Industrial Energy Supply and Demand.

Suggested Reading

1. Gottschalk C.M., "Industrial Energy Conservation", John Wiley & Sons, 1996.
2. Chaturvedi P., and Joshi S., "Strategy for Energy Conservation in India", Concept PublishingCo., New Delhi, 1997.

ME 462 UE

TOOL DESIGN

Instruction (periods per week)	:	4
Duration of University Examination	:	3 Hours
University Examination	:	75 Marks
Sessional	:	25 Marks
Credits		4

Course Objectives:

** To understand the basic knowledge of select appropriate materials for tooling applications*
** To grasp the Design, develop, and evaluate cutting tools and work holders for a manufactured product*
** To comprehend the basic knowledge of press tools for sheet metal working.*

Outcomes:

- Understand ASA and ORS systems of tool geometry
- Design a single point or multi point cutting tool to machine a required job
- Design a die and punch for blanking, piercing, drawing and bending operations
- Discriminate the knowledge of jigs and fixtures design
- Apply the concepts and design a GO and NO GO gauge

UNIT-I

Cutting tool materials and single point cutting tools:

Cutting tool materials, desired properties. Types, major Constituent, relative characteristics, latest development: ISO; classification and coding of carbides.

Geometry of single point cutting tool. Influence of each geometrical parameters on the cutting tool performance. Factors involved in their selection. Tool signature and geometry in MRS, ORS, NRS. Cutting forces and design features of HSS and carbide tipped tools.

Feature of high production cutting tools. Chipbreakers and their types.

UNIT-II

Form tools and multi point cutting tools:

Form tools: Radial and tangential: flat and circular. Form correction and tool holding methods.

Drills Geometry: Variation of rake and clearance angles along tips, effect of geometrical parameters on thrust and torque effect of feed rate on rake and clearance, web thinning. Types of drill points, Grinding of drills.

Milling Cutters: Major types, geometry of peripheral, end and face milling cutters. Profile sharpened and form relieved expression for minimum number of teeth. Design features, forces and power estimation, Grinding of milling cutters.

Reamers: Types, geometry, Reaming allowance, design features tolerance disposition.

Broachers: Pull and push types. Internal and External broaches, geometry and design features. Pull force estimation. Keyway, spline, round, square broaches.

UNIT-III

Press tools for sheet metal working:

Blanking and piercing. Diet set elements. Simple and progressive dies. Estimation of punch load, clearances, centre of pressure, strip layout, methods of reducing punch load.

Bending dies: Spring back and bending allowance estimation of punch load.

Drawing Dies: Punch load, blank size, number of draws, methods of retaining metal in draw dies. Metal flow during drawing.

Metal spinning: Configuration and design features of metal spinning, shear forming and flow forming.

UNTT-IV

Jigs & Fixtures: Design principles and construction features. Locating methods associated with flat, cylindrical internal and external surface. Types of locating pins. Requirements and choice of locating systems. Redundant location, fool proofing. Setting blocks, types of clamping devices and their basic elements. Quick action clamps and nuts. Equalising and multiple clamping pneumatics. Hydraulic, magnetic and vacuum clamping. Types of drill jig and their classification. Types of jig bushes, jig feet. Indexing jigs. Economic analysis of Jigs and Fixtures. Economic tool life for minimum cost maximum production and max profit rate.

ME 462 UE
UNTT-V

Miscellaneous tools: Cam design for single spindle automatics for simple components. Tool layout estimation of cycle time. Gauge design: Taylor's principle, limit gauges for holes and shafts. Estimation of limits on Go and No Go gauges. Forgoing dies: Draft, parting line, filters. Allowances, sequence in multiple impression forging. Flashing, Trimming.

Plastic Tools: Application of plastic as a tooling material viz., for Gauges, Surface plates, jigs and fixtures. Forming dies.

Suggested Reading

1. Surendra kenav and Umesh Chandra, "Production Engineering Design (Tool Design)", Satyaprakashan, New Delhi, 1994.
2. Donaldson, Leain and Goold, "Tool Design", Tata McGraw Hill, New Delhi, 1983.
3. Amitabha Battacharya and Inyong Ham, "Design of Cutting Tools, Use of Metal Cutting Theory", ASTME publication Michigan USA, 1969.

ME 465 UE

NON-DESTRUCTIVE TESTING

Instruction (periods per week)	:	4
Duration of University Examination	:	3 Hours
University Examination	:	75 Marks
Sessional	:	25 Marks
Credits	: 4	

Course Objectives:

** To understand the basic principles, techniques, equipment, applications and limitations of basic NOT methods.*
** To learn the selection of appropriate NOT methods.*
** To grasp the standards and specifications related to NOT technology.*
** To know the developments and future trends in NOT.*

Outcomes:

- Able to understand the basic principles ,techniques and equipment of NDT methods
- Able to analyse and interpret the results from NDT TESTS
- Able to apply the codes, standards and specifications used in NDT
- Able to select proper NDT method for inspection of industrial products
- Able to know the developments and future trends in NDT

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	3	3	3		2	1		1	1	1
CO2	2	3	2	3	3	3	3		2	3		1	1	1
CO3	2	3	2	3	3	3	3		2	3		1	1	1
CO4	2	3	2	3	3	3	2		2	3		1	1	2
CO5	3	2	1	1	3		2		1	2		2	1	1

UNIT-I

Liquid Penetrant Inspection: Principles of penetrant inspection, characteristics of a penetrant, water-washable system, post-emulsification system, solvent-removable system, surface preparation and cleaning, Penetrant application, Development, Advantages limitations, and applications.
Magnetic Particle Inspection: Principle, Magnetisation methods, continuous and residual methods, sensitivities, Demagnetisation, Magnetic particles, Applications, Advantages and limitations.

UNIT-II

Eddy Current Testing: Principle, Lift-off factor, and edge effects, Skin effect, Inspection frequency, coil arrangements, inspection probes, types of circuit, reference pieces, phase analysis, display methods and applications.

UNIT-III

Ultrasonic Testing: Generation of ultra sound, characteristics of an ultrasonic beam, sound waves at interfaces, sound attenuation, Display systems, Probe construction, type of display, Inspection techniques, Identification of defects, Immersion testing, Sensitivity & calibration. Reference standards. Surface condition, Applications.

UNTT-IV

Radiography: Principle and uses of Radiography, limitations, Principle, Radiation sources, Production of X-rays, x-ray spectra, Attenuation of radiation, Radiographic equivalence, Shadow formation, enlargement and distortion, Radiographic film and paper, Xeroradiography, fluoroscopy, Exposure factors, Radiographic screens, identification markers and image quality indicators, Inspection of simple shapes, inspection of complex shapes, viewing and interpretation of radiographs, Radiation hazard, Protection against radiation, measurement of radiation received by personnel.

UNTT-V

Acoustic Emission: Physical Principles, Sources of emission, instrumentation and applications. Other NDT Techniques: Neutron radiography, Laser induced Ultrasonics, Surface analysis, Thermography.

Suggested Reading

1. Barry Hull & Vernon John, "Non Destructive Testing", 1988.
2. HJ.Frissell (Editorial Co-Ordinator) - "Non-Destructive Evaluation and Quality Control" - ASM Hand Book - International Publication, USA, 1989.
3. Dove and Adams, "Experimental stress analysis and motion measurement", Prentice Hall of India, Delhi.

CS 458 UE

DATA MINING

Instruction	4 Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessional	25 marks
Credits	4

Course Objectives

* *To understand the different steps in data mining*
* *To learn the different classification techniques*
* *To gain knowledge of association rule mining*
* *To understand the techniques of clustering*

UNIT-I

Introduction: Challenges – Origins of Data Mining and Data Mining Tasks
Data: Types of Data – Data Quality – Data Preprocessing – Measures of Similarity and Dissimilarity – OLAP and Multidimensional Data Analysis

UNIT-II

Classification: Preliminaries – General approach to solving a classification problem – Decision tree induction – Model overfitting – Evaluating the performance of a classifier – Methods of comparing classifiers - Rule-based classifier

UNIT-III

Classification: Nearest-Neighbor classifiers – Bayesian classifiers – Artificial Neutral Networks – Support vector machine – Ensemble methods – Class imbalance problem – Multiclass problem

UNIT-IV

Association Analysis: Problem definition – Frequent item set generation – Rule generation – Compact representation of frequent item sets – Alternative methods for generating frequent item sets – FP-Growth Algorithm – Evaluation of association patterns – Effect of Skewed support distribution – Handling categorical attributes – Handling continuous attributes – Handling a concept hierarchy

UNIT-V

Cluster Analysis: Overview – K-means – Agglomerative hierarchical clustering – DBSCAN – Cluster evaluation – Characteristics of Data, Clusters, and Clustering Algorithms

Suggested Reading:

1. Pang-Ning Tan, Michael Steinbach, Vipin Kumar, *Introduction to Data Mining*, Pearson Education, 2008.
2. K.P.Soman, Shyam Diwakar, V.Ajay, *Insight into Data Mining Theory and Practice*, PHI, 2010.
3. Arun K Pujari, Data Mining Techniques, University Press, 2nd Edn, 2009.
4. Vikram pudi P. Radha Krishna , Data Mining, Oxford University Press, 1st edition 2009
5. Galit S, Nitin RP, Peter C Bruce. Data Mining for Business Intelligence. Wiley India Edition. 2007

LA 454 UE

INTELLECTUAL PROPERTY RIGHTS

Instruction (periods per week)	:	4
Duration of University Examination	:	3 Hours
University Examination	:	75 Marks
Sessional	:	25 Marks
Credits	:	4

COURSE OUTCOMES:

- Is aware of Engineering Ethics providing basic knowledge about ethics, moral
- issues & moral dilemmas and professional ideals
- Identify different types of Intellectual Properties (IPs), the right of ownership, scope of protection as well as the ways to create and to extract value from IP.
- Recognize the crucial role of IP in organizations of different industrial sectors for the purposes of product and technology development
- Identify activities and constitute IP infringements and the remedies available to the IP owner
- Describe the precautious steps to be taken to prevent infringement of proprietary rights and duties in products and technology development.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						1		3		1	2	1		
CO2						1		3		1	2	1		
CO3						1		3		1	2	1		
CO4						1		3		1	2	1		
CO5						1		3		1	2	1		

UNIT - I

Meaning of Intellectual Property Rights. Justification of Intellectual Property Rights. Classification of these rights. Classification of Treaties relating to Intellectual Property Rights - (i) Standard setting treaties (ii) Global protection system treaties, (iii) Classification treats. The salient features of the TRIPS Agreement. The two international institutions -(i) The world Intellectual Property Organization (ii) The world Trade Organization.

UNIT - II

History of the patent system. Patents in all fields of technology.

i. Patents on genetic resources patents on chemicals, designs, patents based on software, business methods, internet patents, etc.

ii. Exceptions to exclusive rights conferred to a patent holder, iii. Grounds for revocation of a patent, iv. Remedies for infringement of a patent.

UNIT - III

Copyrights and related rights. Nature and scope of protection of copyrights and related rights. Protection of copyrights in the digital media. Defence of fair use. Moral rights of the author. Copyright societies. Remedies for infringement of copyrights.

UNIT - IV

Nature and scope of protection of design rights, protection of layout designs (topographies) of Integrated circuits, protection of undisclosed information, protection of trademarks, domain names and geographical indications.

UNIT - V

Practical aspects - Drafting of a patent. Some exercises on the preliminary rules on preparing an application seeking a patent.

Suggested Reading:

1. Cornish W.R. : Intellectual Property : Patents, Copyright, Trademarks and Allied Rights: Sweet & Maxwell 1993.
2. P.Narayana, Intellectual Property Law. Eastern Law House 2nd Edn. 1997.
3. Robin Jacob & Daniel Alexander, A Guide Book to Intellectual Property Patents Trademarks, Copyrights and Design. Sweet and Maxwell 4th Edn. 1993.

BM 454 UE

BIOELECTRICITY

(Elective for CSE/ECE/EEE/ME)

Instruction:	4 Periods per week
Duration of University Examination:	3 Hours
University Examination	75 Marks
Sessional:	25 Marks
Credits	4

OBJECTIVES:

* *Electrical properties of the cell membrane*
* *Action potentials*
* *Extra cellular waveforms*
* *Cardiac electrophysiology*
* *Function stimulation (FES)*

UNIT I

Basic Electromagnetic theory: Scalar and Vector quantities. Gradient, Divergence, Laplacian Operators. Vector Identities, Guass theorem, Green`s theorem, Electrical sources and fields, Fundamental Relationships, Poisson`s Equation, Concept of monopole and dipole filed.

UNIT II

Action potentials and propagation: Membrane structure, Nernst Potential and Resting Potential Action Potential- Origin and Characteristics. Application of Nernst equation in bio fluids. Voltage clamp. Hodgkin-Huxley equations analysis. Core conductor model, Propagation in myelinated and unmyelinated nerve fibres.

UNIT III

Electrophysiology of skeletal muscle and neuromuscular junction: Release of Neuromuscular transmitter, post junctional response to transmitter. Origin of EPSP and IPSP. Neuro-muscular block, determination of degree of neuro-muscular block. Muscle structure and contraction. Excitation contraction mechanism.

UNIT IV

Electro-physiology of Heart: Properties of Cardiac muscle, Heart vector, electrical activity of the heart. Standard leads, lead vectors. Recording of the ECG from the surface. Dipole theory of the heart. Relationship between the different ECG leads.

UNIT V

Application of Bio-Electric Phenomena:
Functional Neuro-muscular stimulation, impedance plethysmography, measurement of resistance of isotropic & anisotropic tissue and Electro encephalography.

Suggested Reading:

1. Plonsey Robert and Roger C., Barr R., Bioelectricity, Plenum Press, 1988.
2. Plonsey Robert and Flemng David G., Bioelectricity Penomena, McGraw Hill, 1969.
3. D.P.Zipes and J.Jalife, Cardiac Elecro-physiology : From Cell to Bedside, Saunders, Philadelphia, 1990.

CE 461 UE

DISASTER MANAGEMENT
*(*Elective –IV for BME/CSE/CE/ECE/EE/ME)

Instruction	4	Periods per week
Duration of University Examination	3	Hours
University Examination	75	Marks
Sessionals	25	Marks
Credits	4	

Course Objectives:

- To provide students an exposure to disasters, their significance and types.
- To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction
- To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
- To enhance awareness of institutional processes in the country and
- To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity

COURSE OUTCOMES:

- Is exposed to disasters, their significance and types
- Understand the relationship between vulnerability, disasters, disaster prevention and risk reduction and understand impact on Natural and manmade disasters
- Preliminary understanding of approaches of Disaster Risk Reduction (DRR)
- develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity
- Evaluate available Disaster management systems and evolve at better systems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1				1	2	3	1	1	1		1	1	
CO2	2	1	1	1		1	3	1	1	1		1		
CO3	2		1			1	3	1	1	1				
CO4	2					1	3	1	1	1		1		
CO5	2					1	3	1	1	1		1		

UNIT-I

Introduction to Disasters: Concepts and definitions of Disaster, Hazard, Vulnerability, Resilience, Risks.

Natural and Manmade disasters, impact of drought, review of past disasters and drought in India, its classification and characteristics. Classification of drought, causes, Impacts (including social, economic. political, environmental, health, psychosocial, etc.).

UNIT-II

Disaster: Classifications, Causes, Impacts including social, economic, political, environmental, health, psychosocial etc.

Differential Impacts - in terms of caste, class, gender, age, location, disability Global trends in disasters, urban disasters, pandemics, complex emergencies, climate change.

Cyclones and Floods: Tropical cyclones & Local storms, Destruction by tropical cyclones and local storms, Cumulative atmospheric hazards/ disasters, Cold waves, Heat waves, Causes of floods, Rood hazards in India.

UNIT-III

Approaches to Disaster Risk Reduction: Disaster cycle - its analysis, Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural sources, roles and responsibilities of community, Panchayati Raj Institutions/Urban Local Bodies (PRis/ULBs), states, Centre, and other stake-holders.

UNIT-IV

Inter-relationship between Disasters and Development: Factors affecting Vulnerabilities, differential impacts, impact of development projects such as darns, embankments, changes in Land-use etc. Climate Change Adaptation, Relevance of indigenous knowledge, appropriate technology and local resources.

UNIT-V

Disaster Risk Management in India: Hazard and Vulnerability profile of India Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management Institutional arrangements (Mitigation, Response and Preparedness, OM Act and Policy, other related policies, plans, programmes and legislation)

Field Work, Case Studies: The field work is meant for students to understand vulnerabilities and to work on reducing disaster risks and to build a culture of safety. Projects must be conceived creatively based on the geographic location and hazard profile of the region where the college is located.

Suggested Reading:

1. Sharma V. K. (1999). Disaster Management, National Centre for Disaster Management, IIPE, Delhi.
2. Gupta Anil K, and Sreeja S. Nair. (2011). Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi.
3. Nick. (1991). Disaster Management: A Disaster Manager's Handbook. Asian Development Bank, Manila Philippines.
4. Kapur, et al. (2005). Disasters in india Studies of grim reality, Rawat Publishers, Jaipur.
5. Pelling Mark, (2003). The Vulnerability of Cities: Natural Disaster and Social Resilience Earthscan publishers, London.

SERVICE COURSES

ME 471 UE

INDUSTRIAL AND FINANCIAL MANAGEMENT

Instruction (periods per week)	:	4
Duration of University Examination	:	3 Hours
University Examination	:	75 Marks
Sessional	:	25 Marks
Credits	:	4

Course Objectives:

* *To understand various types of organizational structures, manufacturing processes and importance of plant layout and the role of scheduling function in optimizing the utilization of resources*
* *To understand the importance of quality, inventory control and concepts like MRP I and MRP II*
* *To understand the nature of financial management and concepts like breakeven analysis, depreciation and replacement analysis*

Course Outcomes:

- Understand the different phases of product life cycle, types of manufacturing systems, plant layout optimization problems
- Role of scheduling function in better utilization of resources
- Fundamental concepts of quality control, process control, material control and appreciate the importance of MRP-I and MRP –II.
- Know the different terminology used in financial management and apply different techniques of capital budgeting
- Analyse and various types of costs involved in running an industrial organisation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2							1			
CO2	2	2	1	1							2			
CO3	2	2	1	1							2			
CO4	2	2	1	1							2			
CO5	2	2	1	1							2			

Unit-I

Types of organizations, organizational structures. Designing Products, Services and Processes: New product design and development. Product life cycle: phasing multiple products. Manufacturing process Technology: Product, job shop, batch, assembly line and continuous process technology; flexible manufacturing systems.
Design of Services, service process technology operations capacity; capacity planning decisions, measuring capacity; estimating future capacity needs.

Unit-II

Locating production and services facilities, effects of location and costs and revenues, factor rating, simple median model (linear programming)
Layout planning; process layout; product layout — Assembly lines; line balancing manufacturing cellular layout.
Scheduling systems and aggregate planning for production and services; loading assignment algorithm; priority sequencing and other criteria.

Unit-III

Quality planning and Control: basic concepts, definitions and history of quality control. Quality function and concept of quality cycle. Quality policy and objectives. Economics of quality and measurement of the cost of quality. Quality considerations in design.
Process control: machine and process capability analysis. Use of control charts and process engineering techniques for implementing the quality plan. Acceptance sampling: single, double and multiple sampling, operating characteristic Curve - calculation of producers risk and consumers risk.

Unit-IV

Inventory control: deterministic and stochastic inventory models; variable demand; lead time, specific service level, perishable products and service.
Inventory control in application; concepts for the practioners; saving money in inventory systems; ABC classifications.
Inventory control procedures; Quantity - reorders versus periodic inventory systems; material requirement planning (MRP); MRP as a scheduling and ordering system; MRP system components; MRP computational procedure; Detailed capacity planning; MRP - limitation and advantages; Manufacturing Resources Planning (MRP-II).

Unit-V
Elements of cost, overheads, breakeven analysis, depreciation, replacement analysis. Nature of financial management-time value of money, techniques of capital budgeting and method, cost of capital, financial leverage.

Suggested Reading

1. Buifa and Sarin, "Production and operations management" - Wiley Publications.
2. I.M. Pandey, "Elements of Financial Management" Vikas Publications, New Delhi, 1994.
3. James C. Van Home & John, M. Wachowicz, Jr., "Fundamentals of Financial Management", Pearson Education Asia, 11th ed. 2001.