University of Calicut

Scheme and Curriculum

B. Tech. - Mechanical Engineering

2009

B. Tech. Mechanical Engineering

2009 – Scheme & Curriculum

Combined First and Second Semesters (Common for all branches)

Code	Subject	Hours per week			Marks		Sem-end duration-hours	Credits
		L	T	P/D	Internal	Sem End		
EN08 101	Engineering Mathematics I	2	1	-	30	70	3	4
EN08 102	Engineering Mathematics II	2	1	-	30	70	3	4
EN08 103	Engineering Physics	2		-	30	70	3	3
EN08 103(P)	*Physics Lab*	-	-	1	50	50	3	1
EN08 104	Engineering Chemistry	2		-	30	70	3	3
EN08 104(P)	*Chemistry Lab*	-	-	1	50	50	3	1
EN08 105	Engineering Mechanics	2	1	-	30	70	3	4
EN08 106	Basics of Civil & Mechanical Engg.	2	1	-	30	70	3	4
EN08 107	Basics of Electrical, Electronics and Communication Engg.	2	1	-	30	70	3	4
EN08 108	Engineering Graphics	0	-	3	30	70	3	3
EN08 109(P)	*Computer Programming in C*	1	-	1	50	50	3	3
EN08 110A(P)	*Mechanical Workshop*	-	-	2	50	50	3	2
EN08 110B(P)	*Electrical and Civil Workshops*	-	-	2	50	50	3	2
TOTAL		15	5	10				38

Third Semester - Mechanical Engineering

Code	Subject	Hours per week			Marks		Sem-end duration-hours	Credits
		L	T	P/D	Internal	Sem End		
EN09 301	Engineering Maths III	3	1	-	30	70	3	4
EN09 302	Humanities and Communication Skills	2	1	-	30	70	3	3
ME09 303	Fluid Mechanics	4	1	-	30	70	3	5
ME09 304	Computer Assisted Machine Drawing	1	-	3	30	70	3	4
ME09 305	Electrical Technology	3	1	-	30	70	3	4
ME09 306	Metallurgy & Material Science	3	1	-	30	70	3	4
ME09 307(P)	*Electrical Engineering Lab*	-	-	3	50	50	3	2
ME09 308(P)	*Production Engineering Lab-I*	-	-	3	50	50	3	2
TOTAL		16	5	9				28

Fourth Semester - Mechanical Engineering

Code	Subject	Hours per week			Marks		Sem-end duration-hours	Credits
		L	T	P/D	Internal	Sem End		
EN09 401A	Engineering Maths IV	3	1	-	30	70	3	4
EN09 402	Environmental Science	2	1	-	30	70	3	3
ME09 403	Mechanics of Solids	4	1	-	30	70	3	5
ME09 404	Casting and Joining	3	1	-	30	70	3	4
ME09 405	Fluid Machinery	3	1	-	30	70	3	4
ME09 406	Thermodynamics	3	1	-	30	70	3	4
ME09 407(P)	*Material Testing Lab*	-	-	3	50	50	3	2
ME09 408(P)	*Production Engineering Lab-II*	-	-	3	50	50	3	2
TOTAL		18	6	6				28

Fifth Semester - Mechanical Engineering

Code	Subject	Hours per week			Marks		Sem-end duration-hours	Credits
		L	T	P/D	Internal	Sem End		
ME09 501	Heat and Mass Transfer	4	1	-	30	70	3	5
ME09 502	Advanced Mechanics of Solids	3	1	-	30	70	3	4
ME09 503	Engineering Economics and Principles of Management	3	1	-	30	70	3	4
ME09 504	IC Engines and Gas Turbines	3	1	-	30	70	3	4
ME09 505	Mechanics of Machinery	3	1	-	30	70	3	4
ME09 506	Metal Cutting and Forming	2	1	-	30	70	3	3
ME09 507(P)	*Fluids Lab*	-	-	3	50	50	3	2
ME09 508(P)	*Thermal Lab-I*	-	-	3	50	50	3	2
TOTAL		18	6	6				28

Sixth Semester - Mechanical Engineering

Code	Subject	Hours per week			Marks		Sem-end duration-hours	Credits
		L	T	P/D	Internal	Sem End		
ME09 601	Dynamics of Machinery	4	1	-	30	70	3	5
ME09 602	Finite Element Method	3	1	-	30	70	3	4
ME09 603	Machine Design - I	3	1	-	30	70	3	4
ME09 604	Operation Research	3	1	-	30	70	3	4
ME09 605	Computer Integrated Manufacturing	2	1	-	30	70	3	3
ME09 Lxx	Elective - I	3	1	-	30	70	3	4
ME09 607(P)	*Mini Project / Lab*	-	-	3	50	50	3	2
ME09 608(P)	*Thermal Lab-II*	-	-	3	50	50	3	2
TOTAL		18	6	6				28

Electives (Sixth Semester):

ME09 L01	Composite Materials
ME09 L02	Computational Methods in Engineering
ME09 L03	Industrial Maintenance
ME09 L04	Mechatronics
ME09 L05	Tool Engineering and Design

Seventh Semester - Mechanical Engineering

Code	Subject	Hours per week			Marks		Sem-end duration-hours	Credits
		L	T	P/D	Internal	Sem End		
ME09 701	Machine Design - II	4	1	-	30	70	3	5
ME09 702	Operations Management	3	1	-	30	70	3	4
ME09 703	Metrology and Instrumentation	2	1	-	30	70	3	3
ME09 704	Power Plant Engineering	2	1	-	30	70	3	3
ME09 Lxx	Elective - II	3	1	-	30	70	3	4
ME09 Lxx	Elective - III	3	1	-	30	70	3	4
ME09 707(P)	*CAD Lab*	-	-	3	50	50	3	2
ME09 708(P)	*Instrumentation Lab*	-	-	3	50	50	3	2
ME09 709(P)	*Project*	-	-	1	100	-	-	1
TOTAL		17	6	7				28

Eighth Semester - Mechanical Engineering

Code	Subject	Hours per week			Marks		Sem-end duration-hours	Credits
		L	T	P/D	Internal	Sem End		
ME09 801	Refrigeration and Air Conditioning	4	1	-	30	70	3	5
ME09 802	Compressible Fluid Flow	2	1	-	30	70	3	3
ME09 Lxx	Elective - IV	3	1	-	30	70	3	4
ME09 Lxx	Elective - V	3	1	-	30	70	3	4
ME09 805(P)	*Seminar*	-	-	3	100	-	3	2
ME09 806(P)	*Project*	-	-	11	100	-	3	7
ME09 807(P)	*Viva Voce*	-	-	-	-	100	-	3
TOTAL		12	4	14				28

Electives (Seventh and Eighth Semester):

ME09 L06	Aerospace Engineering
ME09 L07	Automobile Engineering
ME09 L08	Combustion Engineering
ME09 L09	Computational Fluid Dynamics
ME09 L10	Computerised Materials Management
ME09 L11	Control System Engineering
ME09 L12	Cryogenic Engineering
ME09 L13	Design of Heat Transfer Equipments
ME09 L14	Design of Jigs and Fixtures
ME09 L15	Design of Pressure Vessels and Piping
ME09 L16	Financial Management
ME09 L17	Fracture Mechanics
ME09 L18	Heating, Ventilation and Air-conditioning Design
ME09 L19	Industrial Automation
ME09 L20	Industrial Tribology
ME09 L21	Logistics and Supply Chain Management
ME09 L22 *	Quality Engineering and Management
ME09 L23 *	Industrial Safety Engineering
ME09 L24 *	Marketing Management

ME09 L25 *	Energy Engineering and Management

(* Global)

GLOBAL ELECTIVES:

PE09 L25	Entrepreneurship
EC09 L25	Bio-medical Instrumentation
CS09 L23	Simulation and Modelling
CE09 L23	Experimental Stress Analysis
EE09 L22	Soft Computing Techniques
EE09 L25	Robotics and Automation
CH09 L22	Solid Waste Management
CH09 L24	Industrial Pollution Control
CH09 L25	Project Engineering
BM09 L24	Virtual Instrumentation
IT09 L24	Management Information Systems
AM09 L25	Technology Forecasting
BT09 L25	Biomaterials
AI09 L23	Microelectronic Electro-Mechanical Systems
AN09 L25	Research Methodology

University of Calicut

Syllabus: 3rd – 8th semesters

B. Tech. - Mechanical Engineering

2009

EN09 301: Engineering Mathematics III

(Common for all branches)

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objective

This course provides a quick overview of the concepts and results in complex analysis that may be useful in engineering. Also it gives an introduction to linear algebra and Fourier transform which are wealths of ideas and results with wide area of application.

Module I: Functions of a Complex Variable (13 hours)

Functions of a Complex Variable – Limit – Continuity – Derivative of a Complex function – Analytic functions – Cauchy-Riemann Equations – Laplace equation – Harmonic Functions – Conformal Mapping – Examples: Z^n, sinz, cosz, sinhz, coshz, $(z+{}^1/_z)$– Mobius Transformation.

Module II: Functions of a Complex Variable (14 hours)

Definition of Line integral in the complex plane – Cauchy's integral theorem (Proof of existence of indefinite integral to be omitted) – Independence of path – Cauchy's integral formula – Derivatives of analytic functions (Proof not required) – Taylor series – Laurent series – Singularities and Zeros – Residues – Residue Integration method – Residues and Residue theorem – Evaluation of real integrals.

Module III: Linear Algebra (13 hours) - Proofs not required

Vector spaces – Definition, Examples – Subspaces – Linear Span – Linear Independence – Linear Dependence – Basis – Dimension – Ordered Basis – Coordinate Vectors – Transition Matrix – Orthogonal and Orthonormal Sets – Orthogonal and Orthonormal Basis – Gram-Schmidt orthogonolisation process – Inner product spaces –Examples.

Module IV: Fourier Transforms (14 hours)

Fourier Integral theorem (Proof not required) – Fourier Sine and Cosine integral representations – Fourier Transforms – Fourier Sine and Cosine Transforms – Properties of Fourier Transforms.

Reference books

1. H S Kasana, *Complex Variables, Theory and Applications,* 2e, Prentice Hall of India.
2. John M Howie, *Complex Analysis,* Springer International Edition.
3. Shahnaz bathul, *Text book of Engineering Mathematics, Special functions and Complex Variables,* Prentice Hall of India.
4. Gerald Dennis Mahan, *Applied mathematics*, Springer International Edition.
5. David Towers, *Guide to Linear Algebra*, MacMillan Mathematical Guides.
6. Howard Anton, Chris Rorres, *Elementary Linear Algebra, Applications Version, 9e*, John Wiley and Sons.
7. Anthony Croft, Robert Davison, Martin Hargreaves, *Engineering Mathematics*, 3e, Pearson Education.
8. H Parthasarathy, *Engineering Mathematics, A Project & Problem based approach*, Ane Books India.
9. B V Ramana, *Higher Engineering Mathematics*, McGrawHill.
10. Sarveswara Rao Koneru, *Engineering Mathematics*, Universities Press.
11. J K Sharma, *Business Mathematics, Theory and Applications*, Ane Books India.
12. John bird, *Higher Engineering Mathematics*, Elsevier, Newnes.
13. M Chandra Mohan, Vargheese Philip, *Engineering Mathematics-Vol. I, II, III & IV.,* Sanguine Technical Publishers.
14. N Bali, M Goyal, C Watkins, *Advanced Engineering Mathematics, A Computer Approach, 7e*, Infinity Science Press, Fire Wall Media.

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A:	*Short answer questions (one/two sentences)* All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.	*5 x 2 marks=10 marks*
PART B:	*Analytical/Problem solving questions* Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.	*4 x 5 marks=20 marks*
PART C:	*Descriptive/Analytical/Problem solving questions* Two questions from each module with choice to answer one question.	*4 x 10 marks=40 marks*

Maximum Total Marks: 70

EN09 302: Humanities and Communication Skills

(Common to all branches)

Teaching scheme **Credits:** 3

2 hours lecture and 1 hour tutorial per week

Objectives

- *To identify the most critical issues that confronted particular periods and locations in history;*
- *To identify stages in the development of science and technology;*
- *to understand the purpose and process of communication;*
- *to produce documents reflecting different types of communication such as technical descriptions, proposals ,and reports;*
- *To develop a positive attitude and self-confidence in the workplace; and*
- *To develop appropriate social and business ethics.*

Module I (8 hours)

Humanities, Science and Technology: Importance of humanities to technology, education and society- Impact of science and technology on the development of modern civilization.
Contributions of ancient civilization: Chinese, Indian, Egyptian and Greek.
Cultural, Industrial, Transportation and Communication revolutions.
Advances in modern India: Achievements in information, communication and space technologies.

Module II (9 hours)

Concept of communication: The speaker/writer and the listener/reader, medium of communication, barriers to communication, accuracy, brevity, clarity and appropriateness
Reading comprehension: Reading at various speeds, different kinds of text for different purposes, reading between lines.
Listening comprehension: Comprehending material delivered at fast speed and spoken material, intelligent listening in interviews
Speaking: Achieving desired clarity and fluency, manipulating paralinguistic features of speaking, task oriented, interpersonal, informal and semi formal speaking, making a short classroom presentation.
Group discussion: Use of persuasive strategies, being polite and firm, handling questions and taking in criticisms on self, turn-taking strategies and effective intervention, use of body language.

Module III (10 hours)

Written Communication : Note making and taking, summarizing, notes and memos, developing notes into text, organization of ideas, cohesion and coherence, paragraph writing, ordering information in space and time, description and argument, comparison and contrast, narrating events chronologically. Writing a rough draft, editing, proof reading, final draft and styling text.
Technical report writing: Synopsis writing, formats for reports. Introductory report, Progress report, Incident report, Feasibility report, Marketing report, Field report and Laboratory test report
Project report: Reference work, General objective, specific objective, introduction, body, illustrations using graphs, tables, charts, diagrams and flow charts. Conclusion and references
Preparation of leaflets, brochure and C.V.

Module IV (9 hours)

Human relations and Professional ethics: Art of dealing with people, empathy and sympathy, hearing and listening. Tension and stress, Methods to handle stress
Responsibilities and rights of engineers- collegiality and loyalty – Respect for authority – Confidentiality – conflicts of interest – Professional rights, Rights of information, Social responsibility

Senses of ethics – variety of moral issues – Moral dilemma – Moral autonomy – Attributes of an ethical personality – right action – self interest

Reference Books

1. Meenakshi Raman and Sangeeta Sharma, *Technical Communication- Principles and Practice* Oxford University press, 2006
2. Jayashree Suresh and B S Raghavan, *Professional Ethics*, S Chand and Company Ltd, 2005
3. Subrayappa, *History of Science in India*, National Academy of Science, India
4. R C Bhatia, *Business Communication*, Ane Books Pvt. Ltd, 2009
5. Sunita Mishra and C Muralikrishna, *Communicatin Skils for Engineers*, Pearson Education, 2007.
6. Jovan van Emden and Lucinda Becker, *Effective Communication for Arts and Humanities Students*, Palgrave macmillam, 2009
7. W C Dampier, *History of Science*, Cambridge University Press
8. Vesilind, *Engineering, Ethics and the Environment*, Cambridge University Press
9. Larson E, *History of Inventions*, Thompson Press India Ltd.
10. Bernal J.D, *Science in History*, Penguin Books Ltd

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 303: Fluid Mechanics

Teaching scheme **Credits: 5**

4 hours lecture and I hour tutorial per week

Objective

- *To study the physical behavior of fluids and fluid systems, and laws governing this behavior*
- *To study the action of forces on fluids and of the resulting flow pattern*

Module I (18 hours)

Fundamentals Concepts : Characteristics of fluids – continuum – properties of fluids – density, specific weight, specific volumes, specific gravity, viscosity, capillarity, compressibility and bulk modulus, surface tension, vapour pressure-Gas laws-thermodynamic relations.

Fluid Statics : Pressure – Pascal's law-Hydrostatic law-variation of pressure in static fluids –absolute and gauge pressures – measurement of high and low pressures – manometers – forces on bodies and surfaces submerged in fluids – Buoyancy and flotation- stability of bodies submerged and floating in fluids – metacentric height.

Module II (16 hours)

System and control volume approach - basic equations – Reynold's transport equations – differential and integral form of continuity , momentum and energy equations – application of the above equations for one dimensional flow – velocity and momentum corrections - one dimensional flow along streamline and stream tubes - Euler's equation - Bernoulli's equation – applications - Venturimeter, Orificemeter, Pitot tube, Orifice , Mouthpiece, Notches and weirs.

Module III (20 hours)

Fluid Kinematics – Eulerian and Lagrangian flow descriptions – classification of fluid flow – graphical description of flow pattern – stream lines , path lines, streak lines, stream tubes – velocity and acceleration in fluid flow.

Ideal fluids – rotational and irrotational flow – circulation and vorticity – stream function and potential function – basic flow fields – rectilinear flow - source and sink . Flow through pipes – Reynold's experiment - laminar and turbulent flow – critical Reynold's number – laminar flow in circular pipes – Haygen - Poiscille law – turbulent flows in circular pipes – Darcey - Weisbach equations – Eddy properties – Minor losses in pipes – total head - pressure lines .

Module IV (18 hours)

Boundary layer – Introduction –boundary layer over flat plate – continuity and momentum equations for laminar boundary layer – boundary layer thickness – velocity profile – integral solutions of momentum equations –Von-karman equation-Blasius equation-prandtl's equations- boundary layer on immersed bodies – drag and lift – skin friction – boundary layer separation

Introduction to turbulance, classification, scales of turbulance - Reynold's stresses- turbulance models-Prandtl mixing length concept.

Text Books

1. Douglas, *Fluid Mechanics*, Pearson Education
2. D. S. Kumar, *Fluid Mechanics*, S K Kataria & Sons

Reference Books

1. F. M. White, *Fluid Mechanics*, 5th Edition, McGraw Hill
2. I. H. Shames, *Fluid Mechanics*,4th Edition, McGraw Hill
3. S. K. Som, G. Biswas, *Fluid Mechanics*, Tata McGraw Hill
4. Fox, *Introduction to Fluid Mechanics*, Eastern Wiley.
5. D. Ramadingeih, *Fluid Mechanics*, New Age International

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: Short answer questions (one/two sentences) *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: Analytical/Problem solving questions *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: Descriptive/Analytical/Problem solving questions *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 304: Computer Assisted Machine Drawing

Teaching scheme **Credits:4**

3 hours practical and 1 hour theory per week

Objectives : *To impart the fundamental concepts of machine drawing.*

- *To develop primary knowledge of working drawings.*
- *To produce orthographic drawing of different machine parts.*
- *To develop skill to produce assembly drawings.*
- *To develop skill to produce detailed drawings of machines parts from assembly drawing.*
- *To develop skill to produce drawings by using any standard CAD software.*

Module I (12 hours - 1 Printout, 2 Drawing sheets)

a) Joints : Bolted joints using hexagonal, square and stud bolts and nuts : Types of cotters and pins - Sleeve and cotter joints - Strap joint and knuckle joints, Pipe joints : Socket and spigot joints – Flanged hydraulic joints – Union joints, Rivet heads : Types of riveting - Lap and butt joint – Zigzag and chain structure - Boiler joints.

b) Couplings and pulleys: Types of shaft keys and their proportions: Solid and split muff couplings - Protected and flexible type - Claw coupling - Universal coupling, Pulleys: Flat pulleys - V-pulleys - Stepped cone pulleys.

Module II (26 Hrs. - 2 Printouts, 4 Drawing sheets)

a) Tolerances and Fits - Limits and tolerances of machine parts - Hole system and shaft system of tolerances - Designation of fundamental deviation - Types of fits and their selection - Indication of dimensional tolerances and fits on simple machine parts - Geometrical tolerances - Recommended symbols - Indication of geometrical tolerances on simple machine parts - Surface roughness - Indication of surface finish on drawings - Preparation of shop floor drawings of simple machine parts.

b) Bearings - Solid journal bearings - Bushed bearings - Plummer block and footstep bearings - Types of rolling contact bearings - Conventional representation of ball and roller bearings - Assembly of radial and thrust type rolling contact bearings in housing. (Scaled drawings of machine parts or their assembly showing dimensional tolerance are to be prepared.)

Module III (34 Hrs. - 3 Printouts, 4 Drawing sheets)

a) Assembly Drawings: Engine parts and other machine parts – stuffing boxes - cross heads – Eccentrics - Petrol Engine connecting rod - Piston assembly - Screws jacks - Machine Vices – Tailstock – Crane hook.
b) Assembly Drawings: Steam stop valve - Spring loaded safety valve – Blow-off-cock - Gate valve- Glob valve- Ball valve- Non return valve (Scaled drawings of assembled views are to be practiced).

Note:

- *Drawing practical classes have to be conducted by using any standard CAD software and using drawing instruments in alternative weeks (3 Hours) preferably for each half of the students. Semester End examination (3 Hours) shall be conducted by using drawing instruments only.*
- *All drawing exercises mentioned above are for class work. Additional exercises where ever necessary may be given as home assignments.*

References:

1. N.D. Bhatt and Panchal, *Machine Drawing,* Charator Publishing House.
2. Gautam Pohit & Gautam Ghosh, *Machine Drawing with AUTO CAD*, Pearson Education, New Delhi.
3. K.C. John, Machine *Drawing*, Jet Publications, Thrissur.
4. N.D.Junnarkar, *Machine Drawing*, Pearson Education, New Delhi.
5. P.I.Vargheese, *Machine Drawing, VIP Publishers, Thrissur*

Internal Assessment

Printouts (Best 5)	05x02	=	10
Drawing sheets (Best 8)	08x01	=	08
Tests (Best 2)	02x05	=	10
Attendance and Regularity		=	02
Total		=	30

University examination pattern

Question I: Two questions of 15 marks each from (a) and (b) sections of module I.

Question II: Two questions of 20 marks each from (a) and (b) sections of module II.

Question III: Two questions of 35 marks each from (a) and (b) sections of module III.

Total = 70 marks

ME09 305: Electrical Technology

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To study the performance of different dc and ac machines*
- *To familiarise various electrical measuring instruments*
- *To give an overview of electric drives and power electronic control scheme*

Module I (12hours)

Review of DC generators – DC generator on no load – open circuit characteristics – basics of armature reaction and commutation – load characteristics of shunt, series and compound generators – Review of dc motors – characteristics of shunt, series and compound motors – starter – 3 point and 4 point starters – losses in DC machines – power flow diagram – efficiency – applications of DC motors.

Module II (12 hours)

Review of transformers – Real transformer – winding resistance and leakage reactance – equivalent circuit – phasor diagram – voltage regulation – losses and efficiency – open circuit and short circuit test – Autotransformer – saving of copper – 3 phase transformer - Δ-Δ, Y-Y, Δ - Y, Y - Δ connections – applications.

Principle of indicating instruments – moving coil, moving iron and dynamometer type instruments – extension of range of ammeter and voltmeter using current transformer and voltage transformer – principle and working of induction type energy meter

Module III (15hours)

Review of alternators – distribution and chording factor – EMF equation – armature reaction – phasor diagram – voltage regulation – predetermination of voltage regulation by EMF method (7 Hrs.)

Review of 3-phase induction motor – slip – rotor frequency – equivalent circuit – phasor diagram – torque equation – torque-slip characteristics – losses and efficiency – power flow diagram – no-load and blocked rotor tests – starting of 3-phase induction motors – direct-on-line, auto transformer, star-delta and rotor resistance starting..(8 Hrs.)

Module IV (15 hours)

Electrical Drives - Parts of electrical drives - Choice of electric drives - Status of DC and AC drives - Dynamics of Electric drives - Fundamental torque equations – Speed torque conventions and multiquadrant operation - Components of load torque - Nature and classification of load torque - Steady-state stability – load equalisation. (7 Hrs.)

Power semiconductor devices - Symbol and control characteristics of SCR – comparison of SCR, TRIAC, MOSFET and IGBT – Basic concepts of Rectifier (AC-DC) , Inverter (DC-AC) and Choppers (DC-DC) (no derivations) - Chopper control of separately excited dc motor - Three phase Induction motor drives - Stator voltage control - Frequency control - Voltage and frequency control (8 Hrs.)

Text Books

1. Vincent Del Toro, *Electrical Engineering Fundamentals*, Prentice-Hall of India
2. Hughes, *Electrical technology*, Tata Mc Graw Hill
3 Dubey G.K., Fundamentals a/Electrical Drives, Narosa

Reference Books

1. K. Sawhney, *Electrical and Electronics measuring Instruments*, Dhanpat Rai & Sons.
2. P.S. Bhimbra, *Electrical Machinery*, Khanna Publishers

3 K. Murukosh Kumar, *DC machines and Transformers*, Vikas Publishing house Pvt Ltd

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 306: Metallurgy and Material Science

Teaching scheme **Credits: 4**
3 hours lecture and I hour tutorial per week

Objective:

- *To impart knowledge on engineering materials, deformation of the crystals, equilibrium diagrams of selected alloy systems, heat treatment of steels, properties of steels, cast iron and other alloys, and its application*

Module I (10 hours)
Introduction to materials science and engineering-Materials classification- Atomic structure and bonding -Primary Secondary bonding-Ionic, metallic, covalent, hydrogen-bonding- Crystallography -SC, FCC,BCC,HCP structures-APF-Miller indices-miller bravais indices- polymorphism- allotropy- density computations-Crystal structure determination-X-ray diffraction techniques- Microscopic examination-Specimen preparation-etching- Metallurgical microscope-SEM-TEM-Grain size determination

Module II (15 hours)
Imperfections in crystals- point defects, line defects, surface defects-Mechanical behavior of materials-Elastic, visco elastic, anelastic behavior-Plastic Deformation of Metals and Alloys- Mechanisms of plastic deformation, role of Dislocation; slip and twinning- Schmids law Strengthening mechanisms-grain size reduction-solid solution strengthening-Work hardening; recovery recrystallisation and grain growth Diffusion-laws of diffusion- Mechanisms of diffusion- applications-Fracture- ductile fracture, brittle fracture, fracture toughness, BT- Fatigue-s-n curve- creep- creep curve

Module III (15 hours)
Solidification of metals and alloys- Solid solution, Hume Rothery's rules-Phase diagrams- Phase and Lever Rules relationship of micro Structure and properties -Isomorphous systems- Cu-Ni -eutectic system- Pb-Sn- eutectoid - peritectic reactions- Iron- Carbon equilibrium diagram. Development of microstructure in Iron Carbon alloys, Phase transformation in steel. TTT diagram, Heat treatment of steel, Annealing, tempering, austempering, martempering, Hardenability, Jomni test- surface hardening methods

Module IV (14 hours)
Applications of ferrous and non ferrous alloys-steel- low, medium, high carbon steels-Stainless steels-ferritic, austenitic, martensitic, duplex steels-tool steels cast iron- gray, white, ductile cast irons- copper and its alloys- aluminium and its alloys-magnesium and alloys- titanium and its alloys-refractories- super alloys-ceramics-PZT -PZLT-refractories-composite and glasses-shape memory alloys- Nano materials-bio materials-Optical fibers

Text Books
1. William D Callister, *Material science and engineering,*
2. Raghavan V, *Material science and engineering,*

Reference Books
1. Shackelford, *Materials science for Engineers,*
2. Van Vlack, *Materials science and Engineering,*

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: Short answer questions (one/two sentences) *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: Analytical/Problem solving questions *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: Descriptive/Analytical/Problem solving questions *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 307(P): Electrical Technology Lab

Teaching Scheme **Credits**: 2

3 hours per week

Objectives

- *To familiarize various electrical measurement equipments and measurement methods*
- *To obtain the performance characteristics of dc and ac machines*

1. Calibration of single phase energy meter (Induction and Static type) by direct loading
2. Load test on DC shunt generator
    a. Plot external characteristics
    b. Deduce internal characteristics
3. Load test on 3-phase squirrel cage induction motor.
4. Load test on DC series motor
    a. Plot the performance characteristics
5. Measurement of 3-phase power by using two-wattmeter method.
6. Determination of V-I characteristics of linear resistance and incandescent lamp
7. No-load and blocked rotor tests on slip ring induction motor
    a. Determine equivalent circuit parameters
    b. Predetermine the torque, line current and efficiency from equivalent circuit corresponding to a specified slip.
8. Measurement of L,M & K of i) transformer windings and ii) air core coil.
9. OC & SC tests on 3-phase alternator
    a. Predetermine the voltage regulation at various loads and different power factors by EMF method.
10. Load test on single phase transformer
    a. Determine efficiency and regulation at various loads and unity power factor.
11. OC & SC tests on single phase transformer
    a. Determine equivalent circuit parameters
    b. Predetermine efficiency and regulation at various loads and different power factors.
12. Open circuit characteristics of dc shunt generator
    a. Plot OCC of rated speed
    b. Predetermine OCC for other speeds
    c. Determine critical field resistance for a specified speed
    d. Determine critical speed for a specified shunt field resistance

Internal Continuous Assessment *(Maximum Marks-50)*

60%-Laboratory practical and Record (30 marks)
30%- Test/s (15 marks)
10%- Regularity in the class (5 marks)

Semester End Examination *(Maximum Marks-50)*

70% - Procedure, conducting experiment, results, tabulation, and inference (35 marks)
20% - Viva voce (10 marks)
10% - Fair record (5 marks)

ME09 308(P): Production Engineering Lab – I

Teaching scheme **Credits:** 2

3 hours practical per week

Objectives

- *To acquaint with the basics of centre lathe and CNC lathe.*
- *To impart training on centre lathe and CNC lathe.*

1. Study of machine tools and machining processes – specification of machine tools – power sources.
2. Study of centre lathe – general features, parts and functions – different machining operations on centre lathe – turning, taper turning, thread cutting, drilling, boring, reaming, tapping, profile turning, knurling.
3. Study of tolerances and surface finish – measuring tools and gauges.
4. Study of tolerances and surface finish – measuring tools and gauges.
5. Exercises: on centre lathe requiring simple turning, taper turning, knurling, boring and thread cutting.
6. Exercises on centre lathe including multi-start thread, square thread, and internal thread.
7. Study of CNC lathe.
8. Exercises on CNC lathe: Turning, step turning

Reference Books

1. W. A. J. Chapman, *Workshop Technology Part I*, ELBS & Edward Arnold Publishers.
2. R. Quesada, T. Jeyapoovan, *Computer Numerical Control*, Pearson Education
3. J. Anderson, *Shop Theory*, Tata McGraw Hill.
4. K. Venkata Reddy, *Workshop Practical*, Vipaka Publishers
5. E. D. Lawrence, *Manufacturing Processes & Materials for Engineers*, Prentice Hall

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Workshop practicals and Record (30 marks)
30% - Test/s (15 marks)
10% - Regularity in the class (5 marks)

Semester End Examination *(Maximum Marks-50)*

70% - Procedure, conducting experiment, results, tabulation, and inference (35 marks)
20% - Viva voce (10 marks)
10% - Fair record (5 marks)

EN09 401A: Engineering Mathematics IV

(Common for ME, CE, PE, CH, BT, PT, AM, and AN)

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objective

The use of probability models and statistical methods for analyzing data has become common practice in virtually all scientific disciplines. Two modules of this course attempt to provide a comprehensive introduction to those models and methods most likely to be encountered and used by students in their careers in engineering. A broad introduction to some important partial differential equations is also included to make the student get acquainted with the basics of PDE.

Module I: Probability Distributions (13 hours)

Random variables – Mean and Variance of probability distributions – Binomial Distribution – Poisson Distribution – Poisson approximation to Binomial distribution – Hyper Geometric Distribution – Geometric Distribution – Probability densities – Normal Distribution – Uniform Distribution – Gamma Distribution.

Module II: Theory of Inference (14 hours)

Population and Samples – Sampling Distribution – Sampling distribution of Mean (σ known) – Sampling distribution of Mean (σ unknown) – Sampling distribution of Variance – Interval Estimation – Confidence interval for Mean – Null Hypothesis and Tests of Hypotheses – Hypotheses concerning one mean – Hypotheses concerning two means – Estimation of Variances – Hypotheses concerning one variance – Hypotheses concerning two variances – Test of Goodness of fit.

Module III: Series Solutions of Differential Equations (14 hours)

Power series method for solving ordinary differential equations – Legendre's equation – Legendre polynomials – Rodrigue's formula – Generating functions – Relation between Legendre polynomials – Orthogonality property of Legendre polynomials (Proof not required) – Frobenius method for solving ordinary differential equations – Bessel's equation – Bessel functions – Generating functions – Relation between Bessel functions – Orthogonality property of Bessel functions (Proof not required).

Module IV: Partial Differential Equations (13 hours)

Introduction – Formation of PDE – Complete Solution – Equations solvable by direct integration – Linear PDE of First order, Legrange's Equation: $Pp + Qq = R$ – Non-Linear PDE of First Order, $F(p,q) =0$, Clairaut's Form: $z = px + qv + F(p,q)$, $F(z,p,q) =0$, $F_1(x,q) = F_2(y,q)$ – Classification of Linear PDE's – Derivation of one dimensional wave equation and one dimensional heat equation – Solution of these equation by the method of separation of variables – D'Alembert's solution of one dimensional wave equation.

Text Books

Module I:
Richard A Johnson, CB Gupta, *Miller and Freund's Probability and statistics for Engineers, 7e*, Pearson Education- Sections: 4.1, 4.2, 4.3, 4.4, 4.6, 4.8, 5.1, 5.2, 5.5, 5.7

Module II:
Richard A Johnson, CB Gupta, *Miller and Freund's Probability and statistics for Engineers, 7e*, Pearson Education- Sections: 6.1, 6.2, 6.3, 6.4, 7.2, 7.4, 7.5, 7.8, 8.1, 8.2, 8.3, 9.5

Module III:
Erwin Kreysig, *Advanced Engineering Mathematics, 8e*, John Wiley and Sons, Inc.-
Sections: 4.1, 4.3, 4.4, 4.5

Module IV:
N Bali, M Goyal, C Watkins, *Advanced Engineering Mathematics, A Computer Approach, 7e*, Infinity Science Press, Fire Wall Media- Sections: 16.1, 16.2, 16.3, 16.4, 16.5, 16.6, 16.7, 16.8, 16.9
Erwin Kreysig, *Advanced Engineering Mathematics, 8e*, John Wiley and Sons, Inc.
Sections: 11.2, 11.3, 11.4, 9.8 Ex.3, 11.5

Reference books

18. William Hines, Douglas Montgomery, avid Goldman, Connie Borror, *Probability and Statistics in Engineering*, 4e, John Wiley and Sons, Inc.
19. Sheldon M Ross, *Introduction to Probability and Statistics for Engineers and Scientists*, 3e, Elsevier, Academic Press.
20. Anthony Croft, Robert Davison, Martin Hargreaves, *Engineering Mathematics*, 3e, Pearson Education.
21. H Parthasarathy, *Engineering Mathematics, A Project & Problem based approach*, Ane Books India.
22. B V Ramana, *Higher Engineering Mathematics*, McGrawHill.
23. Sarveswara Rao Koneru, *Engineering Mathematics*, Universities Press.
24. J K Sharma, *Business Mathematics, Theory and Applications*, Ane Books India.
25. John bird, *Higher Engineering Mathematics*, Elsevier, Newnes.
26. M Chandra Mohan, Vargheese Philip, *Engineering Mathematics-Vol. I, II, III & IV.*, Sanguine Technical Publishers.
27. Wylie C.R and L.C. Barret, *Advanced Engineering Mathematics*, McGraw Hill.
28. V R Lakshmy Gorty, *Advanced Engineering Mathematics-Vol. I, II.*, Ane Books India.

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A:	*Short answer questions (one/two sentences)* All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.	*5 x 2 marks=10 marks*
PART B:	*Analytical/Problem solving questions* Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.	*4 x 5 marks=20 marks*
PART C:	*Descriptive/Analytical/Problem solving questions* Two questions from each module with choice to answer one question.	*4 x 10 marks=40 marks*

Maximum Total Marks: 70

EN09 402: Environmental Science

(Common for all branches)

Teaching scheme **Credits:** 3

2 hours lecture and 1 hour tutorial per week

Objectives

- *To understand the problems of pollution, loss of forest, solid waste disposal, degradation of environment, loss of biodiversity and other environmental issues and create awareness among the students to address these issues and conserve the environment in a better way.*

Module I (8 hours)

The Multidisciplinary nature of environmental science. Definition-scope and importance-need for public awareness. Natural resources. Renewable and non-renewable resources: Natural resources and associated problems-forest resources: Use and over exploitation, deforestation, case studies. Timber extraction, mining, dams and their defects on forests and tribal people- water resources: Use and over utilization of surface and ground water, floods, drought ,conflicts over water, dams-benefits and problems.- Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.- Food resources: World food problems, changes caused by agriculture over grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.-Energy resources: Growing energy needs, renewable and non-renewable energy resources, use of alternate energy resources, Land resources: Land as a resource, land degradation, man induced land slides, soil erosion and desertification.

Module II (8 hours)

Ecosystems-Concept of an ecosystem-structure and function of an ecosystem – producers, consumers, decomposers-energy flow in the ecosystem-Ecological succession- Food chains, food webs and Ecological pyramids-Introduction, types, characteristics features, structure and function of the following ecosystem-Forest ecosystem- Grassland ecosystem –Desert ecosystem-Aquatic ecosystem(ponds, streams, lakes, rivers, oceans , estuaries)

Biodiversity and its consideration

Introduction- Definition: genetic, species and ecosystem diversity-Biogeographical; classification of India –value of biodiversity: consumptive use, productive use, social ethical , aesthetic and option values Biodiversity at Global, national , and local level-India at mega –diversity nation- Hot spot of biodiversity-Threats to biodiversity: habitat loss, poaching of wild life, man , wild life conflicts – Endangered and endemic species of India-Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity.

Module III (10 hours)

Environmental pollution

Definition-Causes, effects and control measures of Air pollution- Water pollution –soil pollution-Marine pollution-Noise pollution-Thermal pollution-Nuclear hazards-Solid waste management: Causes, effects and control measures of urban and industrial wastes-Role of an individual in prevention of pollution-pollution case studies-Disaster management: floods , earth quake, cyclone and landslides-Environmental impact assessment

Module IV (10 hours)

Environment and sustainable development-Sustainable use of natural resources-Conversion of renewable energy resources into other forms-case studies-Problems related to energy and Energy auditing-Water conservation, rain water harvesting, water shed management-case studies-Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust-Waste land reclamation-Consumerism and waste products-Reduce, reuse and recycling of products-Value education.

Text Books

1. Clark,R.S.Marine pollution,Clanderson Press Oxford.
2. Mhaskar A. K. Matter Hazrdous, Techno-science Publications.
3. Miller T. G. Jr., Environmental Science, Wadsworth Publishing Co.
4. Townsend C., Harper J, Michael Begon, Essential of Ecology, Blackwell Science
5. Trivedi R. K., Goel P. K., Introduction to Air Pollution, Techno-Science Publications.

Reference Books

1. Raghavan Nambiar,K Text book of Environmental Studies,Scitech Publishers(India) Pvt. Ltd
2. Bharucha Erach, Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India, Email: mapin@icenet.net
3. Cunningham, W.P., Cooper, T.H., Gorhani, E & Hepworth, M.T. 2001 Environmental Encyclopedia Jaico publ. House Mumbai 1196p
4. Down to Earth, Centre for Science and Environment
5. Hawkins, R.E. Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay
6. Mckinney, M.L. & School, R.M. 1996. Environmental Science system & Solutions, Web enhanced edition, 639p.
7. Odum, E.P. 1971. Fundamentals of Ecology. W.B.Saunders Co. USA, 574p
8. Rao, M.N. & Datta, A.K 1987. Waste Water treatment. Oxford & IBH Publ. Co. Pvt. Ltd., 345p
9. Survey of the Environment, The Hindu (M)
10. Wagner.K.D. 1998. Environmental Management. W.B. Saunders Co. Philadelphia, USA 499p

*M Magazine

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as Report of field work, literature survey, seminar etc.
10% - Regularity in the class

Note: Field work can be a visit to a local area to document environmental assets-river/forest/grass land/mountain or Visit to local polluted site-urban/rural/industrial/agricultural etc. or Study of common plants, insects, birds etc. or Study of simple ecosystems-pond, river, hill slopes etc. or mini project work on renewable energy and other natural resources , management of wastes etc.

University Examination Pattern

PART A:	*Short answer questions (one/two sentences)* All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.	*5 x 2 marks=10 marks*
PART B:	*Analytical/Problem solving questions* Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.	*4 x 5 marks=20 marks*
PART C:	*Descriptive/Analytical/Problem solving questions* Two questions from each module with choice to answer one question.	*4 x 10 marks=40 marks*

Maximum Total Marks: 70

ME09 403: Mechanics of Solids

Teaching scheme **Credits:** 5

4 hours lecture and 1 hour tutorial per week

Objectives

- *To acquaint with the basic concepts of stress and deformation in solids.*
- *To practise the methodologies to analyse stresses and strains in simple structural members, and to apply the results in simple design problems.*

Module I (18 hours)

Simple Stress and Strain: Introduction to analysis of deformable bodies – internal forces – method of sections – assumptions and limitations. Simple stresses – stresses due to normal, shear and bearing loads – strength design of simple members. Axial and shear strains –

Material behaviour – uniaxial tension test – stress-strain diagrams – concepts of orthotropy, anisotropy and inelastic behaviour – Hooke's law for linearly elastic isotropic material under axial and shear deformation – deformation in axially loaded bars – thermal effects – statically indeterminate problems – principle of superposition. Elastic strain energy for uniaxial stress. Definition of stress and strain at a point (introduction to stress and strain tensors and its components only) – Poisson's ratio – biaxial and triaxial deformations – Bulk modulus - Relations between elastic constants.

Module II (18 hours)

Torsion: Torsion theory of elastic circular bars – assumptions and limitations – polar modulus - torsional rigidity – economic cross-sections – statically indeterminate problems – design for torsional load (shaft and flanged bolt coupling) – torsion of inelastic circular bars (introduction only).

Axial force, shear force and bending moment: Diagrammatic conventions for supports and loading - axial force, shear force and bending moment in a beam – differential relations between load, shear force and bending moment - shear force and bending moment diagrams by direct and summation approach - use of singularity functions – elastic curve – point of inflection.

Module III (18 hours)

Stresses in beams: Pure bending – flexure formula for beams – assumptions and limitations – section modulus - flexural rigidity - economic sections – beam of uniform strength. Shearing stress formula for beams – assumptions and limitations - shear flow – design for flexure and shear (reinforced beams, fliched beams, etc.) – inelastic bending (introduction only).

Deflection of beams: Moment-curvature relation – assumptions and limitations - double integration method - singularity functions – Macaulays method – superposition techniques – moment area method and conjugate beam ideas for simple cases – elementary treatment of statically indeterminate beams.

Module IV (18 hours)

Transformation of stress and strains: Plane state of stress - equations of transformation - principal stresses. Plane state of strain – analogy between stress and strain transformation - Mohr's circles of stress and strain – strain rosettes.

Compound stresses: Combined axial, flexural and shear loads – eccentric loading under tension/compression - kern of a section (rectangular and circular section) - combined bending and twisting loads.

Theory of columns: Buckling theory –Euler's formula for long columns – assumptions and limitations – effect of end conditions - slenderness ratio – Rankine's formula for intermediate columns – Eccentric loading of columns – secant formula.

Text Books

1. E. P. Popov, T. A. Balan, *Engineering Mechanics of Solids*, Pearson Education, New Delhi.
2. A. Pytel, F. L. Singer, *Strength of Materials*, Harper & Row Publishers, New York.
3. P. N. Singh, P. K. Jha, *Elementary Mechanics of Solids*, Wiley Eastern Limited, New Delhi.

Reference Books

1. Gere, Timoshenko, , *Mechanics of Materials*, CBS Publishers & Distributors, New Delhi.
2. I. H. Shames, J. H. Pitarresi, *Introduction to Solid Mechanics*, Prentice Hall of India, New Delhi.
3. F. Beer, E. R. Johnston, J. T. DeWolf, *Mechanics of Materials*, Tata McGraw Hill, New Delhi
4. S. H. Crandal, N. C. Dhal, T. J. Lardner, An *Introduction to the Mechanics of Solids*, McGraw Hill

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 404: Casting and Joining

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives:

- *To provide knowledge on theory of solidification of metals*
- *To acquire knowledge on different casting processes*
- *To impart conception on various welding processes*
- *To understand fundamentals of soldering, brazing, adhesive bonding and ceramic joining.*

Module I (10 Hours)
Introduction- solidification of metals and alloys-homogeneous and heterogeneous nucleation-cast structures-casting alloys- foundries-furnaces and melting practices- pattern- pattern allowances- casting design- gating system design- risering -flow of molten metal in moulds.

Module II (16 Hours)
Casting processes- comparison-sand casting-shell moulding-CO2 process-expended polystyrene process – plaster mould casting- ceramic mould casting-investment casting-permanent mould casting-slush casting-pressure casting-die casting-centrifugal casting-squeeze casting-semisolid casting- rapid solidification- casting of single crystal components- defects- inspection and testing of castings.

Module III (14 Hours)
Welding processes-classification-welding power source-Duty cycle - Arc characteristics- filler materials-Electrodes- Coding of the electrodes- Classification of electrodes-- metal transfer – solid state-solid-liquid state process-OFW, SMAW, SAW, GMAW, FCAW, GTAW, PAW, ESW, EGW, RW, RSEW, HFRW, RPW, FW, SW, PEW, FOW, CW, USW, FRW, EXW, TW, EBW, LBW, DFW- Metallurgy of welding-HAZ-weld quality- weldability-welding defects- inspection and testing of welded joints.

Module IV (14 Hours)
Brazing, Soldering and Adhesive bonding –Physical aspects – Surface energy and contact angle – Capillary action - Theory of soldering and Brazing -Fluxes-Heat sources and heat transfer- Filler materials- Different types of brazing- Braze welding- Adhesives bonding- Contact adhesives- Polyester, polyamide and polyurethane melt adhesives- Toughened acrylic and epoxy adhesives- Silicone adhesives Joint design -Joining of Ceramics - Metal/ceramic joining and ceramic/ceramic joining-Diffusion bonding

Reference Books:

1. A. C. Davies, *The Science and Practice of Welding*, Addison Wesley 2001
2. American welding society, *Welding Hand book, Welding, Brazing and Soldering*
3. Haine R W, Loper C R Jr.& Rosenthal P C, *Principles of metal casting*, Tata McGraw Hill
4. Lancaster.J.F, *The metallurgy of welding*, George Allen and Unwin Ltd.
5. P Khanna, *Welding Metallurgy*
6. R.S.Parmar, *Welding processes and Technology*, Khanna Publishers, New Delhi
7. Serope Kalpakjian,*Manufacturing Engineering and Technology*, Addison Wesley

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 405: Fluid Machinery

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives:

- *To impart the basic principles on the relationship between forces and its resulting motion of bodies due to impact of fluid jets.*
- *To understand the working and design principles of hydraulic turbines and pumps.*

Module I (14 Hours)

Impact of jet: Integral form of continuity, energy, and momentum equations – flow over flat plates and curved surfaces – concepts of relative velocity – velocity triangles – force, workdone, and efficiency. Jet propulsion – classification of fluid machinery – performance indices like power and efficiency.
Dimensional analysis: Rayleigh's method – Buckingham's Π method – principles of modeling and similitude.

Module II (14 Hours)

Hydraulic turbines: Impulse and reaction turbines – Pelton wheel – geometry and working performance parameters – conditions for optimum operatuion – brief description of hydel power plant – surge tank – governing techniques. Radial flow turbine – geometry – working – velocity diagram – net head – draft tube – performance parameters. Axial flow reaction turbine – geometry – working – velocity diagram – net head – performance parameters – draft tube theory – cavitation – net positive suction head – specific speed – design and selection criterions.

Module III (14 Hours)

Pumps: Rotodynamic and positive displacment pumps - centrifugal pumps – geometry – working – velocity diagram at entry and exit of impellor – output and performance parameters – manometric head – manometric efficiency – overall efficiency – effect of blade angle on pump head – pump performance curves – cavitation – specific speed for pumps – multistage pumps.

Module IV (12 Hours)

Reciprocating pumps: Geometry – working – pump head – efficiency – discharge variation with crank angle – air vessels – indicator diagrams – theoretical and actual characteristics.
Rotary pumps: Gear pumps and its performance curves – rotary vane pump and its characteristics – screw pumps. Miscellaneous devices – hydraulic ram, accumulator, intensifier, jet pump, air lift pump.

Text Books

1. Bensal, *Hydraulic machines*,
2. Jagadish Lal, *Hydraulic machines*,

Reference Books

1. J. F. Douglas, J. M. Gasiorek, J. A. Swaffield, *Fluid Mechanics*, Addison-Wesley.
2. S. L. Dixon, *Fluid Mechanics and Thermodynamics of Turbo Machinerys*, Butterworth and Hienemann.
3 . D. G. Shepherd, *Principles of Turbo Machinery*,Mc Millan.

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: Short answer questions (one/two sentences) *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: Analytical/Problem solving questions *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: Descriptive/Analytical/Problem solving questions *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 406: Thermodynamics

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives:

- *To impart the basic concepts of thermodynamics*

Module I (14 Hours)

Basic concepts and definitions – Macroscopic and microscopic approach, Continuum concept, system and control volume, properties, processes and cycles, Method of checking of properties, Quasi-static process, homogeneous and heterogeneous systems, thermodynamic equilibrium, Zeroth law of thermodynamics – measurement of temperature, Temperature scales, Concept of absolute temperature scale.

Different forms of energy, Stored energy and transition energy, work and heat, different types of work transfer, pdV work, indicator diagram, Free expansion, First law of thermodynamics, Joule's experiment, First law applied for a cycle and change of state – internal energy and enthalpy, Joule's law, PMM1, first law applied for open system, Steady flow energy equation and applications.

Module II (14 Hours)

Second law of thermodynamics – thermal reservoir, cyclic heat engine, Kelvin – Plank and Clausius' statement, PMM2, refrigerator and heat pump, reversibility and irreversibility, Causes of irreversibility, types of irreversibility, Carnot cycle, Carnot's theorem.

Entropy, Clausius' theorem, Clausius' inequality, Entropy principle and its applications, Available energy, Law of degradation of energy, useful work, dead state, Availability, Gibb's and Helmholtz function, Second law efficiency, Third law of thermodynamics.

Module III (14 Hours)

Properties of pure substances, p-v, p-T, T-s diagram for a pure substances, critical point and triple point, saturation states, liquid vapour mixtures, dry, wet and superheated steam. Use of steam table and Mollier diagram.

Properties of gases and mixtures – Avogadro's law, Equations of state – ideal gas equation, van der Waal's equation, Redlich Kwong equation, Beattie-Bridgeman equation, Virial expansions, simple problems, Law of corresponding states, Compressibility chart, Properties of mixtures of gases – Dalton's law of partial pressures, Dalton's law of partial pressures Amagat Leduc law, mole fraction, Cp and Cv of the mixtures, simple problems.

Module IV (12 Hours)

Themodynamic relations – Maxwell's Equations, Tds equations, Joule Kelvin effect, Clausius – Clapeyron equation

Psychrometrics - Properties of atmospheric air, Psychrometric properties – dry bulb temperature, wet bulb temperature and dew point temperature, specific humidity, relative humidity, degree of saturation, use of psychrometric chart, simple problems.

Text Books

1. P.K.Nag, *Thermodynamics*, Tata Mc Graw Hill, 4th edition

Reference Books

1. C. P. Arora, *Thermodynamics*, Tata Mc Graw Hill
2. Yunus Cengel, *Thermodynamics an Engineering Approach*, Fourth Edition, Mc Graw Hill
3. Y V C Rao, *An Introduction To Thermodynamics*, Unversities Press .
4. R. Yadav, *A Text book on Thermodynamics*, Central Publishing House
5. Sonntag, Van Wylen, *Fundamentals of Thermodynamics*, Sixth edn John Wiley & Sons.

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: Short answer questions (one/two sentences) *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: Analytical/Problem solving questions *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: Descriptive/Analytical/Problem solving questions *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 407(P): Material Testing Lab

Teaching scheme **Credits:** 2

3 hours practical per week

Objectives

- *To provide knowledge on the mechanical behaviour of materials.*
- *To acquaint with the experimental methods to determine the mechanical properties of materials.*

1. Standard tension test on mild steel using Universal Testing Machines and suitable extensometers
2. Stress-strain characteristics of brittle materials – cast iron
3. Spring test – open and closed coiled springs – determination of spring stiffness and modulus of rigidity
4. Determination of modulus of rigidity of wires
5. Hardness tests – Brinnell hardness, Rockwell hardness (B S C scales), Rockwell superficial hardness (N & T scales), and Vickers hardness
6. Impact test – Izod and Charpy
7. Bending test on wooden beams
8. Fatigue testing – study of testing machine
9. Photoelastic method of stress measurements (two dimensional problems)
10. Torsion test on mild steel rod
11. Shear test on mild steel rod

Reference Books

1. G. E. Dieter, *Mechanical Metallurgy*, McGraw Hill.
2. J. W. Dally, W. P. Railey, *Experimental Stress Analysis*, McGraw Hill.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Practicals and Record (30 marks)
30% - Test/s (15 marks)
10% - Regularity in the class (5 marks)

Semester End Examination *(Maximum Marks-50)*

70% - Procedure, conducting experiment, results, tabulation, and inference (35 marks)
20% - Viva voce (10 marks)
10% - Fair record (5 marks)

University of Calicut

ME09 408(P): Production Engineering Lab-II

Teaching scheme **Credits:** 2

3 hours practical per week

Objectives

- *To acquaint with basic machine tools.*
- *To impart training on shaper, slotting, milling and grinding machines.*

Introduction:

a) Limits, fits and tolerances.
b) Shaping machine – slotting machine – horizontal milling machine – surface, centreless and cylindrical grinding.
c) Spindle drives – milling cutter – indexing head.
d) Simple, compound, differential and angular indexing.

Study of machines:

a) Shaper
b) Planer
c) Slotting machine
d) Drilling machine
e) Milling machine
f) Grinding machine
g) Power saws

Exercises:

1) Exercises on shaper and slotting machines – cube with V-groove, slot and guide ways.
2) Exercise on milling machine – spur gear and helical gear milling by simple and differential indexing, surface milling, slot and key way milling.
3) Exercise on grinding and tool grinding

Reference Books

1. HMT, *Production Technology,* Tata McGraw Hill.
2. ASTME, *Tool Engineers Hand Book*.
3. Burghardt, Asilered, Anderson, *Machine Tool Operations I & II*, McGraw Hill.
4. W. A. J. Chapman, *Workshop Technology: Part 2*, CBS Publishers.
5. R. V. Rao, *Metal Cutting and Machine Tools*, S K Kataria & Sons

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Workshop Practicals and Record (30 marks)
30% - Test/s (15 marks)
10% - Regularity in the class (5 marks)

Semester End Examination *(Maximum Marks-50)*

70% - Procedure, conducting experiment, results, tabulation, and inference (35 marks)
20% - Viva voce (10 marks)
10% - Fair record (5 marks)

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ME09 501: Heat and Mass Transfer

Teaching scheme **Credits:** 5

4 hours lecture and 1 hour tutorial per week

Objectives

- *To impart the concept of various modes of heat and mass transfer.*
- *To develop understanding about the method of determination of heat transfer rates in conduction, convection and radiation*

Module II (18 hours)

Conduction: Introduction - basic modes of heat transfer – conduction – general heat conduction equation in Cartesian, cylindrical and spherical coordinates – one dimensional steady state conduction with and without heat generation – critical thickness of insulation – extended surface heat transfer – fin performance – effect of variable thermal conductivity. Two dimensional steady state conduction through plane wall – conduction shape factor. Unsteady state conduction in one dimension – lumped heat capacity system – semi infinite solid with sudden and periodic change in surface temperature.

Module II (18 hours)

Convection: Newton's law – concept of boundary layer – significance of Prandtl number – boundary layer equations – flat plate heat transfer solutions by integral method – laminar and turbulent flow – Reynolds analogy – empirical relations in forced convection – internal flow – boundary conditions – laminar and turbulent flow – heat transfer coefficients – empirical correlations. Natural convection – heat transfer from vertical plate by integral method – empirical relation in free convection. Condensation and boiling heat transfer – film and drop wise condensation – film boiling and pool boiling – boiling curve – empirical relations for heat transfer with change of face.

Module III (18 hours)

Radiation: Fundamentals of radiation – radiation spectrum – thermal radiation – concept of black body and grey body – monochromatic and total emissive power – absorptivity, reflectivity and transmissivity - laws of radiation – radiation between two surfaces – geometrical factors for simple configuration – radiation shields – electrical network method of solving problems.

Module IV (18 hours)

Heat exchangers: Classification – log mean temperature difference – overall heat transfer coefficient – fouling and scaling of heat exchangers – LMTD and NTU method of performance evaluation of heat exchangers. Introduction to mass transfer – Fick's law of diffusion – isothermal evaporation into air – mass transfer coefficients.

Text Books

1. F. P. Incropera, *Fundamentals of Heat and Mass Transfer*, John Wiley.

Reference Books

1. Holman, *Heat and Mass Transfer*, McGraw Hill.
2. P. K. Nag, *Heat and Mass Transfer*, Tata McGraw Hill.
3. Sachedeva, *Heat and Mass Transfer*, New Age International.
4. D. S. Kumar, *Heat and Mass Transfer,*

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, etc. Atleast one assignment should be programming / problem solving using computers.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 502: Advanced Mechanics of Solids

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart concepts of stress and strain analysis in a solid.*
- *To study the methodologies in theory of elasticity at a basic level.*
- *To acquaint with energy methods to solve structural problems.*

Module I (14 hours)

Basic equations of elasticity: Stress at a point with respect to a plane – normal and tangential components of stress – stress tensor – Cauchy's equations – stress transformation – principal stresses and planes – strain at a point - strain tensor – analogy between stress and strain tensors – constitutive equations – generalized Hooke's law – relation among elastic constants – equations of equilibrium – strain-displacement relations – compatibility conditions – boundary conditions – Saint Venant's principle for end effects – uniqueness condition.

Module II (14 hours)

2-D problems in elasticity: Plane stress and plane strain problems – Airy's stress function – solutions by polynomial method – solutions for bending of a cantilever with an end load, and bending of a beam under uniform load. Equations in polar coordinates – Lame's problem - stress concentration problem of a small hole in a large plate. Axisymmetric problems – thick cylinders – interference fit – rotating discs.

Module III (13 hours)

Special problems in bending: Unsymmetrical bending – shear center – curved beams with circular and rectangular cross-section.

Energy methods in elasticity: Strain energy of deformation – special cases of a body subjected to concentrated loads, due to axial force, shear force, bending moment and torque – reciprocal relation – Maxwell reciprocal theorem – Castigliano's first and second theorems – virtual work principle – minimum potential energy theorem - complementary energy.

Module IV (13 hours)

Torsion of non-circular bars: Saint Venant's theory - Prandtle's method - solutions for circular and elliptical cross-sections - membrane analogy - torsion of thin walled open and closed sections – shear flow.

Text Books

1. L. S. Sreenath, *Advanced Mechanics of Solids*, McGraw Hill
2. S. M. A. Kazimi, Solid Mechanics, McGraw Hill

Reference Books

1. S. P. Timoshenko, J. N. Goodier, *Theory of elasticity,* McGraw Hill
2. J. P. Den Hartog, *Advance Strength of Materials*, McGraw Hill
3. C. K. Wang, *Applied Elasticity*, McGraw Hill

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, etc.
10% - Regularity in the class

University Examination Pattern

PART A:	*Short answer questions (one/two sentences)* All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.	*5 x 2 marks=10 marks*
PART B:	*Analytical/Problem solving questions* Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.	*4 x 5 marks=20 marks*
PART C:	*Descriptive/Analytical/Problem solving questions* Two questions from each module with choice to answer one question.	*4 x 10 marks=40 marks*

Maximum Total Marks: 70

ME 09 503: Engineering Economics and Principles of Management
(Common for AM and PT)

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Section 1: Engineering Economics

Objective
Impart fundamental economic principles that can assist engineers to make more efficient and economical decisions.

Module 1 (14 Hrs)
Economic reasoning, Circular Flow in an economy, Law of supply and demand, Economic efficiency. Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Private and Social cost, Opportunity cost. Functions of Money and commercial Banking. Inflation and deflation: concepts and regulatory measures. Economic Policy Reforms in India since 1991: Industrial policy, Foreign Trade policy, Monetary and fiscal policy, Impact on industry.

Module II (13 Hrs)
Value Analysis – Function, aims, procedure.–Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor- equal payment series capital recovery factor-Uniform gradient series annual equivalent factor. Methods of project analysis (pay back, ARR, NPV, IRR and Benefit -Cost ratio) Break-even analysis-, Process planning.

Text Books
1. Panneer Selvam, R, Engineering economics, Prentice Hall of India, New Delhi, 2002.
2. Wheeler R (Ed) Engineering economic analysis, Oxford University Press, 2004.

Internal Continuous Assessment *(Maximum Marks-15)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern – for Section 1
Note: Section 1 and Section 2 are to be answered in separate answer books

PART A:	*Short answer questions (one/two sentences)* All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.	*2 x 2 marks=4 marks* *1 x 1 mark = 1 mark*
PART B:	*Analytical/Problem solving questions* Candidates have to answer two questions out of three. There should be at least one question from each module and not more than two questions from any module.	*2 x 5 marks=10 marks*
PART C:	*Descriptive/Analytical/Problem solving questions* Two questions from each module with choice to answer one question.	*2 x 10 marks=20 marks*

Maximum Total Marks: 35

Section 2: Principles of Management

Objective

- *To provide knowledge on principles of management, decision making techniques, accounting principles and basic management streams*

Module I (13 hours)
Principles of management – Evolution of management theory and functions of management Organizational structure – Principle and types. Decision making – Strategic, tactical & operational decisions, decision making under certainty, risk & uncertainty and multistage decisions & decision tree Human resource management – Basic concepts of job analysis, job evaluation, merit rating, wages, incentives, recruitment, training and industrial relations

Module II (14 hours)
Financial management – Time value of money and comparison of alternative methods. Costing – Elements & components of cost, allocation of overheads, preparation of cost sheet, break even analysis. Basics of accounting – Principles of accounting, basic concepts of journal, ledger, trade, profit &loss account and balance sheet. Marketing management – Basic concepts of marketing environment,

marketing mix, advertising and sales promotion. Project management – Phases, organisation, planning, estimating, planning using PERT & CPM

Reference Books

1. F. Mazda, *Engineering management*, Addison Wesley, Longman Ltd., 1998
2. Lucy C Morse and Daniel L Babcock, *Managing engineering and technology*, Pearson Prentice Hall
3. O. P. Khanna, *Industrial Engineering and Management*, Dhanpat Rai and Sons, Delhi, 2003.
4. P. Kotler, *Marketing Management: Analysis, Planning, Implementation and Control*, Prentice Hall, New Jersey, 2001
5. Venkata Ratnam C.S & Srivastva B.K, *Personnel Management and Human Resources*, Tata McGraw Hill.
6. Prasanna Chandra, *Financial Management: Theory and Practice*, Tata McGraw Hill.
7. Bhattacharya A.K., *Principles and Practice of Cost Accounting*, Wheeler Publishing
8. Weist and Levy, *A Management guide to PERT and CPM*, Prantice Hall of India
9. Koontz H, O'Donnel C & Weihrich H, *Essentials of Management*, McGraw Hill.

Internal Continuous Assessment *(Maximum Marks-15)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern – for Section 2
Note: Section 1 and Section 2 are to be answered in separate answer books

PART A: *Short answer questions (one/two sentences)* — *2 x 2 marks=4 marks*, *1 x 1 mark = 1 mark*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* — *2 x 5 marks=10 marks*

Candidates have to answer two questions out of three. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* — *2 x 10 marks=20 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 35

ME09 504: IC Engines and Gas Turbines

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To provide knowledge on actual engine cycles , **t**hermodynamics of combustion**,** components of SI and CI engines, performance testing of IC engines , theory of combustion in IC engines and gas turbine theory*

Module I (16 hours)

Internal combustion engines –- Engine classification - four stroke and two stroke - spark ignition and compression ignition - valve timing diagram - air standard cycles - Otto, diesel and duel combustion cycles - actual engine cycles - effect of dissociation - variable specific heats and heat losses - scavenging - objectives - effects and methods

Thermodynamics of combustion – combustion reaction of common fuels – air fuel ratio – exhaust gas composition – flue gas analysis – air fuel ratio from exhaust gas composition – enthalpy of formation – application of first law of thermodynamics to chemically reacting systems-

Module II (13 hours)

Systems and components of IC engines - fuel systems - ignition systems - cooling - starting - lubrication - governing of IC engines - supercharging of SI and CI engines - turbocharging - exhaust emissions of IC engines - alternate potential engines - free piston engine - Wankel engine and stratified charged engine - automotive transmission systems and its components - engine testing - performance and characteristics of constant speed and variable speed engines - heat balance test - Morse test - retardation test.

Module III (12 hours)

Combustion in SI engines - flame propagation - normal and abnormal combustion - detonation - pre ignition - after burning - fuel rating - additives in petrol - combustion chambers of SI engines.

Combustion in CI engines - phase of normal combustion - diesel knock - effect of engine variables on diesel knock - cetane number - additives in diesel - combustion chambers of CI engines-IC Engine exhaust emission control-standards.

Module IV (13 hours)

Gas turbine plants - open and closed cycles - thermodynamic cycles - regeneration - reheating - intercooling - efficiency and performance of gas turbines - rotary compressors - analysis - centrifugal and axial flow compressors - combustion chambers of gas turbines - cylindrical - annular and industrial type combustion chamber - combustion efficiency - axial flow turbines - elementary and vortex theories - design of nozzles and blades for turbines - limiting factors in turbine design

Text Books

1. Ganesan V., *Internal Combustion Engines*, Tata McGraw Hill
2. Ganesan V., *Gas Turbines*, Tata McGraw Hill

Reference Books

1. Rogowsky, *Elements of Internal Combustion Engines*, Tata McGraw Hill
2. Gill, Smith, Ziurys, *Fundamentals of Internal Combustion Engines*, Oxford and IBH
3. Maleev, *Internal Combustion Engine Theory and Design*, McGraw Hill
4. Judge, *Modern Petrol Engines*, Chapman & Hall
5. Benson, Whitehouse, "Internal Combustion Engines" Vol. I & II, Pergamon press
6. Mathur, Mehta, *Thermodynamics and Heat Power Engineering*, Vol. I & II
7. Cohen, Rogers, *Gas Turbine Theory*, Longmans

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 505: Mechanics of Machinery

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To provide knowledge on kinematics of selected mechanisms, design of cams, Theory and Analysis of gears, Gear Trains and Synthesis of Mechanisms. These are the topics based on which the student will develop the design and practical problem solving skills in the area of Mechanisms in the future courses.*

Module I (14 hours)
Introduction to kinematics and mechanisms - Various mechanisms, kinematic diagrams, degree of freedom- Grashof's criterion, inversions, Coupler curves - straight line mechanisms exact, approximate – Ackerman Steering Mechanism - Hooke's joint - Geneva Mechanism - Mechanical advantage, Transmission angle - Displacement Velocity and Acceleration analysis - Relative motion - Relative velocity - Instant centre -Kennedy's theorem - Relative acceleration - Coriolis acceleration - Graphical and analytical methods – Complex number methods - Computer oriented methods.

Module II (13 hours)
Cams - Classification of Cam and followers - Displacement diagrams, Velocity and Acceleration analysis of SHM, Uniform Velocity, Uniform acceleration, Cycloidal – Graphical Cam profile synthesis –Pressure angle- Analysis of Tangent cam with roller follower and Circular cam with flat follower. Introduction to Polynomial cams.

Module III (14 hours)
Gears – Terminology of Spur gears – Law of Gearing - Involute spur gears - Involutometry - Contact ratio - Interference - Backlash - Gear standardization - Interchangability - Non-standard gears Centre distance modification, Long and Short Addendum system. - Internal gears - Theory and details of bevel, helical and worm gearing - Gear trains - Simple and Compound gear trains - Planetary gear trains – Differential -Solution of planetary gear train problems - Applications

Module IV (13 hours)
Kinematic synthesis (Planar Mechanisms) - Tasks of kinematic synthesis – Type, Number and dimensional synthesis – Precision points - Graphical synthesis for motion - Path and prescribed timing - Function generator – 2 position and 3 position synthesis – Overlay Method - Analytical synthesis techniques Freudenstein's equation – Complex number methods - One case study in synthesis of mechanism.

Text Books

1. S. S. Rattan, *Theory of Machines*, 2nd Edition,, Tata Mc Graw Hill

Reference Books

1. J. E. Shigley, J. J. Uicker, *Theory of Machines and Mechanisms*, McGraw Hill
2. C. E. Wilson, P. Sadler, *Kinematics and Dynamics of Machinery*, 3rd edition, Pearson Education.
3. A. Ghosh, A. K. Malik, *Theory of Mechanisms and Machines*, Affiliated East West Press
4. A. G. Erdman, G. N. Sandor, *Mechanism Design: Analysis and synthesis Vol I & II*, Prentice Hall of India
5. D. H. Myskza, *Machines and Mechanisms Applied Kinematic Analysis*, Pearson Education.

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

Note: Computer oriented assignments using spread sheet or any suitable software packages are to be included

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME 09 506: Metal Cutting and Forming

Teaching scheme **Credits:** 3

2 hours lecture and 1 hour tutorial per week

Objectives:

- *To impart fundamental knowledge on theory of machine tools, metal cutting principles, advanced machining processes and press working operations.*

Module I (7 Hours)

Metal cutting: cutting variables - mechanics of chip formation - types of chips produced - orthogonal and oblique cutting –velocity relationships - cutting forces – cutting power temperature in cutting – single point and multipoint tools – tool geometry - tool designation – tool wear and tool life – machinability – cutting tool materials - cutting fluids - economics of machining.

Module II (9 Hours)

Machining Process – tool-work motion – turning – parameters – lathes and lathe operations – material removal rate – cutting force – Milling – parameters – up milling and down milling – power - torque – cutting forces – drilling – drills – material removal rate – cutting forces – reaming – broaching – tapping – boring – planning – shaping – slotting – grinding – cylindrical and surface grinding- grinding wheels – wheel wear.

Module III (10 Hours)

Advanced Machining Processes: Electrical Discharge Machining - wire EDM – Electro Chemical machining – laser beam machining – abrasive jet machining – ultrasonic machining - electron beam machining – plasma arc machining – water jet machining – nano fabrication – micro machining – machining time - economics of advanced machining process.

Module IV (10 Hours)

Press working operations – types of presses – press selection – press working terminology – forming - principles – cutting forces – dies and punches –clearance – constructional features – simple, compound, combination & progressive dies – strippers - scrap strip layout – centre of pressure – press tonnage – drawing - drawing forces – blank holding pressure – bending force – die blank size estimation – forging – forgebility – open and closed die forging – forging force – grain flow – extrusion – explosive forming – electro hydraulic forming – electromagnetic forming. - rolling - extrusion.

Text books

1. Serope Kalpakjaian, Steven R. Schmid., *Manufacturing Engineering and Technology*, Pearson, New Delhi.
2. Sharma. P C, *A Text book of Production Engineering*, S. Chand & Co.
3. Jain .R K, *Production Technology*, Khanna Publishers.

Reference Books

1. HMT, *Production Technology*, Tata McGraw Hill Pvt. Ltd.
2. ASTME, *Fundamentals of Tool Design*, Prentice Hall of India

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 507(P): Fluids Lab

Teaching scheme **Credits:** 2

3 hours practical per week

Objectives

- *To strengthen the knowledge on fluid mechanics principles, and hydraulic machinery through lab experiments.*
- *To equip the students to carry out independent experiments, and to train them to analyse, report and infer the results.*

1. Study of plumbing tools and pipe fittings
2. Measurement of metacentric height and radius of gyration of floating bodies
3. Measurement of viscosity of fluids
4. Study of discharge measuring instruments
5. Measurement of pressure and velocity
6. Calibration of venturimeter, orifice meter, notches and weirs, nozzle meters, and rotameters
7. Pipe friction – minor losses in pipes - verification of Bernouli's theorem
8. Demonstration of laminar and turbulent flow in pipes – critical velocity
9. Experiment on flow through open channels – venturiflume
10. Demonstration of forces on curved and plane surfaces
11. Evaluation of torque & performance of turbines – operating characteristics – Muschel's curves
12. Performance of pumps: Centrifugal pumps, Reciprocating pumps, Gear pumps, Hydraulic ram, Torque converter.

Reference Books

1. I. H. Shames, *Fluid Mechanics*, 4th Edition, McGraw Hill
2. J. P. Holman, *Experimental methods for Engineers*, McGraw Hill
3. D. G. Shepherd, *Principles of Turbo Machinery*, Mc Millan

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Practicals and Record (30 marks)
30% - Test /s (15 marks)
10% - Regularity in the class (5 marks)

Semester End Examination *(Maximum Marks-50)*

70% - Procedure, conducting experiment, results, tabulation, and inference (35 marks)
20% - Viva voce (10 marks)
10% - Fair record (5 marks)

ME09 508(P): Thermal Lab-I

Teaching scheme **Credits:** 2
3 hours practical per week

Objectives

- *To strengthen the knowledge on heat engine, and heat transfer principles through lab experiments.*
- *To equip the students to carry out independent experiments, and to train them to analyse, report and infer the results.*

1. Study of systems of petrol and diesel engines
2. Study of automotive parts
3. Study of heat transfer equipments
4. Test on IC engines:
    - Constant speed performance characteristics of petrol and diesel engines.
    - Valve timing diagram
5. Determination of viscosity, flash and fire point and calorific value of the fuel
6. Heat transfer experiments:
    - Emissivity measurement of a radiating surface
    - Measurement of solar radiation
    - Thermal conductivity of a metal rod
    - Measurement of unsteady state conduction heat transfer
    - Experimental study on forced convection heat transfer

Reference Books

1. P. L. Bellani, *Thermal Engineering*, Khanna Publishers
2. J. P. Holman, Heat Transfer, McGraw Hill
3. Obert, *Internal Combustion Engines*, McGraw Hill

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Practicals and Record (30 marks)
30% - Test /s (15 marks)
10% - Regularity in the class (5 marks)

Semester End Examination *(Maximum Marks-50)*

70% - Procedure, conducting experiment, results, tabulation, and inference (35 marks)
20% - Viva voce (10 marks)
10% - Fair record (5 marks)

ME09 601: Dynamics of Machinery

Teaching scheme **Credits:** 5

4 hours lecture and 1 hour tutorial per week

Objectives

- *To impart knowledge on Force analysis of machinery, balancing of rotating and reciprocating masses, Gyroscopes, Energy fluctuation in Machines. This forms the second part of the basics needed in the area of Mechanisms for Design courses in future.*
- *To introduce the fundamentals in Vibration, Vibration analysis of Single degree and multi degree freedom systems. To impart knowledge required to understand the physical significance and design vibration systems with desired conditions*

Module I (16 hours)
Force analysis of machinery - static and dynamic force analysis of plane motion mechanisms - graphical method - principle of superposition - matrix methods - method of virtual work - complex number method – Force Analysis of Spur- Helical - Bevel and Worm gearing

Module II (18 hours)
Flywheel analysis - balancing - static and dynamic balancing - balancing of masses rotating in several planes - balancing of reciprocating masses - balancing of multicylinder in line engines - V Engines - balancing machines. Gyroscope – Gyroscopic couples- Stabilisation of ships and aeroplanes – Effect on automobiles.

Module III (20 hours)
Introduction to vibrations – Free vibrations of single degree freedom systems – Energy Method – un damped and Damped free vibrations – Viscous damping – Critical Damping - Logarithmic decrement - Coulomb damping – Harmonically excited vibrations – Response of an Un damped and Damped system – beat phenomenon - Transmissibility - whirling of shafts – Critical speed - free torsional vibrations – Self excitation and Stability analysis - Vibration control - Vibration Isolation – Vibration absorbers.

Module IV (18 hours)
Two degree of freedom systems - coordinate coupling and principal coordinates – Torsional systems - orthogonality principle - undamped vibration absorbers - Torsional vibrations – Free torsional vibration of Single, two and three rotor systems - Torsionally equivalent shaft - Vibration of continuous systems - Transverse vibrations - axial vibration of rods - bending vibration of bars - Eigenvalue problem - Introduction to nonlinear vibration - exact methods – Approximate numerical methods - Phase plane representation - vibration measurement - accelerometer – seismometer – vibration exciters.

Text Books

1. S. S. Rattan, *Theory of Machines*, 2nd Edition,, Tata Mc Graw Hill
2. Lasithan L G, *Elementary Engineering Vibration and Industrial Noise Control*, 1st edition, Pentex Book Publishers and Distributors

Reference Books

1. J. E. Shigley, J. J. Uicker, *Theory of Machines and Mechanisms*, McGraw Hill
2. C. E. Wilson, P. Sadler, *Kinematics and Dynamics of Machinery*, 3rd edition, Pearson Education.
3. A. Ghosh, A. K. Malik, *Theory of Mechanisms and Machines*, Affiliated East West Press
4. S. S. Rao., *Mechanical Vibrations*, 4th Edition, Pearson Education.
5. W. T. Thompson, *Theory of Vibrations with Applications*, Prentice Hall of India.

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

Note: Computer oriented assignments using spread sheet or any suitable software packages are to be included

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 602: Finite Element Method

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To acquaint with basic concepts of finite element formulation methods.*
- *To practise finite element methodologies through simple structural and heat transfer problems.*

Module 0 (2 hours)

Review : Matrices and matrix operations – solution of system of linear equations – Gauss elimination. Basic equations of elasticity – strain-displacement relations – compatibility - stress-strain relationship – boundary condition – St. Venant's principle - theorem of minimum potential energy – principle of virtual work. Steady state heat conduction equation – Fourier's law – boundary conditions.

(No direct questions from the above part)

Module I (13 hours)

Introduction: Finite element method as a numerical tool for design – basic concepts – formulation procedures – historical development – current trends – free and commercial FE packages.

FE modelling Direct approach: 1-D bar element – element stiffness – assembly of elements – properties of [K] matrix – treatment of boundary conditions – temperature effects – stress computation – support reaction – simple problems. Analogous (1-D) problems of torsion, heat conduction and laminar pipe flow.

Beam element: Beam relationships – 1-D beam element FE formulation - element stiffness matrix – load considerations – boundary conditions – member end forces.

Module II (13 hours)

FE modelling Direct approach : Plane truss element formulation – coordinate transformation – local and global coordinates – element matrices – assembly of elements – treatment of boundary conditions – stress calculation – simple problems - band width of the stiffness matrix – node numbering to exploit matrix sparsity – conservation of computer memory.

Interpolation – shape function – Lagrange interpolation - 1D linear and quadratic, 2D linear triangle and bilinear rectangular elements.

FE formulation from virtual work principle – B-matrix – element matrices for bar and CST elements – load considerations – consistent nodal loads – simple problems.

Module III (13 hours)

Variational methods : – Functionals – weak and strong form – essential and non- essential boundary conditions - Principle of stationary potential energy – Rayleigh-Ritz method –simple examples.

FE formulation from a functional: 2-D steady state heat conduction – element matrices for a triangular element – boundary conditions – simple problems. FE formulation for 2-D stress analysis from potential energy - element matrices - plane bilinear element.

Convergence requirements – patch test – modelling aspects – symmetry – element size and shape – sources of error.

Module IV (13 hours)

Weighted residual methods: Galerkin FE formulation – axially loaded bar – heat flow in a bar.

Isoparametric formulation: Natural coordinates – linear and quadratic bar element – linear triangle and plane bilinear elements for scalar fields – jacobian matrix – element matrices - Gauss quadrature – requirements for isoparametric elements – accuracy and mesh distortion.

Advanced topics: Introduction to non-linear and dynamic finite element procedures, error estimation, coupled problems (only brief details are needed).

Text Books

1. T. R. Chandrupatla, *Finite Element Analysis for Engineering and Technology*, University Press
2. R. D. Cook, D. S. Malkus, M. E. Plesha, R. J. Witt, *Concepts & Applications of Finite Element Analysis*, John Wiley & Sons
3. D. V. Hutton, *Fundamentals of Finite Element Analysis*, Tata McGraw Hill
4. S. S. Bhavakatti, *Finite Element Analysis*, New Age International

Reference Books

1. J. N. Reddy, *An Introduction to the Finite Element Method*, McGraw Hill International Edition
2. S. S. Rao, *The Finite Element Method in Engineering*, Butterworth Heinemann
3. K. J. Bathe, *Finite Element Procedures in Engineering Analysis*, Prentice Hall of India
4. O. C. Zienkiewics, R. L. Taylor, *The Finite Element Method*, Vol I & II, McGraw Hill

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, etc. Atleast one assignment should be programming / problem solving using computers.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 603: Machine Design-I

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To provide basic knowledge on the design considerations and methodology of various machine elements.*

Module I (15 Hrs)
System design cycle - Different phases in design process – design factors and considerations – tolerances and fits – Hole basis & Shaft basis system - standardization – selection of materials – stress concentration – Methods to reduce stress concentration - theoretical stress concentration factor - theories of failure – Guest's theory – Rankine's theory – St. Venant's theory – Haigh's theory – Von Mises & Hencky theory - shock and impact loads – fatigue loading – endurance limit stress- Factors affecting endurance limit - Factor of safety - creep and thermal stresses.

Module II (13 Hrs)
Threaded joints – thread standards- thread nomenclature - stresses in screw threads- bolted joints- preloading of bolts- eccentric loading- fatigue loading of bolts - gasketed joints- power screws - design of riveted joints- Failure of riveted joints and efficiency of joint -boiler and tank joints- structural joints- cotter and knuckle joints

Module III (14 Hrs)
Design of welded joints- Representation of welds - stresses in fillet and butt welds- design for static loads - bending and torsion in welded joints- eccentrically loaded welds - design of welds for variable loads.
Springs- stresses and deflection of helical springs with axial loading – curvature effect – resilience - design of spring for static and fatigue loading- surging- critical frequency- stress analysis and design of leaf springs- nipping.

Module IV (12 Hrs)
Shafts and axles design- stresses- causes of failure in shafts - design based on strength, rigidity and critical speed- design for static and fatigue loads- repeated loading- reversed bending-design of couplings- rigid and flexible couplings-design of keys and pins.

Note: The following data books are permitted for reference in the final examination:

- PSG Design Data, DPV Printers, Coimbatore.
- Prof. Narayana Iyengar B.R & Dr Lingaiah K, Machine desing Data Handbook, Vol I & II

Text Books
1. J. E. Shigley, *Mechanical Engineering Design*, McGraw Hill Book Company.
2. M. F. Spotts, T. E. Shoup, *Design of Machine Elements*, Pearson Education.

Reference Books
1. Juvinall R.C & Marshek K.M., Fundamentals of Machine Component Design, John Wiley

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, etc. Atleast one assignment should be programming / problem solving using computers.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 604: Operations Research

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart knowledge on linear programming, transportation problem, assignment problem, game theory and queuing theory.*

Module I (13 hours)
Review of the properties of matrices and matrix operations - Lines and hyper planes – linear inequalities – convex sets – extreme points – fundamental theorem of linear programming - Development of OR – Phases of OR – Scope of OR – Advantages and limitations of OR.
Formulation and application of linear programming to production, marketing, finance and other areas – Concepts of Solution space, convex region, basic feasible solution, optimal solution – Solving LPP by graphical method

Module II (14 hours)
Solving LPP by Simplex method– slack and surplus variables – basic feasible solutions – reduction of a feasible solution to a basic feasible solution – artificial variables – optimality conditions – unbounded solutions –big M method- two phase method- degeneracy – duality.

Module III (13 hours)
Transportation problem – coefficient matrix and its properties – basic set of column vectors – linear combination of basic vectors – tableau format – stepping stone algorithm – UV method – inequality constraints – degeneration in transportation problems
Assignment problem as a maximally degenerate transportation problem – Koning's method

Module IV (14 hours)
Game theory –Two person zero sum games– saddle points – pure and mixed strategies - dominance – graphical solutions
Basic structure of queuing models – exponential and Poisson distributions - queuing models based on Poisson inputs and exponential service times – basic model with constant arrival rate and service rate – Poisson-exponential single server model, infinite population– Poisson-exponential single server model, finite population - Poisson-exponential multiple server model, infinite population
Dynamic programming – Bellman's principle of optimality – formulation and solution of simple problems

Reference Books

1. Ravindran A., Phillips D. T., Solberg J. J., *Operations Research Principles and Practice*, John Wiley
2. Vohra N. D. *Quantitative Techniques for Management*, Tata McGraw Hill, New Delhi
3. Hadley G., *Linear Programming* , Addison Wesley
4. Hillier F. S., Lieberman G.J. *Introduction to Operations Research* , McGraw Hill
5. Taha H. A., *Operations Research, An introduction* , P.H.I.
6. Wagner H.M., *Principles of Operations Research with Application to Managerial Decision*,
7. R. Panneerselvam, "*Operations Research*", PHI (2002).
8. S. D. Sharma, *Operation Research*, Kedarnath and Rannalt Pub.
9. Hira and Gupta, *Operation Research*, S. Chand and Co.

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 605: Computer Integrated Manufacturing

Teaching scheme **Credits: 3**

2 hours lecture and 1 hour tutorial per week

Objectives

- *To impart fundamental knowledge of Numerical Control, NC part programming, Controls in CIM, material handling systems.*
- *To acquire comprehensive idea on FMS and Robotics.*

Module I (7 hours)

Introduction- fundamentals of numerical control- advantages of NC system - classification of NC system - NC and CNC - open loop and closed loop systems - features of NC machine tools - fundamentals of machining- design considerations of NC machine tools- methods of improving machine accuracy and productivity- special tool holders.

Module II (10 hours)

NC part programming - manual programming - part programming examples- point to point programming and contour programming- computer aided programming concepts- post processor- program languages- APT- programming - part programming examples.

Module III (10 hours)

Controls in CIM- material handling in CIM- AGV- Vehicle guidance- vehicle management and safety- automated storage systems- ASRS components and operations- features of ASRS- automatic data capture- barcode technology- magnetic strips- optical character recognition- group technology- part family- part classification and coding - features OPITZ classification and multi class coding system.

Module IV (9 hours)

Flexible manufacturing system- types of FMS- components of FMS- FMS workstations- material handling and storage systems- FMS layout- configurations- computer control systems in FMS- applications and benefits of FMS- industrial robotics- robot anatomy- configurations- joints- drive systems- robot control systems- end effectors- sensors in robots- industrial robot applications- robot programming- on line and off line programming

Text Books

1. Yoram Koran, *Computer control of manufacturing systems*, Mc Graw Hill IntI. Book Co., John Wiley & Sons, N. Y., 2002
2. Mickel. P. Grooer, *Automation, Production Systems and Computer Integrated Manufacturing*, Pearson Education

Reference Books

1. H.M.T, *Mechatronics*, Tata Mc Graw Hill
2. Mickel. P. Groover, *Industrial Robotics Technology, Programming and Applications*, Mc Graw Hill.
3. Radhakrishnan P., *Computer Numerical Control Machines*, New Central Book Agency.
4. Radhakrishnan P., Subramanian S., *CAD/CAM and CIM*, Wiley Eastern, 1994.
5. Groover, *Automation, Production Systems and CIM*, Prentice Hall, 1990.
6. Nagpal G.R. , *Machine Tool Engineering*, Khanna Publishers, 2000

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 607(P): Mini Project

Teaching scheme **Credits:** 2

3 hours practical per week

Objectives

- *To practise the steps involved for the selection, execution, and reporting of the project.*
- *To train the students for group activities to accomplish an engineering task.*

A team of students having a maximum of five members shall constitute a batch for the mini-project. The head of the department will decide the framing of the project batches. The subject content of the mini project shall be from emerging /thrust areas, topics of current relevance having research aspects or shall be based on industrial visits undergone in 4th, 5th semesters. At the end of the semester, each group of students should submit a report duly authenticated by the respective guide, to the head of the department.

Mini Project will have internal marks 50 and Semester-end examination marks 50. Internal marks will be awarded by respective guides as per the stipulations given below.

- Attendence, regularity and individual contribution of each student (20 marks)
- Individual evaluation through viva voce / test (30 marks)

Total (50 marks)

Semester End examination will be conducted by a committee consisting of three faculty members. The students are required to bring the report completed in all respects duly authenticated by the respective guide and head of the department, before the committee. Students individually will present their work before the committee. The committee will evaluate the students individually and marks shall be awarded as follows.

- Report = 25 marks
- Concept/knowledge in the topic = 15 marks
- Presentation = 10 marks

Total marks = 50 marks

ME09 608(P): Thermal Lab - II

Teaching scheme **Credits:** 2
3 hours practical per week

Objectives

- *To strengthen the knowledge on heat engines, and heat transfer principles through advanced experiments.*
- *To equip the students to carry out independent experiments, and to train them to analyse, report and infer the results.*

1. Test on IC engines:
    - Variable speed performance test on petrol and diesel engines
    - Determination of friction power – retatrdation test and morse test
    - Study of the effect of cooling water on engine performance
    - Heat balance test
    - Analysis of the exhaust gas of IC engines
2. Heat transfer experiments:
    - Performance studies on a shell and tube heat exchanger
    - Performance studies on parallel and counter flow arrangements in a concentric pipe heat exchanger
3. Performance tests on air compressor and blower
4. Performance test on refrigeration plant

Reference Books

1. P. L. Bellani, *Thermal Engineering*, Khanna Publishers
2. J. P. Holman, Heat Transfer, McGraw Hill
3. Obert, Internal Combustion Engines, McGraw Hill

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Practicals and Record (30 marks)
30% - Test /s (15 marks)
10% - Regularity in the class (5 marks)

Semester End Examination *(Maximum Marks-50)*

70% - Procedure, conducting experiment, results, tabulation, and inference (35 marks)
20% - Viva voce (10 marks)
10% - Fair record (5 marks)

ME09 L01: Composite Materials

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To provide knowledge on characteristics of composites, manufacturing and testing methods, mechanical behaviour, recent trends and its application.*

Pre-requisites: *Basic knowledge of material science and mechanics of solids*

Module I (13 hours)
Introduction to composites: Characteristics and classifications of composites – study of fibers, flake and particulate composites.
Manufacturing methods: Production of various fibers – matrix materials and surface treatments – fabrication of composites – fabrication of thermosetting resin matrix composites – fabrication of thermoplastic resin matrix composites – short fiber composites – fabrication of metal matrix and ceramic matrix composites.

Module II (13 hours)
Testing aspects of composites: Experimental characterisation of composites – uniaxial tension, compression and shear tests – determination of interlaminar fracture toughness – damage identification through non-destructive evaluation techniques – ultrasonic, acoustic emission and X-radiography.

Module III (13 hours)
Mechanical behaviour of UD composites: Longitudinal strength and stiffness – transverse strength and stiffness – failure modes – analysis of laminated composites – stress-strain variation in a laminate.

Module IV (13 hours)
Special laminates: Symmetric laminates, uni-directional, cross-ply and angle-ply laminates, quasi-isotropic laminates. Recent trends in composite materials – carbon-carbon composites, Bucky Papee. Application of composite materials in aerospace, automotive, defence and industry.

Text Books
1. B. D. Agarwal, L. J. Broutman, *Analysis and Performance of Fiber Composites*, John Wiley.

Reference Books
1. R. F. Gibson, *Principle of Composite Material Mechanics*, McGraw Hill
2. M. M. Schwartz, *Composite Materials Handbook*, McGraw Hill. Inc.
3. R. M. Jones, *Mechanics of Composite Materials*, McGraw Hill. Inc
4. S. W. Tsai, *Introduction to Composite Materials*, Technomic Publishing Company.

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 L02: Computational Methods in Engineering

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart the concept of various numerical methods in engineering.*
- *To develop understanding about the method of applying numerical techniques with the help of computers for solving complex problems.*

Pre-reqisites: *Basic knowledge of engineering mathematics*

Module I (13 hours)
Errors in numerical calculations: Sources of errors, significant digits and numerical instability – numerical solution of polynomial and transcendental equations – bisection method – method of false position – Newton-Raphson method – fixed-point iteration – rate of convergence of these methods – iteration based on second degree equation – the Muller's method – Chebyshev method – Graeffe's root squaring method for polynomial equations – Bairstow method for quadratic factors in the case of polynomial equations.

Module II (13 hours)
Solutions of system of linear algebraic equations: Direct methods – Gauss elimination and Gauss-Jordan methods – Crout's reduction method – error analysis – iterative methods – Jacobi's iteration – Gauss-Seidal iteration – relaxation method – convergence analysis – solution of system of nonlinear equations by Newton-Raphson method – power method for the determination of Eigen values – convergence of power method. Solution of tri-diagonal system – Thomas algorithm.

Module III (14 hours)
Polynomial interpolation: Lagrange's interpolation polynomial – divided differences – Newton's divided difference interpolation polynomial – error of interpolation – finite difference operators – Gregory-Newton forward and backward interpolations – Stirling's interpolation formula – interpolation with a cubic spline – numerical differentiation – differential formula in the case of equally spaced points – numerical integration – trapezoidal and Simpson's rules – Gaussian integration – errors of integration formulae.

Module IV (14 hours)
Numerical solution of ordinary differential equations: Taylor series method – Euler and modified Euler methods – Runge-Kutta methods (2^{nd} order and 4^{th} order only) – multistep methods – Milne's predictor-corrector formulae – Adam-Bashforth and Adam-Moulton formula – solution of boundary value problems in ordinary differential equations – shooting method – finite difference methods for solving two dimensional Laplace's equation for a rectangular region – finite difference method of solving heat equation and wave equation with given initial and boundary conditions.

Text Books

1. Chapra and Canale, *Numerical methods for scientist and engineers*, McGraw Hill.

Reference Books

1. Froberg, *Introduction to numerical analysis*, Addison Wesley.
2. Kandaswamy, *Numerical Analysis*, S Chand
3. Hildebrand, *Introduction to Numerical Analysis*, Tata McGraw Hill.

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, etc. Atleast one assignment should be programming / problem solving using computers.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 L03: Industrial Maintenance

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To provide knowledge on basic concepts of maintenance, vibration monitoring, non destructive testing and concepts of reliability*

Module I (12 hours)
Basic concepts purpose and functions of maintenance- types of maintenance- condition monitoring– principles and method –Transducers for vibration measurement.

Module II (14 hours)
Elementary problem diagrams – misalignment – unbalance – vibration monitoring and analysis – vibration analysis – proximity analysis – frequency analysis – spectral analysis – real time analysis vibration limits vibration severity criteria vibration severity charts – shock pulse analysis application to condition monitoring of ball and roller bearings - vibration signature analysis.

Module III (14 hours)
Ferrography – spectral oil analysis procedure – non destructive testing – liquid penetrant testing – radio graphic inspection – ultra sonic testing acoustic emission corrosion monitoring – resistance techniques – technique providing information on plant regarding corrosion monitoring

Module IV (14 hours)
Reliability: Basic concepts – reliability , maintainability and availability – failure rate – mean time between failures – system reliability – reliability of series and parallel systems – reliability estimation using exponential distribution function.

Text Books

1. L. S. Sreenath, *Vibration spectrum analysis A practical approach:*, Steve Goldman Industrial Press Inc.

Reference Books

1. Miller, Blood, *Modern Maintenance Management*, D B Tarapur.

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, etc. Atleast one assignment should be programming / problem solving using computers.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 L04: Mechatronics

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To provide basic knowledge on elements, principles and design of electronic controls for mechanical systems.*

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Pre-requisites: *Basic knowledge of electronics and mechanical engineering.*

Module I (13 hours)
Introduction to Mechatronics – scope - Mechatronics and Engineering Design. Sensors and transducers – classification-thermal, electrical, optical, acoustic, pneumatic, magnetic, and piezo electric sensors. Open loop and closed loop control systems - continuous and discrete processes - servo mechanism – principles - components - error detectors - potentiometers- types. Pneumatic and hydraulic systems - mechanical and electrical systems.

Module II (13 hours)
Condition monitoring – principles - sensors for force, vibration, temperature, and noise-acoustic emission – principles and applications.
Design of modern CNC machines and Mechatronic elements - Machine structure - guide ways – drives – bearings - anti friction bearings, hydrostatic bearing, hydrodynamic bearing. Measuring system for NC machines - direct and indirect measuring system - Smart sensors.

Module III (14 hours)
Closed loop controllers - proportional, derivative and integral controls - PID controller - digital controllers - controller tuning - adaptive control of machine tools.
Mechatronics in Robotics - robot position and proximity sensing - tactile sensing. Man-machine interface.
Micro controllers and microprocessors - digital logic circuits - micro controller architecture and programming - programmable logic controllers. Automatic control and real time systems-Neural network systems - Fundamentals of ANN – perceptions – back propagation.

Module IV (14 hours)
System modelling - mathematical models - mechanical, electrical, fluid and thermal system building blocks - system models - dynamic response of systems - first and second order systems - modelling dynamic systems - system transfer functions - frequency response – stability.
Stages in designing mechatronic systems - traditional and mechatronic design -possible design solutions - case studies of mechatronic systems - pick and place robot - automatic car park system - engine management system.

Text Books

1. W. Bolton, *Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering*, Addison Wesley Longman Limited.

Reference Books

1. R. C. Dorf, R. H. Bishop, *Modern Control Systems*, Addison Wesley
2. Krishna Kant, *Computer Based Industrial Control*, Prentice Hall of Indian Private Limited
3. HMT Limited, *Mechatronics*, Tata McGraw Hill Publishing Company Limited
4. Herbert Taub, Donald Schilling, *Digital Integrated Electronics*, McGraw Hill International Editions
5. Dan Necsulescu, *Mechatronics*, Pearson Education Asia, 2002(Indian reprint).

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, etc. Atleast one assignment should be programming / problem solving using computers.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 L05: Tool Engineering and Design

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart knowledge on basic concepts of tool design.*

Module I (13 hours)
Design of chips forming tool, chip removal process, principle, classification of tools, tool geometry – tool materials – multi point tools – milling cutter, drills, reamer, taps, broaches, Machining time estimation for milling, drilling, cutting power estimation in milling, drilling operations, boring bar, vibration damping of bar boring.

Module II (13 hours)
Power presses, types, die cutting operation, press tonnage calculations – scrap-strip layout, compound & progressive dyes, design of dies for simple components, drawing dies, blank development, press tonnage and blank holding pressure, draw dies for simple components.

Module III (13 hours)
Design of thermoplastic injection moulds: Plastic materials, classes of plastics, injection moulds, specifications, injection moulding machine and its influence in mould design, phases of moulding cycle, parting surfaces, feed systems – sprue, runner and gate systems, mould casting, ejection methods, shrinkage, mould tool materials.

Module IV (13 hours)
Design of work holders: Purpose of work holders, function, principle of location and clamping, locators, toll forces, design of work holder for tapping, fixture components, work holders for round work pieces – mandrels, collets.

Reference Books

1. A. Bhattacharya, Metal cutting theory and practice, Central Book Publishers.
2. ASTME, *Fundamentals of tool design*, Prentice Hall.
3. G. R.. Nappel, *Machine Tool Engineering, Khanna Publishers*
4. P. S. Cracknell, R. W. Dysor, *Handbook of thermoplastic injection mould design*, Blackie Academic and Professional, Glasgow.
5. HMT, *Production Technology*, Tata McGraw Hill

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, etc. Atleast one assignment should be programming / problem solving using computers.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 701: Machine Design-II

Teaching scheme **Credits:** 5
4 hours lecture and 1 hour tutorial per week

Objectives

- *To provide basic design skill with regard to clutches, brakes, belt drives, bearings and gears.*

Module I (20 Hrs)
Clutches – friction clutches- design considerations-multiple disc clutches-cone clutch- centrifugal clutch - Brakes- Block brake- band brake- band and block brake-internal expanding shoe brake - Design of Flat belt- materials for belts- slip of the belts- creep - centrifugal tension - Design of V-belt drives- Advantages and limitations of V-belt drive- selection of roller chains- power rating of roller chains- galling of roller chains- polygonal action- silent chain.

Module II (17 Hrs)
Design of bearings – Types – Selection of a bearing type - bearing life – Rolling contact bearings - static and dynamic load capacity – axial and radial loads – selection of bearings – dynamic equivalent load - lubrication and lubricants – viscosity – Journal bearings – hydrodynamic theory – design considerations – heat balance – bearing characteristic number – hydrostatic bearings.

Module III (19 Hrs)
Gears- classification- Gear nomenclature – Tooth profiles – Materials of gears - design of spur, helical, bevel gears and worm & worm wheel - Law of gearing - virtual or formative number of teeth- gear tooth failures- Beam strength - Lewis equation- Buckingham's equation for dynamic load- wear load- endurance strength of tooth- surface durability- heat dissipation – lubrication of gears – Merits and demerits of each type of gears.

Module IV (16 Hrs)
Design recommendations for Forgings- castings and welded products- rolled sections- turned parts- screw machined products- Parts produced on milling machines. Design for manufacturing - preparation of working drawings - working drawings for manufacture of parts with complete specifications including manufacturing details.

Note: The following data books are permitted for reference in the final examination:

- PSG, Design *Data*, DPV Printers, Coimbatore.
- Prof. Narayana Iyengar B.R & Dr Lingaiah K, *Machine design Data Handbook*, Vol I & II.

Text Books

1. J. E. Shigley, *Mechanical Engineering Design*, McGraw Hill Book Company.
2. M. F. Spotts, T. E. Shoup, *Design of Machine Elements*, Pearson Education.

Reference Books

1. Juvinall R.C & Marshek K.M., Fundamentals of Machine Component Design, John Wiley
2. Doughtie V.L., & Vallance A.V., Design of Machine Elements, McGraw Hill Book Company.
3. Siegel, Maleev & Hartman, Mechanical Design of Machines, International Book Company.

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, etc. Atleast one assignment should be programming / problem solving using computers.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 702: Operations Management

Teaching scheme **Credits: 4**
3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart knowledge on production, planning and control functions, method study, materials management, inventory models, maintenance management and project management*

Pre-requisites: *nil*

Module I (14 hours)
Operations Management – An overview: Nature and scope of production and Operations Management – Productivity and factors affecting productivity – Types of production systems- product life cycle
Forecasting technique – Causal, Time series and Qualitative methods – Regression, Moving average- Trend and seasonality- Exponential smoothing and Delphi technique
Product design and development – principles of good product design- quality and cost consideration – standardization – simplification

Module II (13 hours)
Process design and planning – Types – Fixed, Product, process, hybrid and FMS
Facility location and layout – Influencing factors and evaluation methods – Layout design process – Computerised layout planning - Assembly line balancing – Material handling systems
Work system design – Method study – Recording techniques- micro motion study – work measurement
Aggregate production planning – Master production scheduling – Material requirement planning – Manufacturing resource planning

Module III (14 hours)
Materials Management: Purchase Management- Stores Management
Inventory: Functions – Costs – classifications – Deterministic and Probabilistic Inventory models- Quantity discount – Safety stock
Operations scheduling: Strategy and guidelines – charts and methods – sequencing – Johnson's rules for sequencing
Dispatching, progress reporting and expediting functions

Module IV (13 hours)
Maintenance and replacement – Preventive and breakdown maintenance – Economic aspects – Replacement of equipment – methods
Network techniques for Project management – Time estimates – Time- Cost trade offs- Crashing – Shortest route problem – Minimal Spanning tree problem – Maximal flow in capacitated network

Reference Books

1. *Mahadevan B. Operations Management Theory and Practice, Pearson education, Second impression 2007*
2. *William, J. Operations Management,. Stevenson 8th 2005 edition*
3. *Chase Richard B Operations Management, 11th edition Tata Mc Grawhil*
4. *Ashwathappa. K, Sridhar Bhat. K, Production and Operations Management, Himalaya Publications*
5. *Monks, Joseph G. Operations Management, Mc Grawhil*
6. *Riggs J.L Economic Decision Models for Engineers and Managers, McGraw Hill International Student Edition*
7. *Weist and Levy, A Managemnt Guide to Pert and CPM, Prentice Hall of India*
8. *Samuel Eilon, Production Planning and Control, Universal Book Corporation*
9. *Francis and White, Facility Layout and Location, Prentice Hall Inc*
10. *Hillier and Liberman, Introduction to Operations Research, Holden Day Inc*
11. *Biegel, Production Control, Prentice Hall of India*
12. *James Moore, Plant Layout and Design, The MacMillan Company*

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

University Examination Pattern

PART A: Short answer questions (one/two sentences) *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: Analytical/Problem solving questions *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: Descriptive/Analytical/Problem solving questions *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 703: Metrology & Instrumentation

Teaching scheme **Credits:** 3
2 hours lecture and 1 hour tutorial per week

Objectives

- *To provide the fundamental concepts and principles of metrology and instrumentation*
- *To impart the various methods of measurement of physical and mechanical quantities*

Module I (9 hours)
Mechanical measurement – direct comparison and indirect comparison – the generalized measurement system – types of input quantities – measurement standards – calibration – uncertainty – systematic and random errors – common types of errors – classifications of errors – terms used in rating instrument performance – introduction to uncertainty – propagating uncertainity Kline and Mc lintock approach – zero first and second order instruments – methods of correcting for spurious inputs – inherent insensitivity – high gain feed back – signal filtering and opposing inputs.

Module II (9 hours)
Sensors – loading error – primary and secondary transducers – compatibility of mechano electric transducer combination – variable resistance transducers - sliding contact devices – variable inductance elements – self inductance and mutual inductance elements – differential transformer – construction and characteristics – rotary differential transformer –variable reluctance transducer – capacitance transducers – active and passive transducers – piezo electric transducers – photoelectric sensors – Hall effect transducers – resistance wire strain gages – types – theory of metallic strain gauges – selection and installation – strain gauge circuits – ballast circuit – bridge circuit – bridge with two and four arm sensitivity – calibration of strain gauges – application of strain gauges-load cells-measurement of strain in rotating shafts – measurement of pressure – standards of pressure – measurement of high pressure – bulk modules gauge – measurement of low pressure – the Mc Leod Gauge – thermal conductivity gauges – ionizing gauges.

Module III (9 hours)
Measurement of temperature – liquid in glass thermometer – complete partial and total immersion thermometers – resistance thermometers – constructional details – resistance thermometer circuits – lead wire compensation for resistance thermometers – thermistors – constructional details – measuring circuits for thermistors – thermo electric thermo meters – laws of thermocouples – industrial thermocouples and their ranges – making of thermocouple junctions – ambient temperature compensation- use of extension heads – pyromeres – optical total radiation and photo electric pyrometers -linear Quartz thermometer - measurement of flow – need for flow metering – rotameter – theory and constructional details – magnetic flow meters – hotwire anemometers – drag force flow meter

Module IV (9 hours)
Linear and angular measurement – slip gauges stack of slip gauge – method of selecting slip gauges – adjustable slip gauge – measurement of angles – sine bar checking unknown angles- sine center – sources of error – angle gauges – optical instruments for angular measurement- auto collimator – applications – straightness and square ness – angledekkor – precision spirit levels – Clinometers – measurement of surface roughness – surface texture – primary texture – secondary texture and the lay specification for surface textures – methods of measuring surface finish . The Talysurf instrument – the profilograph – Tomlinson surface meter – Tracer type profilograph – measurement of screw thread profiles – errors in pitch – microscopic method -measurement of internal thread – measurement of effective diameter – two wire and three wire method – measurement of root diameter – gear tooth measurement – measurement of gear profile – tooth thickness – tooth spacing – pitch circle diameter – Parkinson’s gear tester- the

coordinate measuring machine construction – operation and programming – machine vision – image acquisition and digitization - image processing and analysis.

Text Books

1. Ernest O. Doebelin, *Measurement Systems Application and Design*, McGraw-Hill Publishing Company
2. Jain R.K., *Engineering Metrology,* Khanna Publishers, Delhi
3. Holman J.P., *Experimental Methods for Engineers,* Mc Graw Hill Co

Reference Books

1. Beckwith, T.G. and Buck, N.L., *Mechanical Measurements,* Addition Wesley Publishing Company Limited
2. Jain R.K., *Mechanical and Industrial Measurements,* Khanna Publishers, Delhi
3. Rangan, Mani and Sharma, *Instrumentation*, Tata McGraw-Hill Publications
4. Instrumentation, measurement & analysis by B.C.Nakra & K.K.Choudhary, TMH
5. ASME, *Hand Book of Industrial Metrology*.
6. Kastushiko Ogatta, Modern control systems, McGraw-Hill.

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 =10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 =20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 =40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 704: Power Plant Engineering

Teaching scheme **Credits:** 3
2 hours lecture and 1 hour tutorial per week

Objectives

- *To impart the concept of power plant technology.*
- *To develop understanding about power plant cycles, power generation devices, and power plant economics.*

Module I (9 hours)
Analysis of vapor power cycle- Rankine cycle-re heat and re- generative cycles-open and closed feed water heaters –cogeneration- combined gas power cycle-binary vapour cycle.

Module II (9 hours)
Steam turbines- classification-velocity diagrams-efficiencies-turbine performance and governing. condensers and cooling towers –classification –selection and performance
Thermal power plant systems- fuel handling and ash handling systems-combustion equipments-super heaters, economizers and air-pre heaters. Pollution from thermal power plant-pollution control.

Module III (9 hours)
Modern high pressure boilers-sub critical and super critical steam generation-rating of boilers-boiler efficiency-equivalent evaporation-boiler draught-guidelines for selection of boilers for steam power plants-.boiler testing and trials-inspection and safety regulations.

Module IV (9 hours)
Nuclear and MHD power generation-nuclear fission-chain reaction- pressurized water reactors-boiling water reactors-gas cooled reactors-fast breeder reactors-MHD power cycle principles.
Economics of power plant-actual load curve- fixed cost- operating cost-variable load operation.

Text Books
1. P. K. Nag, *A Text Book of Power Plant Engineering*, Tata McGraw Hill.

Reference Books
1. E. L. Wakil, *Power Plant Technology*, McGraw Hill.
2. P. C. Sharma, *Power Plant Engineering*, S.K Kataria and Sons
3. Domkundwar, *Power Plant Engineering*, S. Chand.

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 707(P): CAD Lab

Teaching scheme **Credits:** 2
3 hour practical per week

Objectives

- *To train the students in solid modelling*
- *To practise static and dynamic analyses using FEM*
- *To practise computer controlled manufacturing methods*

1. Exercises on solid modeling (12 hours)
Introduction to computer graphics - viewing transformations, curves and surfaces generation, curve fitting and curve fairing techniques - 2D, wire frame, 3D shading - familiarity with Boolean operations - sweep, revolve, loft, extrude, filleting, chamfer, splines etc. - windowing, view point, clipping, scaling and rotation transformations using commercial solid modeling packages

2. Exercises on finite element analysis (12 hours)
Introduction to FEM - 1D, 2D and 3D elements - shape functions - preprocessing - boundary conditions, structured and free mesh generation - analysis - linear and non linear analysis - static and dynamic analysis - post processing - display, animation, extraction of nodal data - exercises on heat conduction and elasticity may be given using commercial FEM packages

3. Assembly and mechanism design (6 hours)
Assembling of various parts and tolerance analysis - synthesis and design of mechanisms - animations - exercises on various mechanisms like four bar linkages and its variations - cam and follower - two and four stroke engines

4. Computer aided manufacturing (9 hours)
Part programming fundamentals - manual part programming and computer aided part programming - hands on training in computer controlled turning and milling operations - familiarity with windows based software packages - tool path generation and simulation - exercises on CNC lathe and machining center/milling machines

5. Programming of industrial robots (6 hours)
Introduction to robotics - structure, workspace analysis and various components - actuators - sensors - encoders - end effectors - applications - hands on training on industrial robots - manual and programmed path planning

6. Computer aided inspection and quality control (3 hours)
Introduction to CMM - classification - structure - components - familiarity with measurement software packages and its modules - demonstration of the capability of coordinate measuring machine using a sample component e.g. - engine block - concepts of reverse engineering and rapid prototyping technology

Reference Books

1. D. F. Rogers, J. A. Adams, *Mathematical Elements for Computer Graphics*, McGraw Hill
2. F. R. David, *Procedural Elements for Computer Graphics*, McGraw Hill
3. R. D. Cook, D. S. Malkus, M. E. Plesha, R. J. Witt, *Concepts & Applications of Finite Element Analysis*, John Wiley & Sons
4. K. Yoram, *Computer Control of Manufacturing Systems*, McGraw Hill
5. K. Rao, Tewari, *Numerical Control and Computer Aided Manufacturing*, Tata McGraw Hill
6. V. Ramamurthy, *Computer Aided Mechanical Design*, Tata McGraw Hill
7. K. S. Fu, R. C. Gonzalez, C. S. G. Lee, *Robotics: Control, Sensing, Vision and Intelligence*, McGraw Hill
8. K. Yoram, *Robotics for Engineers*, McGraw Hill
9. J. A. Bosch, *Coordinate Measuring Machines and Systems*, Marcel Decker Inc.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Practicals and Record (30 marks)
30% - Test /s (15 marks)
10% - Regularity in the class (5 marks)

Semester End Examination *(Maximum Marks-50)*

70% - Procedure, modelling steps, analysis, results, and inference (35 marks)
20% - Viva voce (10 marks)
10% - Fair record (5 marks)

ME09 708(P): Instrumentation Lab

Teaching scheme **Credits:** 2
3 hour practical per week

Objectives

- *To provide knowledge of uncertainties involved in any measurement.*
- *To train the students in the calibration and use of different measuring instruments.*

I. (a) Determination of uncertainties in computed quantities such as the following
(i) Volume of a rectangular block or cylinder computed from measurements of length, width, height and diameter
(ii) Water power computed from measurements of density, local acceleration due to gravity, volumetric flow rate and head
(iii) Shaft power computed from measurements of speed and torque
(iv) Electrical power computed from measurements of "number of rotations of energymeter disk", time taken and "energymeter constant"
(b) Selection of instruments for computing quantities with desired uncertainties

II. Determination of bias and random error of the following instruments by calibrating them using proper standards
(i) Load cells such as strain-gauge-load cells, strain-gauge-beam transducer etc.
(ii) Rotameter
(iii) Bourdon-tube pressure gauge
(iv) LVDT
(v) Thermocouples
(vi) Tachometers
(vii) Constant area flow meters

III. (a) Preparation of a psychrometric chart for the laboratory and determination of psychrometric properties of atmospheric air - use of Sling psychrometer
(b) Analysis of exhaust gases and flue gases with the help of orsats apparatus, gas chromatograph, paramagnetic oxygen analyser, smokemeter etc.
(c) Acoustic measurements: sound level meter-octave band filter- preparation of noise contours
(d) Plotting of velocity profiles using pitot tubes and hot wire anemometers

IV. Study of, and making measurements with: Water meter, velometers, pH meter, slip gauges, comparators, planimeter, pyrometers, RTDs, thermistors, CRO, multimeters, linear capacitance meters & LDR (light depended resistance)

V. Determination of static and dynamic characteristics of zero, first and second order instruments

Reference Books

1. E. O. Doebelin, *Mechanical Measurements- Application and Design,* McGraw Hill.
2. J.P. Holman, *Experimental Methods for Engineers*, McGraw Hill.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Practicals and Record (30 marks)
30% - Test /s (15 marks)
10% - Regularity in the class (5 marks)

Semester End Examination *(Maximum Marks-50)*

70% - Procedure, modelling steps, analysis, results, and inference (35 marks)
20% - Viva voce (10 marks)
10% - Fair record (5 marks)

ME09 709(P): Project

Teaching scheme **Credits:** 1
1 hour practical per week

Objectives

- *To practise the steps involved for the selection, execution, and reporting of the project.*
- *To train the students for group activities to accomplish an engineering task.*

The project work shall be a theoretical/ experimental/ design/ software project on any of the topics of mechanical engineering interest. The head of the department will decide the framing of the project batches. Each of the batches shall consist a minimum of five students. The topic of the project should be different from his/her mini project. A faculty member will always be supervising each group as a internal guide. In case an industrial project is selected by a batch, in addition to the internal guide, there should be an external guide from the industry.

During this semester, each group is required to select a topic for the project and study the feasilbility. A project evaluation committee will be constituted by head of the department at the beginning of the semester. A brief report of the chosen project should be submitted before the committee within two weeks from the beginning of the VIIth semester. The committee will give permission for the project after examining the feasibility. In the event of rejection of the topic by the committee, the students should resubmit a new project topic within one week, and get it approved by the committee. After getting the permission, they have to conduct a detailed literature survey, and collect sufficient information and necessary data. Further, they have to a prepare an action plan to carry out the project in the next semester. At the end of the semester, each group should prepare a preliminary report of the project, and appear before the committee for evaluation.

The assessment of the projects should be done at the end of the seventh semester by the committee. The committee will award the group average marks based on the group-wise performance. Based on the group average awarded by the committee, the respective guide will award the individual internal marks (max. 100 marks). For awarding individual marks following points shall be noted.

- Attendence, regularity and individual contribution of each student
- Individual evaluation through viva voce / test

ME09 801: Refrigeration and Air Conditioning

Teaching scheme **Credits: 5**
4 hours lecture and 1 hour tutorial per week

Objectives

- *To impart the concept of the basic principles, working, scientific analysis and system components of different types of refrigeration and air conditioning systems.*
- *To impart the knowledge of various types of refrigerants, their properties, selection criteria and environmental aspects*

Pre-requisites: *Fundamentals of thermodynamics and heat and mass transfer*

Module I (18 hours)
Introduction to refrigeration: Brief history and applications – methods of refrigeration – conventional methods – unit of refrigeration - C.O.P. Mechanical Refrigeration – ideal refrigeration cycles - Carnot refrigeration cycle – limitations of reversed Carnot cycle, air refrigeration cycles: Bell Coleman cycle and Brayton Cycle - open and dense air systems – actual air refrigeration systems – numerical problems. - Air craft refrigeration –basics only. Steam Jet Refrigeration System–working principle and basic components. Principle of thermoelectric refrigeration, adiabatic demagnetization refrigeration and Vortex tube or Hilsch tube refrigeration.

Module II (18 hours)
Vapour compression refrigeration – working principle and essential components- simple vapour compression refrigeration cycle – representation of cycle on T-S and p-h charts – thermodynamic analysis - effect of operating parameters on the performance – liquid vapour regenerative heat exchanger - actual cycle - numerical Problems. Multi pressure systems – multi compression and multi evaporator systems – inter cooling – flash inter cooling and flash gas removal. Vapour Absorption System – working principle - calculation of max COP – description and working of NH_3 – water and Li Br –water systems - comparison with vapour compression system. Three fluid absorption system. Refrigerants and their properties – nomenclature of refrigerants - selection of refrigerants – environmental aspects.

Module III (20 hours)
Introduction to air conditioning - comfort and industrial air conditioning. Psychrometric properties and processes – psychrometric chart - adiabatic mixing – sensible heating and cooling, – humidifying dehumidifying and combinations – sensible heat factor – bypass factor – ADP – concept of RSHF and GSHF – simple problems. Comfort Air conditioning – requirements of human comfort and concept of effective temperature- comfort charts. Air conditioning systems – room air conditioner – split systems – packaged systems – all air and chilled water systems. Summer, winter and year round air conditioning systems. Air conditioning loads – characterization of sensible and latent heat loads – ESHF - need for ventilation and ventilation load – room air distribution – types of supply air outlets – location of outlets and return air. Clean rooms – conventional flow – laminar flow and cross flow clean rooms. Industrial applications of air conditioning.

Module IV (16 hours)
Refrigeration system components: Compressors – general classification - working principle – comparison – advantages and disadvantages. Reciprocating compressors - single and multistage compressors - work of compression - effect of clearance - effect of intercooling - optimum pressure ratio – efficiencies. Condensers and cooling towers – classification – working principle. Evaporators – classification – working principle. Expansion devices – types – working principle. Air conditioning systems components:

filters, grille – grille accessories – dampers, diffusers, registers, fans and blowers, AHUs. AC system controls – thermostat and humidistat.

Text Books

1. C. P. Arora , *Refrigeration and Air Conditioning*, Tata McGraw-Hill Publishing Company Ltd.
2. S. C. Arora, Domkundwar, *A Course in Refrigeration and Air conditioning*, Dhanpatrai.
3. W. F. Stoecker, *Refrigeration and air conditioning*, Tata McGraw-Hill Publishing Company Ltd.
4. ASHRAE *Handbook*.

Reference Books

1. Manohar Prasad, *Refrigeration and Air Conditioning*, New Age.
2. Dossat, *Principles of Refrigeration*, Pearson Education
3. Ananthanarayanan, *Basic Refrigeration and Air-Conditioning*, Tata McGraw-Hill Publishing Company Ltd.
4. Norman Harris, *Modern Air Conditioning Practice*, McGraw Hill

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 802: Compressible Fluid Flow

Teaching scheme **Credits:** 3
2 hours lecture and 1 hour tutorial per week

Objectives

- *To impart the concept of compressible fluid flow.*
- *To develop understanding about flow through duct and nozzles under various conditions.*

Module I (9 hours)
Introduction to compressible flow – continuum concept – control volume analysis – momentum and energy equations for compressible flow – properties of atmosphere – regimes of compressible flow – mach angle and mach cone – wave propagation in elastic medium – acoustic velocity.

Module II (9 hours)
One dimensional isentropic flow through varying area – stagnation conditions – effect of mach number on compressibility – stream thrust and impulse function – flow through nozzle and diffusers – mass flow reactions - choking in isentropic flow – operation of converging and diverging nozzle under varying pressure ratio – use of gas tables.

Module III (9 hours)
Adiabatic flow through constant area duct with friction – fanno line – variation of flow properties – coking due to friction – use of gas tables.
Flow through constant area duct with heat transfer – Rayleigh line – Rayleigh flow equations – conditions for maximum heat transfer – use of gas tables.

Module IV (9 hours)
Flow with normal shock-development of normal shock – normal shock relations – measurement of velocity in supersonic flow – impossibility of normal shock in subsonic flow – strength of normal shock – table and charts for normal shock.

Text Books
1. S. M. Yahia, *Compressible Fluid Flow*, New Age International Pvt. Ltd.

Reference Books
1. A. H. Shapiro, *Dynamics and Thermodynamics of Fluid Flow*, Ronald Press.
2. Oosthuizen, *Compressible Fluid Flow*, McGraw Hill.
3. M. J. Zukrow, D. H. Holfman, *Gas Dynamics*, McGraw Hill.

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 805(P): Seminar

Teaching scheme **Credits:** 2
3 hour practical per week

Objectives

- *To practise various activities involved in a seminar talk – gathering information, preparation of slides, discussion, reporting.*
- *To develop the communicative and writing skills in technical reporting.*

Individual students are required to choose a topic from emerging /thrust areas, topics of current relevance having research aspects in the field of mechanical engineering, or shall be based on industrial visits undergone in the previous semesters, preferably from outside the B.Tech syllabus and give a seminar on that topic for about thirty minutes. A group consisting of at least three faculty members should assess the presentation and will award the marks to the students. Evaluation shall be based on the following pattern.

- Report = 50 marks
- Concept/knowledge in the topic = 20 marks
- Presentation = 30 marks

Total marks = 100 marks

ME09 806(P): Project

Teaching scheme **Credits:** 7
11 hour practical per week

Objectives

- *To practise the steps involved for the selection, execution, and reporting of the project.*
- *To train the students for group activities to accomplish an engineering task.*

During VIIIth semester, each group is required to complete the project as per the plan made in the preliminary report submitted during the VIIth semester. At the middle of the VIIIth semester an Interim Evaluation will be carried out by the evaluation committee constituted in the previous semester. At the end of the semester, each group should also appear for Final Evaluation. Maximum marks for the Interim Evaluation and Final Evaluation will be 30 and 70, respectively.

Interim Evaluation of the project should be done at the middle of the eighth semester by the committee. Each group should submit a copy of the Interim Report of the Project before the committee. Also, copies of the Approval of Project and Preliminary Report shall be submitted to the evaluation committee. The committee will award the group average marks based on the group-wise performance. Based on the group average awarded by the committee, the respective guide will award the individual internal marks (max. 30 marks). For awarding individual marks following points shall be noted.

- Attendence, regularity and individual contribution of each student
- Individual evaluation through viva voce / test

Final Evaluation will be conducted by the committee at the end of the semester. The students are required to bring the Final Project Report completed in all respects duly authenticated by the respective guide and head of the department, before the committee. Students individually will present their work before the committee. The committee will evaluate the students individually and marks shall be awarded as follows.

- Report = 40 marks
- Concept/knowledge in the topic = 20 marks
- Presentation = 10 marks

Total marks = 70 marks

ME09 807(P): Viva Voce

Credits: 3

Objectives

- *To assess the knowledge and experience gathered during the course.*

There will be an Semester-end Examination for the conduct of viva voce. The examination will be covering the theory subjects, mini project, main project, seminar, industrial visit, paper presented at national level or above that has been undergone by the student. A panel of examiners consisting of three members, two external examiners and one internal examiner will conduct the viva voce and award the marks. Mark distribution shall be as follows.

- Subjects : 40
- Seminar : 20
- Project & Mini project : 30
- Industrial visit/ paper presented at national level or above : 10

Total marks : 100

ME09 L06: Aerospace Engineering

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart the concepts of aerospace engineering.*
- *To develop understanding about aerofoil theory and airplane performance.*

Pre-requisites: *Basic knowledge of fluid mechanics and gas dynamics*

Module I (13 hours)
Review of gas dynamics: Control volume analysis, continuity, momentum and energy equations. Static, dynamic and stagnation conditions. Phenomena in supersonic flow – aerostatics – international standard atmosphere – pressure, temperature and density variation in international standard atmosphere.

Module II (13 hours)
Equations for incompressible inviscid flows: Circulation and vorticity - kelvin's theorem – velocity potential and stream function. Elementary flow patterns and their superposition. Blasius theorem. Flow past a cylinder, magnus effect, kutta condition, vortex theory of lift. Conformal transformation, Jowkowski transformation.

Module III (13 hours)
Theory of aerofoil: Application of dimensional analysis to viscous flow over bodies – aerofoil geometry – lift, drag and moment equations, characteristic curves, low theory, symmetric aerofoil, tear drop theory. wave drag of aerofoil – The NACA aerofoils. Theory of propeller – momentum and blade element theory, propeller characteristics.

Module IV (13 hours)
Straight and level flight – stalling speed, minimum drag and maximum power conditions, performance curves. Gliding – gliding angle and speed of fastest glide. Climbing – rate of climb, take off and landing performance, length of runway required. Circling flight, banked flight, range and endurance of airplanes. aircraft instruments – airspeed indicators – calculation of true airspeed, altimeters, rate of climb meter, gyro compass.

Text Books
1. J. D. Anderson Jr., *Fundamentals of Aerodynamics*, McGraw Hill

Reference Books
1. Dommasch, *Airplane Aerodynamics*,
2. A. C. Kermode, *Mechanics of Flight*,
3. Houghton, Brock, *Aerodynamics for Engineering Students*,

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

Internal

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*
Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

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PART A

PART B: Analytical/Problem solving questions *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions

ME09 L07: Automobile Engineering

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart the concepts of automobile engineering.*
- *To develop understanding about various automobile components*

Pre-requisites: *Basic knowledge of mechanical engineering*

Module I (13 hours)
Intorduction: General classification of automobiles, layout of chasis, types of drives of automobile. Engines: Component details – engine parts – cylinder head – cylinder block – piston – piston rings – connecting rod – crank shaft – valve actuating mechanism – combustion chambers.

Module II (13 hours)
Fuel systems: Fuel pump - fuel filter - simple carburettor – modern carburettors. Petrol injection – MPFI, CRDI.
Ignition system: Classification – battery ignition – electronic ignition – starter mechanism – solenoid switch – bendix drives.
Cooling system: Methods of cooling – coolant types.
Lubrication system: Pressurised systems – SAE classification of lubricating oil – oil filter – oil pump.

Module III (13 hours)
Trnasmission: Clutch – single and multi-plate clutches – centrifugal clutches – fluid couplings.
Gear box: Principle and necessity of manual gear box – constant mesh, sliding mesh and synchro mesh gear boxes – over drives – rear wheel and four wheel drives – universal joint – rear axles.
Brakes: Mechanical, hydraulic, vacuum and air brakes – antilock braking systems.

Module IV (13 hours)
Steering and suspension: Different steering mechanisms – power steering – suspension systems – front axle, rigid axle and independent suspensions – anti-roll bar –coil spring and leaf spring – torsion bar – Macpherson struct shock absorber – steeing geometry – caster-ccamber, toe-in, toe-out.
Types of wheel: Integrated rim – flat base rim alloy wheel – wheel balancing.
Tyres: Tubeless tyres – ply ratings – radial tyres.

Text Books
1. J. Heitner, *Automotive Vehicles*,

Reference Books
1. K. Singh; *Automobile Engineering- vol I and II*
2. Narag, *Automobile Engineering, Khanna publishers*
3. *K. M. Gupta, Automobil Engineering- vol I and II*

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 L08: Combustion Engineering

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart the concept of principles of combustion.*
- *To develop understanding about principles of thermodynamics of combustion.*

Pre-requisites: *Baisc knowledge of thermodynamics and heat transfer.*

Module I (13 hours)
Thermodynamics of reactive mixtures: Bond energy – heat of formation, heat of combustion – adiabatic flame temperature. Entropy change for reacting mixtures – chemical equilibrium – equilibrium criteria – evaluation of equilibrium constant and equilibrium composition – simple numerical problems.

Module II (13 hours)
Elements of chemical kinetics: Las of mass action – order and molecularity of reaction – rate equation – arrheniuss law – activation energy – collision theory of reaction rates. General theory of chain reactions – kinetics of chemical chain reactions – reaction of hydrogen with oxygen.

Module III (13 hours)
Laminar flame propagation: Structure of a laminar flame – concentration and temperature profile flames in tubes – theories of laminar flame propagation – thermal and diffusion theories. Determination of burning velocity – flat flame burner method – tube method.

Module IV (13 hours)
Flame stabilisation: Stability diagrams for open flames – mechanism of flame stabilisation – critical boundary velocity gradient – stabilisation by eddies bluff body stabilisation.
Miscellaneous topics: Droplet combustion – fluidised bed combustion – air pollution.

Text Books
1. S. P. Sharma, *Fuels and Comustion*, Tata McGraw Hill

University Examination Pattern

PART A: Short answer questions (one/two sentences) *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: Analytical/Problem solving questions *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A:	*Short answer questions (one/two sentences)* All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.	*5 x 2 marks=10 marks*
PART B:	*Analytical/Problem solving questions* Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.	*4 x 5 marks=20 marks*
PART C:	*Descriptive/Analytical/Problem solving questions* Two questions from each module with choice to answer one question.	*4 x 10 marks=40 marks*

Maximum Total Marks: 70

ME09 L09: Computational Fluid Dynamics

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives:

- *To impart the concept of computational methods in fluid flow and heat transfer*
- *To develop understanding about principles of fluid flow modelling.*

Pre-requisites: *Basic knowledge of fluid mechanics and heat transfer*

Module I (13 hours)
Classification of partial differential equations - system of first and second-order partial differential equations - initial and boundary conditions - finite difference formulations - finite difference equations – simple applications in steady state conduction and convection.

Module II (13 hours)
Elliptic partial differential equations – relaxation method. Parabolic partial differential equations - explicit and implicit method – ADE and ADI method. Hyperbolic partial differential equations – method of characteristics - explicit and implicit method. Consistency, errors and stability analysis.

Module III (13 hours)
Fundamentals of fluid flow modelling – upwind scheme – artificial viscosity – hybrid scheme. Solution of viscous incompressible flows by the stream function – vorticity formulation. Solution of Navier-Stokes equations for incompressible flows using MAC and SIMPLE algorithms – stability considerations.

Module IV (13 hours)
Introduction to finite volume method – regular finite volume – approximations in the discretization technique – discretization procedure – semi-explicit method – implementation of boundary conditions (only elementary theory and no direct problems).

Text Books

1. T. Sundararajan, *Computational fluid flow and heat transfer*, Narosa publishing House

Reference Books

1. A. Hoffmann Klaus, *Computational Fluid Dynamics for Engineers - Volume I*, Engineering Education System, Wichita
2. V. Patankar Suhas, *Numerical Heat Transfer and Fluid Flow*, Taylor & Francis
3. C. A. J. Fletcher, *Computational Techniques for Fluid Dynamics I*, Springer Verlag

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

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PART A

PART B: Analytical/Problem solving questions *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions

ME09 L10: Computerised Materials Management

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To provide knowledge on basics of advances in materials management*

.

Pre-requisites: *Basic knowledge of management principles*

Module I (14 hours)
Introduction to Materials management – Importance of material management and its role in industries. The need for the integrated approach in Material management Demand forecasting – Various qualitative and quantitative methods of demand forecasting – Different type of averaging, Exponentially weighed smoothening, Correction for fluctuations, Time series analysis, Delphi and other Group techniques. Development of simple Computer Programme for forecasting.

Module II (13 hours)
Inventory control – Basic methods in Inventory – Assumptions used in deriving models. Inventory costs and EOQ model. Price breaks and quantities – Effects of variations in lead-time and demand. Effects of shortage cost on EOQ. Systems of Inventory control, Design of Inventory control systems. Development of Computer Programme for forecasting.

Module III (14 hours)
Classification systems and selective Inventory control – ABC, VED, FSN, HML, and MUSIC, 3-D approaches, Coverage analysis in Material management. Development of Computer Programme for ABC analysis – Codification and standardization Systems and Techniques, Effects in Cost.
Vendor rating and source selection. Techniques and materials. Use of Indian Standards for Vendor rating. Make or buy decisions – Materials Requirements Planning Concept, methods and illustration examples.

Module IV (13 hours)
Introduction to JIT philosophy – Features and impact in Materials Management. Purchasing – Purchase organization – legal aspects of buying – Purchase Procedure. Store and Material control – Receipts and issues – Stores Record. Methods and principles of Storing and retrieving items. Material handling devices used in stores – Application of Computers in Material handling – Design of informatics systems for procurement and storage using computer.

Reference Books

1. Bnchan, Kbenigsberg, *Scientific Inventory Management*
2. Starr, Miller, *Inventory Management*
3. R. M. Shah , *Materials Management*
4. P.Gopalakrishnan , *Integrated Material management*
5. Tershine, *Principles of Inventory management*

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 L11: Control System Engineering

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To provide knowledge on basics of control system*

.

Pre-requisites: *Basic mathematics*

Module I (14 hours)
Mathematical modelling –block diagrams-modelling in state space-mechanical,electrical,liquid level and thermal systems- functions, Set point- Identification of plat Characteristics- First order proportional and second order proportional elements.

Module II (13 hours)
Classification of control systems-Trancient response analysis-first and second order representations-Derivation of Transfer functions.

Module III (14 hours)
Dynamic response –stability of control systems- Routh – Hurvitz criterion- Nyquist criterion.Bode plots-root locus method-lead ,lag , lead –lag compensations-introduction to instrument design.

Module IV (13 hours)
Math lab fundamentals- linear and non linear systems –matrix, tensor representations of control systems –solutions by math lab (simple examples).

Reference Books

1. R. K.Jain, *Mechanical and Industrial Measurements*
2. D. M. Considine, *Process Instrument and Control Hand Book*
3. E. O. Doeblin, *Measurements System, Application and Design*
4. K. Ogatta, *Modern control systems*,
5. B. Kuo, *Control Systems, Prentice Hall*

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A:	*Short answer questions (one/two sentences)* All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.	*5 x 2 marks=10 marks*
PART B:	*Analytical/Problem solving questions* Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.	*4 x 5 marks=20 marks*
PART C:	*Descriptive/Analytical/Problem solving questions* Two questions from each module with choice to answer one question.	*4 x 10 marks=40 marks*

Maximum Total Marks: 70

ME09 L12: Cryogenic Engineering

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To provide knowledge on basics of low temperature production and applications*

.

Pre-requisites: *Basic knowledge of thermodynamics and refrigeration*

Module I (13 hours)
Introduction to Cryogenic Systems, Historical development, Low Temperature properties of Engineering Materials, Mechanical properties- Thermal properties- Electric and magnetic properties –Cryogenic fluids and their properties. Applications of Cryogenics: Applications in space, Food Processing, super Conductivity, Electrical Power, Biology, Medicine, Electronics and Cutting Tool Industry.

Module II (16 hours)
Liquefaction systems: ideal system, Joule Thomson expansion, Adiabatic expansion, Linde Hampson Cycle, Claude & Cascaded System, Magnetic Cooling, Stirling Cycle Cryo Coolers.
Gas liquefaction systems: Introduction - Production of low temperatures- General Liquefaction systems- Liquefaction systems for Neon. Hydrogen and Helium – Critical components of Liquefaction systems.

Module III (12 hours)
Cryogenic Refrigeration systems: Ideal Refrigeration systems- Refrigeration using liquids and gases as refrigerant- Refrigerators using solids as working media, cryogenic fluid storage and transfer systems:

Module IV (13 hours)
Cryogenic Storage vessels and Transportation, Thermal insulation and their performance at cryogenic temperatures, Super Insulations, Vacuum insulation, Powder insulation, Cryogenic fluid transfer systems, Pressure flow-level and temperature measurements – Types of heat exchangers used in cryogenic systems. Cryo pumping Applications.

Text Books

1. Klaus D.Timmerhaus, Thomas M. Flynn, *Cryogenic Process Engineering*, Plenum Press, New York, 1989.

Reference Books

1. Randal F.Barron, *Cryogenic systems*, McGraw Hill, 1986
2. R. B. Scott, *Cryogenic Engineering*
3. J. H. Boll Jr., *Cryogenic Engineering*

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 L13: Design of Heat Transfer Equipments

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart the concepts of design of heat transfer equipments.*
- *To develop understanding about design of various heat exchangers*

Pre-requisites: Basic knowledge of fluid mechanics and heat transfer

Module I (13 hours)
Heat exchangers - classification – selection – heat transfer and flow friction characteristics – pressure drop analysis – basic thermal design – theory of heat exchangers – E-NTU, P-NTU and MTD method - F-factor for various configurations - applications to design.

Module II (13 hours)
Shell and tube heat exchanger – construction and thermal features – thermal design procedure – kern method – Bell Delaware method – flow stream analysis method – flow induced vibration in shell and tube heat exchanger.

Module III (13 hours)
Thermal design of double pipe heat exchanger – design of air-cooled heat exchanger – design variables, preliminary sizing – heat transfer and pressure loss calculations – detailed design. Thermal design of regenerators – classifications – governing equations – design parameters.

Module IV (13 hours)
Design of compact heat exchangers – plate and fin, fin-tube and plate and frame heat exchangers – fouling and corrosion in heat exchanger – sizing and cost estimation of heat exchanger.

Text Books

1. Hewitt., *Process Heat Transfer*, CRC Press
2. Saunders, *Heat Exchanger – selection, design and construction*, Longman Scientific and Technical, U. K.

Reference Books

1. R. K. Shah, *Fundamental of Heat Exchanger Design*, John Wiley & Sons

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A:	*Short answer questions (one/two sentences)* All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.	*5 x 2 marks=10 marks*
PART B:	*Analytical/Problem solving questions* Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.	*4 x 5 marks=20 marks*
PART C:	*Descriptive/Analytical/Problem solving questions* Two questions from each module with choice to answer one question.	*4 x 10 marks=40 marks*

Maximum Total Marks: 70

ME09 L14: Design of Jigs & Fixtures

Teaching scheme **Credits: 4**
3 hours lecture and I hour tutorial per week

Objectives

- *To provide knowledge on design of different cutting tools*
- *To develop comprehensive idea on design of jigs and fixtures*

.

Pre-requisites: *Metal cutting and Forming*

Module I (12 Hours)
Location – method of location - Principles of location – 3-2-1 principle – types of location – plane surface – six point – profile – cylindrical – conical – vee – redundant – nest locator – radial – extreme locations.

Module II (14 Hours)
Clamping – principles of clamping - Design and methods of clamping - types of clamps – screw – strap – swing – wedge – multiple – magnetic – latch – self locking – toggle clamps - hydraulic and power clamping.

Module III (14 Hours)
Jigs - Classification of Jigs - Principles of design of Jigs – elements of jig – types of drill jigs – template – sandwich – leaf – box – indexing - drilling and reaming jigs - guide bushings - Simple design for drill Jigs.

Module IV (14 Hours)
Fixtures - Elements of fixture – standard work holding devices - machine vices – mandrels – collets – chucks – magnetic and vacuum chucks - face plates – turning fixture – milling fixture – indexing fixture– grinding fixture – welding and assembly fixtures - modular fixtures - design & sketching of fixtures for turning & milling of simple components.

Text books:

1. Cyril Donaldson, *Tool Design*, Tata McGraw Hill
2. Sharma. P C, *A Text book of Production Engineering*, S. Chand & Co.
3. Jain .R K, *Production Technology*, Khanna Publishers.
4. P H Joshi, *Jigs & Fixtures*, Tata McGraw Hill

University Examination Pattern

PART A:	*Short answer questions (one/two sentences)*	*5 x 2 marks=10 marks*
	All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.	
PART B:	*Analytical/Problem solving questions*	*4 x 5 marks=20 marks*
	Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.	
PART C:	*Descriptive/Analytical/Problem solving questions*	*4 x 10 marks=40 marks*
	Two questions from each module with choice to answer one question.	

Maximum Total Marks: 70

question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 L15: Design of Pressure Vessels and Piping

Teaching scheme **Credits: 4**
3 hours lecture and I hour tutorial per week

Objectives

- *To provide knowledge on design of pressure vessels and piping*

.

Pre-requisites: *Basic knowledge of solid mechanics*

Module I (13 Hours)
Methods for determining stresses - terminology and ligament efficiency - applications.
Stresses in pressure vessels: Stresses in a circular ring, cyclinder - membrane stress analysis of vessel shell - components - cylindrical shells, spherical shells, torispherical heads, conical heads - thermal stresses - discontinuity of stresses in pressure vessels.

Module II (13 Hours)
Design of vessels: Design of tall cylindrical self supporting process columns - supports for short vertical vessels – stress concentration - at a variable thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings. Theory of reinforcement - pressure vessel design.

Module III (14 Hours)
Bucking and fracture analysis in vessels : Buckling phenomenon - elastic Buckling of circular ring and cylinders under external pressure - collapse of thick walled cylinders or tubes under external pressure - effect of supports - elastic buckling of cylinders - buckling under combined external pressure and axial loading

Module IV (14 Hours)
Fracture mechanics based design: LEFM - stress intensity factor – fracture toughness – fracture criterion – fatigue – fatigue crack growth – fail safety criterion – leak before brake - control and significance of fracture mechanics in vessels - FEM application.
Piping: Introduction - flow diagram - Piping layout and piping stress analysis.

Text book

1. J. F. Harvey, *Theory and Design of Pressure Vessels*, CBS Publishers and Distributors, 1987.

Reference books

1. Henry H. Bedner, *Pressure Vessels, Design Hand Book* , CBS Publishers and Distributors, 1987.
2. Stanley, M. Wales, *Chemical Process Equipment, Selection and Design*, Buterworths series in Chemical Engineering, 1988.
3. D. Broek, *Elementary Engineering Fracture Mechanics*, Sijthoff & Noordhoff International publishers.
4. R. D. Cook, D. S. Malkus, M. E. Plesha, R. J. Witt, *Concepts & Applications of Finite Element Analysis*, John Wiley & Sons

Internal Continuous Assessment (Maximum Marks-30)

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 L16: Financial Management

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart knowledge on financial management of organisations*

Module I (14 hours)
Scope of financial management- Investment financing and asset management decisions.
Type of business organisations- sole proprietorship, partnership, private company and public company. Goals of the firm: Profit maximization, wealth maximization- management verses owners, social responsibility.
Major financial decision areas: Investment financing and dividend decisions. Basic factors influencing financial decisions-internal and external factors.

Module II (14 hours)
Capital budgeting- meaning, importance, difficulties and rationale.
Data requirement: Cash flow patterns
Tax effect, effect on other projects, effect of depreciation and effect of indirect expenses.
Method of appraisal: traditional techniques: Average rate of return (ARR) method-Pay back method.
Discounted cash floe techniques: present value, net present value, internal rate of return. Terminal value and profitability index methods.

Module III (13 hours)
Working capital management: Need for working capital, classification of working capital-Source of fixed and variable working capital.
Components of working capital: Positive and negative working capital-estimation of working capital requirement-Liquidity profitability tangle.

Module IV (13 hours)
Sources of company finance: Long term sources-other sources-Retained earnings-Capital market-short term sources- External and internal sources- Merger of companies-reasons-impact type of mergers.
Lease financing: Concept and classification-Significance and limitations.

Reference Books

1. James C Van Horne, *Fundamentals of financial management.*
2. Ezera Solomon, *Theory of financial management*.
3. H Beeman Jr. and S. Smdidi, *Capital budgeting decisions*
4. Prasanna Chandra, *Financial management theory and practice*
5. M Y Khan & P K Jain, *Financial management*
6. S K R Paul, *Financial management*.

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

University Examination Pattern

PART A:	*Short answer questions (one/two sentences)* All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.	*5 x 2 marks=10 marks*
PART B:	*Analytical/Problem solving questions* Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.	*4 x 5 marks=20 marks*
PART C:	*Descriptive/Analytical/Problem solving questions* Two questions from each module with choice to answer one question.	*4 x 10 marks=40 marks*

Maximum Total Marks: 70

ME09 L17: Fracture Mechanics

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart knowledge on linear elastic fracture mechanics, crack tip plasticity, Elastic – Plastic Fracture Mechanics, Fatigue crack growth and application of fracture mechanics concepts to design*

Module I (13 hours)
Introduction: Introduction to conventional and fracture mechanics approaches to design – significance of defects in materials – brittle fracture experienced in the past – the effect of material properties on fracture.
Linear elastic fracture mechanics (LEFM): Atomic view of fracture - stress concentration effect of flaws - Griffith's energy balance - energy release rate - criterion for crack growth. Stress analysis of cracks - Expressions for stresses and strains in the crack tip region (derivation not required) – stress intensity factor (SIF) – Relationship between K and G – critical stress intensity factor – principle of superposition – SIF solutions for simple cases.

Module II (13 hours)
Crack tip plasticity: Plastic zone size – Irwin plastic zone correction – the Dugdale approach – effective crack length – Plastic zone shapes according to Mises criterion - K as a failure criterion – Effect of specimen dimensions – limits to the validity of LEFM - measurement of fracture toughness.
Introduction to dynamic fracture mechanics: Crack speed and kinetic energy – dynamic stress intensity and elastic energy release rate – dynamic fracture toughness – crack branching – crack arrest.

Module III (13 hours)
Elastic – Plastic Fracture Mechanics (EPFM) : Fracture beyond general yield – crack tip opening displacement (CTOD) – determination and use of CTOD – critical CTOD – J integral – HRR singularity - measurement of J – relation between J integral and CTOD - crack growth resistance curves - tearing modulus stable and unstable crack growth – J-controlled fracture for stationary and growing cracks – effect of specimen dimensions – fracture mechanisms in metals.

Module IV (13 hours)
Fatigue crack growth: Fatigue cracking criteria (constant amplitude only) – crack growth and stress intensity factor – crack closure and fatigue threshold - factors affecting crack growth - growth of small cracks – measurement of fatigue crack growth.
Application of fracture mechanics concepts to design: Means to provide fail safety and damage tolerance – application to pressure vessel and pipelines – Leak before break criterion – material selection – use of fatigue crack growth parameters and its application to design.

Text Books

1. Prashant Kumar, *Elements of fracture mechanics*, Wheeler publishing
2. D. Broek, *Elementary engineering fracture mechanics*, Sijthoff & Noordhoff International publishers.

Reference Books

1. T. L. Anderson, *Fracture Mechanics: Fundamentals and Applications*, CRC Press, USA
2. K. Hellan K, Introduction to fracture mechanics, McGraw Hill Book company
3. Edwalds H L & Wanhill RJH, *Fracture mechanics*, Edward Arnold Edition.

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 L18: Heating, Ventilation and Air-conditioning Design

Teaching scheme **Credits: 4**
3 hours lecture and I hour tutorial per week

Objectives

- *To impart knowledge on principles of refrigeration, cooling and heating load calculation, design of air conditioning system and selected systems in comfort engineering*

.

Pre-requisites: *Basics of thermodynamics, fluid mechanics, and heat transfer*

Module I (14 Hours)
Principles of refrigeration and psychrometry. Psychrometric properties and processes. Air conditioning systems and its applications – Psychrometric chart- various process-sensible cooling and heating- adeabate saturation- use &absorbent or adsorbent - Heating and humidification - cooling and dehumidification - mixing of air streams - use of psychrometric chart for air conditioning - various process - S.H.F, G..S.H.F, E.S.H.F Etc.

Module II (13 Hours)
Cooling and heating load calculation - selection of design temperatures - sources of heat load- heat transfer through structures - solar radiation - Infilteration and ventilation- Heat generation inside the conditioned space - heat storage, Diversity and stratification.

Module III (13 Hours)
Design of air conditioning system. Continuty equation, Bernoulli's equation, pressure losses, Duct design - pressure drop in ducts, pressure drop by graphical method- method of duct design- Arrangements of ducts, fan – design, thermal insulation

Module IV (14 Hours)
Heating systems-warm air systems-hot water systems steam heating systems-panel and central heating systems-heat pump circuit. Applications- comfort air conditioning-effective temperature-thermal analysis of human body- Air conditioning systems- evaporate cooling- low humidity applications Automobile and Train car air conditioning.

Refernce Books:

1. C. P. Arora, *Refrigeration and Air Conditioning*.
2. Manohar Prasad, *Refrigeration and Air Conditioning*.
3. W. P. Jones, *Air-conditioning Engineering*
4. Carriers Handbook system design of Air Conditioning
5. R. G. Jordan, G. B. Priester, *Refrigeration and Air conditioning*.

Internal Continuous Assessment (Maximum Marks-30)

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 L19: Industrial Automation

Teaching scheme **Credits: 4**
3 hours lecture and I hour tutorial per week

Objectives

- *To impart knowledge on basics of automation, sensors, robots and its application*

.

Pre-requisites: *Nil*

Module I (13 Hours)
Introduction to automation: Basic notions and definitions, technical and economic requisites. Automation as a means of control and inspection- Basic control system concepts - control system analysis, systems of automatic control.

Module II (14 Hours)
Sensors**:** Sensory equipment, range sensing - proximity sensing - touch sensing - force and torque sensing - signal conditioning equipment.
Introduction to machine vision, sensing and digitizing - image processing and analysis - applications.
Introduction to robots: Definition of robot - basic concepts - robot configurations - types of robot drives - basic robot motions - point to point control - continuous path control.

Module III (14 Hours)
Components and operations: Basic actuation mechanisms - robot actuation and feed back, manipulators –director and inverse kinematics, coordinate transformation - brief robot dynamics. types of robot and effectors - grippers - tools as end effectors – robot end - effort interface.
Robot programming: Methods - languages - capabilities and limitation - artificial intelligence – knowledge representation – search techniques - AI and robotics.

Module IV (13 Hours)
Industrial Applications: Application of robots in machining - welding - assembly - material handling - loadingand unloading - CIM - hostile and remote environments. Parts handling automation, products inspection automation, machine tool automation, In-plant transport automation, automatic transfer machines, assembly automation.

Text books:

1. K. S. Fu., R. C.Gonalez, C. S. G.Lee, *Robotics Control Sensing, Vision and Intelligence*, McGraw Hill International Edition, 1987.

Refernce Books:

1. Mikell P. Groover, mitchell Weiss, *Industrial Robotics, Technology, Programming, and Applications*, McGraw Hill International Editions, 1986.
2. Richard D. Klafter, Thomas A. Chmielewski, Michael Negin, *Robotic Engineering - An Integrated Approach*, Prentice Hall Inc, Englewoods Cliffs, NJ, USA, 1989.
3. Yu.Kozyrev, *Industrial Robots*,
4. V. Tergan, I. Andreev, B. Liberman, *Fundamentals of Industrial Automation*,

Internal Continuous Assessment (Maximum Marks-30)

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 L20: Industrial Tribology

Teaching scheme **Credits: 4**
3 hours lecture and I hour tutorial per week

Objectives

- *To impart knowledge on theory of lubrication, finite journal and thrust bearings, hydrodynamic gas bearing and theory of friction and wear*

.

Pre-requisites: *Basics of material science and mechanics*

Module I (13 Hours)
Introduction – viscosity and its temperature dependents – models of visco elastic materials – Navier Stoke's equations – derivation of Reynold's equation from Navier Stoke's equation – one dimensional journal bearing – infinitely long bearing – infinitely short bearing - one dimensional thrust bearing.

Module II (13 Hours)
Finite journal and thrust bearings – journal bearing work – axial and circumferential feeding – journal bearing solutions – centrally loaded partial bearings – axial groove bearings – non circular bearings – finite thrust bearings – step bearings.

Module III (14 Hours)
Hydrodynamic gas bearing – general equations – limiting characteristics – infinitely long slider bearings – parallel, plane, inclined, slider, step slider – finite slider bearings – infinitely long journal bearings – journal bearings with inertia considered – journal bearings with inertia neglected – finite journal bearings – perturbation and numerical solutions.

Module IV (14 Hours)
Friction and wear – mixed friction theory of sliding friction – boundary friction – extreme pressure lubrications – surface layer – extreme pressure additives – thick boundary film thickness – scuffing boundary friction – stick – slip- wear- adhesive wear – mild and sever wear – abrasive wear – fatigue and corrosive wear- delaminations – measurement of friction and wear.

Text books:

1. B. C. Majumdar, *Introductin to Tribology*, A H Wheeler, Bangalore.

Refernce Books:

1. Pinkus and Sternilincht, *Theory of hydrodynamic lubrication*, John Wiley and Son, Newyork
2. D. F. Moore, *Principle and Application of Tribology*, Pergamon Press, Newyork
3. E. Rabinnowizc, *Friction & Wear of Metals*, John Wiley & Sons , Newyork
4. K. L. Johnson, *Contact Mechanics*, Cambridge University Press.
5. T. R. Thomas, *Rough Surfaces*, Longman Inc.

Internal Continuous Assessment (Maximum Marks-30)

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: Short answer questions (one/two sentences) *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: Analytical/Problem solving questions *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: Descriptive/Analytical/Problem solving questions *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 L21: Logistics and Supply Chain Management

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To equip students with a comprehensive understanding of supply chain management*
- *To understand how the environment affects the design, implementation and management of supply chains.*
- *To develop competence in distribution and logistics management*

Pre-requisites: *nil*

Module I (13 hours)
Concept of Supply Chain – Decision phases in Supply Chain – Process view of Supply Chain - Supply Chain flows - Supply Chain and competitive performance – performance measures of Supply Chain – Strategic fit – Drivers and Obstacles

Module II (14 hours)
Demand forecasting in Supply Chain – Components of forecast and forecasting methods – Managing supply, Managing demand and Managing variability – Inventory Management in Supply Chain – Uncertainties of demand

Module III (13 hours)
Sourcing decisions in Supply Chain – Pricing and revenue management in Supply Chain – Coordination in Supply Chain – IT and Supply Chain

Module IV (14 hours)
Logistics Management – Definition of Logistics and concept of Logistics – Logistic activities – Functions of Logistics system – Transportation in Supply Chain – Design options for a transportation network – Trade offs in transportation design – Designing distribution network

Text Books

1. Chopra S. & Meindl P., Supply Chain Management: Strategy, Planning, and Operation, Pearson Education, South Asia, 2005

Reference Books

1. Janat Shah, *Supply Chain Management: Text and Cases*, Pearson Education South Asia, 2009
2. Ronald H Ballou and Samir K Srivastava, *Business Logistics/ Supply Chain Management,*, Pearson Education South Asia, 2007
3. Harald Dyckhoff et al, *Supply Chain Management and Reverse Logistic*, Springer, 2004
4. Christopher M., Logistics and Supply Chain Management , Pitman Publishing Company
5. John Mortimer (Editor), Logistics in Manufacturing: An IFS Executive Briefing , IFS Publications, U.K. & Springer-Verlag
6. Raghuram G. & Rangaraj N., Logistics and Supply Chain Management: Cases and Concepts , Macmillan India Limited

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A:	*Short answer questions (one/two sentences)* All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.	*5 x 2 marks=10 marks*
PART B:	*Analytical/Problem solving questions* Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.	*4 x 5 marks=20 marks*
PART C:	*Descriptive/Analytical/Problem solving questions* Two questions from each module with choice to answer one question.	*4 x 10 marks=40 marks*

Maximum Total Marks: 70

ME09 L22: Quality Engineering and Management

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To analyse key definitions of quality, focusing on a customer-centric approach.*
- *To provide knowledge on the managerial tools and techniques on quality*
- *To analyze the relationship of statistics to a process and to use the statistical tools*
- *To analyze and generate acceptance sampling plans*
- *To provide knowledge on the reliability and life testing of components and systems*

Module I (14 hours)
Concepts of quality: Quality – Quality control – Quality assurance – Quality management- Quality costs
Total Quality Management: Axioms – Management commitment- Deming's approach – Quality council – Customer satisfaction and retention – Employee involvement and empowerment – Suggestion system – Quality circle – Continuous process improvement – Juran's trilogy – PDSA cycle – Kaizen – Six-sigma – Crosby's quality treatment

Module II (13 hours)
Management tools and techniques: Benchmarking – ISO quality management systems – Quality function deployment – Quality by design – Failure mode and effect analysis – Affinity diagram – Block diagram – Pareto chart – Fish bone diagram – Flow chart – Run chart – Scatter diagram – Tree diagram – Matrix diagram

Module III (14 hours)
Statistical tools 1-control charts: Basic concepts - Attributes and variables - Random and assignable causes of variations- Patterns of variation - Measures of central tendency and dispersion - Probability distributions: Binomial, Poisson and Normal
Control charts for variables : $\bar{X}$, R and sigma charts – Details of construction and uses Control charts for attributes: p, np, c and u charts – Details of construction and uses
(Numerical problems included)

Module IV (13 hours)
Statistical tools 2- Acceptance sampling, Reliability and Life testing: Sampling Vs inspection - OC curve - Single and double sampling plans - ATI - AOQL - Life testing - Bathtub curve – MTBF - OC curve for Life testing - System reliability (Numerical problems included)

Reference Books

1. Bester Field, Dale H, Carol Boeterfreld – Muchna, Glen H, Boeterfreld Mery Boeterfeld-Scare, 2003, *Total Quality Management*, 3rd edition, Pearson, Education, New Delhi.
2. Logethetis, N. (1992), *Managing for Total Quality*, Prentice Hall International, Englewood Cliffs, NJ.,
3. Grant.E.L., *Stastical Quality Control*, McGraw Hill
4. Juran J.M, Gryna I.M., *Quality Planning and Analysis*, Tata McGraw Hill Publishing Company
5. Montgomery, Douglas C, 2001, *Introduction to Statistical Quality Control*, Fourth edition, John Wiley and Sons, Inc, New Delhi
6. Gerals M Smith- 2004, *Statistical Process Control and Quality Improvement*- 5th edition,

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 L23: Industrial Safety Engineering

Teaching scheme **Credits: 4**
3 hours lecture and I hour tutorial per week

Objectives

- *To provide on concept of safety in industry, principle of accident prevention, major hazards, consequences and concept of reliability.*

Pre-requisites: *Nil*

Module I (14 Hours)
Introduction to the concept of safety-Need-safety provisions in the factory Act-Laws related to the industrial safety-Measurement of safety performance, Safety Audit, Work permit system, injury and accidents-Definitions-Unsafe act –unsafe condition- causes, investigations and prevention of accidents, hazards, type of industrial hazards-nature, causes and control measures, hazard identifications and control techniques-HAZOP, FMEA,FMECA etc.

Module II (14 Hours)
Concept of Industrial hygiene, programmes-Recognition –Evaluation- Control, Noise- source –effects and noise control, exposure limits –standards, Hearing conservation programmes, Fire –fire load-control and industrial fire protection systems, Fire Hydrant and extinguishers, Electrical Hazards, protection and interlock-Discharge rod and earthling device, safety in the use of portable tools.

Module III (13 Hours)
Logics of consequence analysis-Estimation-Toxic release and toxic effects-Threshold limit values, Emergency planning and preparedness, Air pollution-classification- Dispersion modeling -pollution source and effects- -control method and equipments-Gravitational settling chambers-cyclone separators-Fabric filter systems-scrubbers etc.

Module IV (13 Hours)
Concept of reliability-Definition-Failure rate and Hazard function, System reliability models-series, parallel systems, reliability hazard function for distribution functions-exponential-normal –lognormal-weibull and gamma distribution.

Text books

1. Thomas J. Anton, *Occupational Safety and Health Management*, McGraw Hill
2. Ian T.Cameron & Raghu Raman, *Process Systems Risk Management*, ELSEVIER Academic press.
3. C.S.Rao, *Environmental Pollution Control Engineering*, New Age International Limited
4. L. S. Srinath, *Reliability Engineering*, East west Press, New Delhi.

Reference books

1. Frank E. McErloy,P.E; C.S.P, *Accident Prevention Manual for Industrial Operations*,NSC Chicago.
2. Lees F.P, *Loss Prevention in Process Industries*, Butterworths, New Delhi.
3. BHEL,*Occupational Safety Manual*, Tiruchirappalli.
4. Dr. A.K. Gupta, *Reliability, Maintenance and Safety Engineering*, Laxmi Publications, New Delhi.

Internal Continuous Assessment (Maximum Marks-30)

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: Short answer questions (one/two sentences) *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: Analytical/Problem solving questions *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: Descriptive/Analytical/Problem solving questions *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

ME09 L24: Marketing Management

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart knowledge on fundamentals of marketing, marketing environment market oriented strategic planning, marketing research and marketing communications.*

.

Pre-requisites: *Basic knowledge of principles of management*

Module I (13 hours)
Introduction to marketing : Defining marketing for the twenty first century, marketing – scope, tasks, concept of market and marketing, company orientations towards the market place – production , product, selling, marketing, customer and societal marketing concepts.
Marketing environment : Controllable factors, identifying and responding to the major macro environment – uncontrollable factors – demographic, economic, natural technological, political- legal and social – cultural environment.

Module II (13 hours)
Market Oriented strategic planning – key areas, organizational levels, corporate and division strategic planning – corporate mission, strategic business units, The Boston consulting group approach, The general electric model, Planning new businesses – Growth – Intensive, integrative, diversification, Marketing mix – variables, marketing-mix strategy. Market-segmentation – levels, patterns, procedure, effectiveness. Market targeting – Evaluation, target market selection.

Module III (13 hours)
Marketing research – Need, scope – Marketing research process. Consumer behaviour – factors influencing buyer behaviour – Cultural, social personal, psychological factors. Defining customer value and satisfaction. Product life cycles – marketing strategies for different stages of product life cycle.

Module IV (15 hours)
Marketing communications – process – developing effective communications – Identification of the target audience, determination of communication objectives, Designing the message, select the communication channels, establishing the total marketing communications budget – Deciding on the marketing communications mix – promotional tools an over view – advertising, sales promotion, public relations and publicity, sales force and direct marketing- developing and managing an advertising program – setting objectives, deciding budget, choosing message – an overview on measuring effectiveness of a media – sales promotion – purpose, major decisions.

Text Books

1. P. Kotler, *Marketing Management*, 11th Edition – Pearson Eductation (Singapore) Pvt Ltd, New Delhi (2004)

Reference Books

1. V. S. Ramaswamy, S. Namkumari, *Marketing Management*, Mc Millan India Ltd, New Delhi (1997).
2. Saxena, *Marketing Management*, 2nd Edition, Tata Mc Graw Hill (2002).

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, Literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

University Examination Pattern

PART A:	*Short answer questions (one/two sentences)* All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.	*5 x 2 marks=10 marks*
PART B:	*Analytical/Problem solving questions* Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.	*4 x 5 marks=20 marks*
PART C:	*Descriptive/Analytical/Problem solving questions* Two questions from each module with choice to answer one question.	*4 x 10 marks=40 marks*

Maximum Total Marks: 70

ME09 L25: Energy Engineering and Management

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To provide knowledge on energy conservation and management.*
- *To impart the basics of renewable energy technology*

Pre-requsites: *Nil*

Module I (13 hours)
Energy and environment: Introduction – fossil fuel reserves – world energy consumption – green house effect – global warming – renewable energy sources – environmental aspects utilization – energy prices – energy policies

Module II (14 hours)
Energy conservation: Industrial energy use – energy surveying and auditing – energy index – energy cost – energy conservation in engineering and process industry, in thermal systems, in buildings and non conventional energy resources schemes.

Module III (14 hours)
Energy technologies: Fluidized bed combustion – fluidized bed boilers – waste heat recovery systems – heat pump and refrigerators – wind energy collectors and storage systems – insulated pipe work systems.

Module IV (13 hours)
Energy management: Energy management principles – energy resources management – energy management information systems – computerized energy management. Costing techniques – cost optimization – optimal target investment schedule – financial appraisal and profitability.

Text Books

1. W. R. Murphy, G. Mc Kay, *Energy Management*, Butterworths, London

Reference Books

1. O. Callaghn, *Design and Management for energy conservation*, Pergamon Press, Oxford
2. D. Merick, *Energy - Present and Future Options*, vol 1 and 2, John Wiley and Sons
3. N. A. Chaigier, *Energy Consumption and Environment*, McGraw Hill

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A:	*Short answer questions (one/two sentences)* All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.	*5 x 2 marks=10 marks*
PART B:	*Analytical/Problem solving questions* Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.	*4 x 5 marks=20 marks*
PART C:	*Descriptive/Analytical/Problem solving questions* Two questions from each module with choice to answer one question.	*4 x 10 marks=40 marks*

Maximum Total Marks: 70

PE09 L25: Entrepreneurship

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To give an idea on entrepreneurial perspectives*

Module I (14 hours)
Entrepreneurial perspectives- understanding of entrepreneurship process- entrepreneurial decision process- entrepreneurship and economic development- characteristics of entrepreneur- entrepreneurial competencies- managerial functions for enterprise.

Module II (14 hours)
Process of business opportunity identification and evaluation- industrial policy- environment- market survey and market assessment- project report preparation-study of feasibility and viability of a project-assessment of risk in the industry

Module III (13 hours)
Process and strategies for starting venture- stages of small business growth- entrepreneurship in international environment- entrepreneurship- achievement motivation- time management creativity and innovation structure of the enterprise- planning, implementation and growth

Module IV (13 hours)
Technology acquisition for small units- formalities to be completed for setting up a small scale unit-forms of organizations for small scale units-financing of project and working capital-venture capital and other equity assistance available- break even analysis and economic ratios technology transfer and business incubation

Text Books

1. Harold Koontz & Heinz Weihrich, *Essentials of Management*, McGraw hill International
2 Hirich R.D. &Peters Irwin M.P., *Entrepreneurship*, McGraw Hill
3. Rao T.V., Deshpande M.V., Prayag Mehta &Manohar S. Nadakarni, *Developing Entrepreneurship a Hand Book*, Learning systems
4. Donald Kurado & Hodgelts R.M., *Entrepreneurship A contemporary Approach*, The Dryden Press
5. Dr. Patel V.G., *Seven Business Crisis*, Tata McGraw hill
Timmons J.A., *New venture Creation- Entrepreneurship for 21st century*, McGraw Hill International
6. Patel J.B., Noid S.S., *A manual on Business Oppurnity Identification*, selections, EDII
7. Rao C.R., *Finance for small scale Industries*
8. Pandey G.W., *A complete Guide to successful Entrepreneurship*, Vikas Publishing

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

EC09 L25: Biomedical Instrumentation

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart knowledge about the principle and working of different types of bio-medical electronic equipments/devices*

Module I (14 hours)

Electrical activity of excitable cells-SD curve-functional organization of the peripheral nervous system-electrocardiogram (in detail with all lead systems)-electroencephalogram-electromyogram –electroneurogram- electrode –electrolyte interface-polarisation-polarisable and non polarisable electrodes- surface electrodes –needle electrodes-micro electrodes- practical hints for using electrodes-'skin- electrodes' equivalent circuit-characteristics of 'bio-amplifiers'

Module II (14 hours)

Blood pressure-direct measurements-harmonic analysis of blood pressure waveform-system for measuring venous pressure-heart sounds- phonocardiography-cardiac catheterization-indirect blood pressure measurement –electromagnetic blood flow meters-ultrasonic blood flow meters-impedance plethysmography –photo plethysmography-'indicator- dilution'method for blood flow determination –spirometry-measurement of various respiratory parameters- respiratory plethysmography-chamber plethysmography

Module III (13 hours)

Measurement of gas flow rate cardiac pacemakers and other electric stimulators-defbrillators and cardio converters –blood plumps –hemodialysis-ventilators –infant incubators-drug delivery devices-lithotripsy-therapeutic applications of laser

Module IV (13 hours)

Physiological effects of electricity-important susceptibility parameters-macro shock hazards-micro shock hazards-protection against shock-electrical isolation- electrical safety analyzers-measurements of pH,pC2, and PO2

Text Books

1. Webster J,' Medical Instrumentation-Application and Design', John Wiley
2. Handbook of Biomedical Instrumentation, Tata-Migraw Hill, New Delhi

Reference Books

1. Geddes& Baker,'Principles of Applied Biomedical Instrumentation', Wiley
2. Encyclopedia of Medical Devices and Instumentation Wiley
3. Bronzino,Hand book of Biomedical Engineering,IEEE press book

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

Note: One of the assignments shall be simulation using any of the tools

University Examination Pattern

PART A:	*Short answer questions (one/two sentences)* All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.	*5 x 2 marks=10 marks*
PART B:	*Analytical/Problem solving questions* Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.	*4 x 5 marks=20 marks*
PART C:	*Descriptive/Analytical/Problem solving questions* Two questions from each module with choice to answer one question.	*4 x 10 marks=40 marks*

Maximum Total Marks: 70

CS09 L23 : Simulation and Modelling

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To teach the students how to reproduce real-world events or process under controlled laboratory conditions, using mainly mathematical models.*

Module I (10 hours)
Introduction - systems and models - computer simulation and its applications -continuous system simulation - modeling continuous systems - simulation of continuous systems - discrete system simulation - methodology – event scheduling and process interaction approaches - random number generation -testing of randomness - generation of stochastic variates - random samples from continuous distributions - uniform distribution - exponential distribution m-Erlang distribution - gamma distribution - normal distribution - beta distribution - random samples from discrete distributions - Bernoulli - discrete uniform -binomial - geometric and poisson

Module II (12 hours)
Evaluation of simulation experiments - verification and validation of simulation experiments - statistical reliability in evaluating simulation experiments -confidence intervals for terminating simulation runs - simulation languages -programming considerations - general features of GPSS - SIM SCRIPT and SIMULA.

Module III (15 hours)
Simulation of queueing systems - parameters of queue - formulation of queueing problems - generation of arrival pattern - generation of service patterns -Simulation of single server queues - simulation of multi-server queues -simulation of tandom queues.

Module IV (15 hours)
Simulation of stochastic network - simulation of PERT network - definition of network diagrams - forward pass computation - simulation of forward pass -backward pass computations - simulation of backward pass - determination of float and slack times determination of critical path - simulation of complete network - merits of simulation of stochastic networks.

Reference Books

1. C. Deo N., *System Simulation And Digital Computer*, Prentice Hall of India.
2. Gordan G., *System Simulation*, Prentice Hall of India.
3. Law A.M. & Ketton W.D., *Simulation Modelling and Analysis*, McGraw Hill.

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

Note: One of the assignments shall be computer based simulation of continuous systems using any technical computing software
One of the tests must be computer based (practical).

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*
Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

CE09 L23: Experimental Stress Analysis

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objective
To make students aware of various measurement techniques and experimental planning and procedures adopted in laboratory

Module I (14 hours)
Strain gauges - definition of gauge length - sensitivity and range - characteristics of an ideal strain gauge - different types of mechanical strain gauges, optical strain gauge - acoustic strain gauge - pneumatic strain gauge - merits and demerits - electrical strain gauges - inductance, capacitance and piezo electric gauges - bonded and unbonded resistance gauges and their application in stress analysis - fixing techniques and measurement of strains - rosettes - determination of principal stress - construction of stress, strain circles - analytical solution

Module II (13 hours)
Photo elasticity - basics of optics, stress optic law - plane and circularly polarized light and their use in photos elasticity - polariscopes - diffusion type - lens type polariscopes - isoclinics and isochromatics

Module III (14 hours)
Model materials - calibration methods for finding material fringe values - model fringe values - examples of beam flexure and diametrically loaded circular plates.
Non Destructive Testing Methods – Ultrasonic Methods – Hardness methods – Rebound Hammer – Detection of embedded reinforcement.
Computer based data acquisition systems.

Module IV (13 hours)
Model analysis - direct and indirect models - laws of structural similitude - choice of scales - limitation of model studies - buckingham pi-theorem - dimensional analysis - model materials - Begg's deformater and its use - simple design of direct and indirect models

Text Books
1. Dally, J. W. and Raliey W.F., Experimental Stress Analysis, McGraw Hill.
2. Srinath L.S., Experimental Stress Analysis, Tata McGraw Hill
3. Roy, T.K., Experimental Analysis of stress and strain

Reference Books
1. Dove and Adams, Experimental Stress Analysis and Motion measurement, Prentice Hall
2. Hetenyi M., Hand book of Experimental Stress Analysis, John Wiley
3. Bently JP – Principles of Measurement Systems, Longman, 1983
4. Nakra & Chowdhary – Instrumentation Measurement & Analysis – Tata McGraw Hill, 1995

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

EE09 L22: Soft Computing Techniques

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To acquaint the students with the important soft computing methodologies- neural networks, fuzzy logic, genetic algorithms and genetic programming*

Module I (12 Hours)
Artificial Intelligent systems – Neural Networks, Fuzzy Logic and Evolutionary Programming concepts. Artificial Neural Networks – Biological neural networks – Model of an artificial neuron- Comparison between biological neuron and artificial neuron– Basic models of artificial neural network –Learning methods – - Activation function and terminologies of ANN- - Mc Culloch Pitts Neuron – Linear Separability – Hebb network – Perceptron Networks , Adaline, Madaline.

MODULE II (14 Hours)
Back propagation Networks : Architecture - Multi layer perceptron –Back propagation learning – Input layer, Hidden Layer , Output Layer computations, Calculation of error, Training of ANN, Back propagation Algorithm, Momentum and Learning rate, Selection of various parameters in BP networks- Radial Basis Function Networks [T. B. 1].
Variations in standard BP algorithms – Decremental iteration procedure, Adaptive BP, GA based BP, Quick prop training, Augmented BP networks, Sequential learning Approach for single hidden layer Neural networks.

Module III (14 Hours)
Fuzzy sets and crisp sets-Fuzzy sets –Fuzzy set operations-Fuzzy relations- Membership functions – Features of the membership functions-Fuzzification- Methods of membership value assignments- Defuzzification- Defuzzification methods-Fuzzy Rule Base and approximate reasoning- Truth values and tables in fuzzy logic, Fuzzy propositions, Formation of rules, Decomposition of rules, Aggregation of fuzzy rules- Fuzzy Inference Systems- Construction and Working Principle of FIS- Methods of FIS- Mamdani FIS and Sugeno FIS- Fuzzy Logic Control Systems- Architecture and Operation of FLC System- FLC System Models- Application of FLC Systems.

Module IV (14 Hours)
Genetic Algorithms- Basic Concepts- Creation of off- springs- Working Principle- Encoding- Fitness function- Reproduction- Roulette- Wheel Selection, Boltzmann Selection- Tournament selection- Rank Selection- Steady- State Selection- Elitism- Generation gap and steady state replacement- Inheritance operators- Cross Over- Inversion and deletion- Mutation Operator- Bit- wise operators- Generational Cycle- Convergence of Genetic Algorithm- Differences and Similarities between GA and other traditional methods- Applications.

Text Books

1. S. N. Sivanandam, S. N. Deepa, *Principles of Soft Computing*, Wiley India Pvt. Ltd.[Module I& III]
2. R.Rajasekharan and G.A. Vijayalakshmi Pai, *Neural Networks, Fuzzy Logic and Genetic Algorithms- Synthesis and Applications*, Prentice Hall of India. [Module II, & IV]

Reference Books

1. Fakhreddine O.Karray, Clarence De Silva, Intelligent Systems Design, Theory, Tools and Application, Pearson Education
2. S. Haykins, Neural Networks – A Comprehensive Foundation , Prentice Hall 2002.
3. L. Fausett, Fundamentals of Neural Networks, Prentice Hall 1994.
4. T.Ross, Fuzzy Logic with Engineering Applications, Tata McGrawHill, New Delhi 1995.
5. D.E. Goldberg, Genetic Algorithms in search, Optimization and Machine Learning, Addison Wesley MA, 1989.

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class
Note: *One of the assignments may be simulation of systems using any technical software*

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

EE09 L25: Robotics and Automation

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To give an introduction of industrial robotics and automation*

Module I (14 Hours)
Automation and Robotics - Robotics in Science Fiction - A Brief History of Robotics - The Robot and Its Peripherals-Robot Activation and Feedback Components - Position Sensors - Velocity Sensors - Actuators - Power Transmissions Systems - Robot Joint Control Design- Introduction to Manipulator Kinematics - Homogeneous Transformations and Robot Kinematics -Manipulator Path Control - Robot Dynamics - Configuration of a Robot Controller.

Module II (13 Hours)
Types of End Effectors - Mechanical Grippers - Other Types of Grippers - Tools as End Effectors - The Robot/End Effector Interface - Considerations in Gripper Selection and Design - Sensors in Robotics - Tactile Sensors - Proximity and Range Sensors - Miscellaneous Sensors and Sensor-Based Systems - Uses of Sensors in Robotics - Introduction to Machine Vision - The Sensing and Digitizing Function in Machine Vision - Image Processing and Analysis - Training and Vision System - Robotic Applications.

Module III (14 Hours)
Methods of Robot Programming – Lead through Programming Methods - A Robot Program as a Path in Space - Motion Interpolation - WAIT, SIGNAL, and DELAY Commands - Branching - capabilities and Limitations of Lead through Methods - The Textual Robot Languages - Generations of Robot Programming Languages - Robot Language Structure - Constants, Variables, and Other Data Objects - Motion Commands - End Effector and Sensor Commands - Computations and operations - Program Control and Subroutines - Communications and Data Processing - Monitor Mode Commands.

Module IV (13 Hours)
Introduction to robot intelligence and task planning- state space search-problem reduction-use of predicate logic-means –end analysis-problem-solving –robot learning-robot task planning-expert systems and knowledge learning.

Text Books

1. Mikell P. Groover- et. Al, *Industrial robotics, Technology, programming and Applications*, McGraw Hill

2. K. S. Fu, R. C. Gonzalez, C. S. G. Lee, *Robotics, Control, Sensing and Intelligence*, McGraw Hill

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

CH09 L22: Nuclear Engineering

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart the basic concepts of nuclear fusion and fission as energy source*
- *To develop understanding about feed processing and fuel recovery for nuclear reactors*

No Pre-requisites

Module 1 (13 Hours)

Nuclear fission and fusion, types and classification of nuclear reactors, nuclear fuels, other reactor materials, fuel processing flow sheet, chemical processes for nuclear power industries, separation of reactor products, nuclides, radioactivity, decay chains, neutron reactions, fission process, growth and decay of fission products in a reactor with neutron burnout and continuous processing. Make up of reactor, reactor fuel process flow sheet, irradiation schemes, neutron balance, feed requirements and fuel burn up for completely mixed fuels with no recycle.

Module 2 (13 Hours)

Fundamentals of the Atom, Binding Energy and Nuclear Instability, Alpha Decay, Beta Decay, Gamma Decay, Activity and Exponential Decay, Radiological Dating, Radiation Interactions: Heavy Charged Particles, Radiation Interactions: Light Charged Particles, Radiation Interactions: Neutrons, Neutron Sources, Radiation Detection

Module 3 (13 Hours)

Introduction to nuclear power systems, Thermal-hydraulics: Thermal parameters: definitions and uses. Sources and distribution of thermal loads in nuclear power reactors. Conservation equations and their applications to nuclear power systems: power conversion cycles, containment analysis. Thermal analysis of nuclear fuel, Single-phase flow and heat transfer. Two-phase flow and heat transfer, Structural mechanics: Fundamentals of structural mechanics, Applications to nuclear systems.

Module 4 (13 Hours)

Feed requirements and fuel burn up for completely mixed fuels-plutonium recycle feed requirements and fuel burn up and reactivity changes for unmixed fuel, flow sheets for uranium 235,238 fuel cycle, single region thorium breeder. Production of uranium feed materials. Solvent extraction of metals. Properties of irradiated fuels. Uses of stable isotopes and methods of isotope separation. Principles of isotope. separation. separation of isotopes of light and heavy elements.

References:

1. Vanson benedict and Thomas H Pigford “Nuclear chemical Engineering ”Mcgraw hill
2. Turner, J. E. *Atoms, Radiation, and Radiation Protection*. 2nd ed. New York, NY: J. Wiley, 1995
3. Williamson, M. *Essentials of Ultrasound.*
4. Selman, J. *The Fundamentals of X-Ray and Radium Physics.*
5. *Knief, R. A. Nuclear Engineering: Theory and Technology of Commercial Nuclear Power. New York, NY: Taylor & Francis Inc., May, 1992. ISBN: 9781560320890. (General nuclear engineering)*

6. Bird, R. B., W. E. Stewart, and E. N. Lightfoot. *Transport Phenomena*. New York, NY: John Wiley and Sons, 1960.
7. Incropera, F. P., and D. P. DeWitt. *Fundamentals of Heat and Mass Transfer*. New York, NY: John Wiley and Sons, 1990.
8. Collier, J. G., and J. R. Thome. *Convective Boiling and Condensation*. 3rd ed. Oxford, UK: Oxford Science Publications, June 1, 1996.
9. Tong, L. S., and J. Weisman. *Thermal Analysis of Pressurized Water Reactors*. 1st ed., 1970; 2nd ed., 1979; 3rd ed., 1996
10. Lahey, R. T., Jr., and F. J. Moody. *The Thermal-Hydraulics of a Boiling Water Nuclear Reactor*. 2nd ed. La Grange Park, IL: American Nuclear Society, 1993.
11. Todreas, N. E., and M. S. Kazimi. *Nuclear Systems II: Elements of Thermal Hydraulic Design*. New York, NY: Francis and Taylor, 1990.

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

CH09 L24: Industrial Pollution Control

Teaching scheme **Credits:** 4
3 hours lecture & 1 hour tutorial per week

Objectives

- *To impart the basic concepts of industrial pollution control*
- *To develop understanding about water, air, light pollution control*

No Pre-requisites

Module 1 (13hours)
Classification of industrial wastewater - types of pollutants and their effects - monitoring and analysis methods - water pollution laws and standards - industrial wastewater treatment - processes and equipment

Module 2 (13hours)
Water pollution control in industries - pulp and paper, textile processing, tannery wastes, dairy wastes, cannery wastes, brewery, distillery, meet packing, food processing wastes, pharmaceutical wastes, chlor-alkali industries, fertilizer industry, petrochemical industry, rubber processing industry, starch industries, metal industries, nuclear power plant wastes, thermal power plant wastes.

Module 3 (13hours)
Air pollution control in industries: source and classification of industrial air pollutants - monitoring equipment and method of analysis - damages to health, vegetation and materials - air pollution laws and standards - treatment method in specific industries - thermal power plants - cement - fertilizers - petroleum refineries - iron and steel - chlor-alkali - pulp and paper

Module 4 (13hours)
Industrial odour control - sources and solutions - odour control by adsorption and wet scrubbing - industrial noise control methods - sludge treatment and disposal - industrial hazardous waste management, waste minimization. Environmental Impact Assessment and risk assessment-Environmental Audit and Environmental management system- Concept of common effluent treatment plants.

References:

1. Nelson & Nemerow, Industrial Water pollution-Origin, Characteristics and treatment, Addison, Wesley Publishing Co.
2. Gerard Kiely,Environmental Engineering, McGraw Hill
3. Rao M.N. & Rao H,Air Pollution, Tata McGraw Hill
4. Sincero A.P.& Sincero G.A., Environmental Engineering, A Design Approach, Prentice Hall of India
5. Rao C.S., Environmental Pollution Control Engineering, New Age Int. Pub.
6. Mahajan S.P., Pollution Control in Process Industries, Tata McGraw Hill
7. Babbitt H.E, Sewage & Sewage Treatment, John Wiley
8. Abbasi S.A, & Ramasami E, Biotechnical Methods of Pollution Control, Universities Press(India) Ltd.

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

CH09 L25: Project Engineering

Teaching scheme **Credits:** 4
3 hours lecture & 1 hour tutorial per week

Objectives

- *To impart the basic concepts of project management*

No Pre-requisites

Module 1 (13 hours)
Scope of project engineering - the role of project engineer - R & D - TEFR - plant location and site selection - preliminary data for construction projects - process engineering - flow diagrams - plot plans - engineering design and drafting

Module 2 (13 hours)
Planning and scheduling of projects - bar chart and network techniques - procurement operations - office procedures - contracts and contractors - project financing - statutory sanctions

Module 3 (13 hours)
Details of engineering design and equipment selection I - design calculations excluded - vessels - heat exchangers - process pumps - compressors and vacuum pumps - motors and turbines - other process equipment

Module 4 (13 hours)
Details of engineering design and equipment selection II - design calculations excluded - piping design - thermal insulation and buildings - safety in plant design - plant constructions, start up and commissioning

References:

1. Rase & Barrow, Project Engineering of Process Plants, John Wiley
2. Peter S. Max & Timmerhaus, Plant design and economics for chemical engineers.
3. Mc Graw Hill (2002).
4. Srinath L. S., “PERT AND CPM.” affiliated east press pvt. Ltd., new york (1973)
5. Perry J. H.,”Chemical engineering handbook” 7TH ed. Mc Graw Hill (1997).
6. JELLEN F. C., “Cost and optimization in engineering”. Mc Graw Hill (1983).
7. Frederick B. Plummer, Project Engineering, BH
8. Ernest E. Ludwig, Applied project engineering and management, Gulf Pub. Co., (1988)

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

BM09 L24: Virtual Instrumentation

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart knowledge on the concepts of virtual instrumentation.*
- *To provide knowledge on the data acquisition*

Module 1 (13 hours)
Review of Virtual Instrumentation, Historical perspective, Need of VI, Advantages of VI, Define VI, block diagram & architecture of VI, data flow techniques, graphical programming in data flow, comparison with conventional programming.

Module II (14 hours)
Programming Techniques, VIS & Sub VIS, loops & charts, arrays, clusters, graphs, case & sequence structures, formula modes, local and global variable, string & file input. Data Acquisition basics, ADC, DAC, DIO, Counters & timers, PC Hardware structure, timing, interrupts, DMA, Software and Hardware Installation

Module III (13 hours)
Common Instrument Interfaces for Current loop, Rs 232C/Rs 485, GPIB, System basics, interface basics: USB, PCMCIA, VXI, SCXI, PXI etc, networking basics for office & industrial application VISA & IVI, image acquisition & processing, Motion Control.

Module IV (14 hours)
Use of Analysis Tools, Fourier transforms, Power spectrum, Correlation methods, windowing & flittering. Application of VI: Application in Process Control Designing of equipments like Oscilloscope, Digital Millimeter using Lab view Software, Study of Data Acquisition & control using Lab view Virtual instrumentation for an Innovative Thermal Conductivity Apparatus to measure the Thermal Conductivity Apparatus- to measure the conductivity of non Newtonian fluids while they are subjected to shearing force.

Text Books

1. G. Johnson, *LabVIEW Graphical Programming*, McGraw Hill, New York
2. L. K. Wells and J. Travis, *LabVIEW for Everyone*, Prentice Hall, New Jersey.
3. K. James, *PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control*, Newnes, 2000.

Reference Book

1. Sokoloff , *Basic Concepts of Labview*, Prentice Hall, New Jercy

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

Note: One of the assignments shall be a term-project. The term project shall consist of Design of following Virtual Instruments (any two) using a graphical Programming software.

1. Data Acquisition using Virtual Instrumentation from Temperature transducer.
2. Data Acquisition using Virtual Instrumentation from a Pressure Transducer
3. Creation of a CRO using Virtual Instrumentation.
4. Creation of a Digital Multi-meter using Virtual Instrumentation.
5. Design Variable Function Generator Using Virtual Instrumentation.
6. Creation of Digital Temperature Controller using Virtual Instrumentation.
7. Machine Vision concepts using Virtual Instrumentation

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

IT09 L24: Management Information Systems

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *This course will introduce the methods and the influence of the information systems in management milieu and use MIS as an effective tool in management and decision making*.

Module - I: (12 hours)
Information systems - functions of management - levels of management - framework for information systems - systems approach - systems concepts - systems and their environment - effects of system approach in information systems design - using systems approach in problem solving - strategic uses of information technology

Module - II: (10 hours)
An overview of computer hardware and software components - file and database management systems - introduction to network components - topologies and types - remote access - the reasons for managers to implement networks - distributed systems - the internet and office communications

Module - III: (14 hours)
Application of information systems to functional - tactical and strategic areas of management, decision support systems and expert systems

Module - IV: (16 hours)
Information systems planning - critical success factor - business system planning - ends/means analysis - organizing the information systems plan - systems analysis and design - alternative application development approaches - organization of data processing - security and ethical issues of information systems

Text Books

1. Robert Schultheis & Mary Sumner, *Management Information Systems-The Manager's View*, Tata McGraw Hill.

Reference Books

1. Laudon K.C. & Laudon J.P, *Management Information Systems - Organization and Technology*, Prentice Hall of India
2. Sadagopan S, *Management Information Systems*, Prentice Hall of India
3. Basandra S.K, *Management Information Systems*, Wheeler Publishing.
4. Alter S, *Information Systems: A Management Perspective*, Addison Wesley.
5. Effy Oz, Management Information Systems, Thomson Vikas Publishing House

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

AM09 L25: Technology Forecasting

Teaching scheme **Credits:** 4
3 hours lecture and 1 hour tutorial per week

Objectives

- *To provide knowledge on basics of forecasting techniques*

.

Pre-requisites: *nil*

Module I (16 hours)
Introduction and Historical Background – Examples of notable successes and failures. Epistemology of forecasting : Nature of technological change – ontological and teleological views – Types of forecasts – Exploratory projections – Target projections – Validity criteria. Dimensions of technological change: Intellectual, Philosophical and cultural factors – Political and international factors – Military and strategic posture.

Module II (12 hours)
Macro economics – Micro economics – communications and social feed back – technological diffusion and innovation.
Forecasting techniques: Morphological analysis - Analysis of functional capabilities - Morphological analysis of future words – Network methods. Trend extrapolation: Curve fitting – Envelops, constraints and scales – intensive and extensive micro variables – The inertia of trend curves.

Module III (12 hours)
Heuristic forecasts: Extrapolation of dependant variables and constrained variables – analogies, metaphors and structural models – Phenomenological models – Operational models and simulations. Intuitive methods –Forecasting by experts – Structured interactions – Man – machine interactions.
Policy and strategic planning: Planning as tool for forecasting – Policy – Planning methods – Strategic planning methods – Cast effectiveness – PPOS – Demand oriented planning – Operations analysis and systems analysis.

Module IV (14 hours)
Introduction to technology assessment. TA and its relevance – History of TA in Government and Industry – Steps in TA – The MITRE Methodology – Brief review of techniques which can be used in TA including cross impact analysis, systems analysis, cost benefit analysis and formal models – Case studies – (Suggested projects : To be a TA project relevant to the Kerala context)

Reference Books

1. Rober U Ayres, *Technology forecasting* , Mc Graw Hill
2. Selected readings on Technology assessment – IIT Bombay, and Dept. of Science and Technology, N.Delhi

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

BT09 L25: Bio Materials

Teaching Scheme : **Credits :4**
3 hours lecture and 1 hour tutorial per week

Objectives:

- *To study the structure and characteristics of biomaterials of synthetic and natural origin*
- *To give an idea on the effective uses of these biomaterials*

Prerequisite: Nil

Module 1
Structure of solid. Review of basic concepts. Biomaterials,: Definition, classification. Polymers, metals, alloys, ceramics and composites, physical, chemical and mechanical aspects of bulk and surface properties of metallic ,polymer and ceramic biomateriuals (in vivo and in vitro) Corrosion studies. Structure property relation. Characterisation of biomaterials. Bulk analysis-XRD,FTIR,SEM,TGA etc. Surface aaaaanalysis-XPS,SIMS,AES,STM etc.

Module II
Hard tissue replacement implant: orthopaedic implants (hip, knee), dental implants, adhesives and sealants.Soft tissue replacement implant. Skin implant, burn (wound) , dressings/ synthetic skin, dialysis membranes, scaffolds, vascular implants, heart valve implants . Artififial kidneys and livers. sutures, biomaterials for gene delivery. Hydrogel as stimuli- sensitive biomaterials, ophthalmologic implants, biomaterials for drug delivery

Module III
Blood and tissue compatibility of biomaterials and their in vitro and in vivo assessment. Tissue response to biomaterials. Importance of interfacial tissue reaction (eg. Ceramic bone tissue reaction). Qualification of implant (in vivo and in vitro) Blood materials interaction. Mineralization and cncrustation, , microbial- biofilm formation, badterial adhesion toxicology, degradation of biomaterials in biological environments. toxicity of biomaterials, acute and chronic toxicity studies. Implant associated infection

Module IV
Biopolymers, definition, plant and animal biopolymers- polynucleotide, polyamides,polysaccharides,polyisoprene, lignin, polyphosphate and poly hydroxyl alkanoates.Application and chemical synthesis of super absorbent polmers,polyethylene glycol,polypropylene glycol, poly tetra methylene glycol, polyglycerine. Bioplastics and environment, commercial bioplastics. Natural fibers like silk, wool, flax, jute, linen, cotton, sisal, bamboo. Biocomposite- properties and applications

Reference Books

1. Ratner, Hoffman,Schoen Biomaterial science- an introduction to materials in medicine Academic press
2. Park .J.B. Biomaterials- science and engineering, Plenum press
3. Sharma C.P., Szycher.M Blood compatible materials and devices Technomic publishing company
4. R.M. Johnson, R.M. Mwaikambo, Tucker Biopolymers Rapra technology

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

AI09 L23: Micro Electro Mechanical Systems

Teaching Scheme : **Credits :** 4
3 hours lecture and 1 hour tutorial per week

Objectives:
To introduce the following concepts to the students

- *manufacturing of a micro device from material selection to final product design*
- *the various materials used in microfabrication and their applications*
- *how basic engineering design can couple with practice manufacturing techniques for getting a MEMS device*
- *the changes in properties when the dimensions of the system are scaled*

Module I (11 hours)
MEMS and microsystems: MEMS and microsystem products – evaluation of microfabrication – microsystems and microelectronics – applications of microsystems – working principles of microsystems – microsensors – microactuators – MEMS and microactuators – microaccelerometers.
Scaling laws in miniaturization: Introduction – scaling in geometry – scaling in rigid body dynamics – the Trimmer force scaling vector – scaling in electrostatic forces, electromagnetic forces, scaling in electricity and fluidic dynamics, scaling in heat conducting and heat convection.

Module II (13 hours)
Materials for MEMS and microsystems: Substrates and wafers – Silicon as a substrate material, ideal substrates for MEMS – single crystal Silicon and wafers crystal structure – mechanical properties of Si – Silicon compounds – SiO_2, SiC, Si_3N_4 and polycrystalline Silicon – Silicon piezoresistors – Gallium arsenside, quartz – piezoelectric crystals – polymers for MEMS – conductive polymers.
Engineering mechanics for microsystems design: Introduction – static bending of thin plates – circular plates with edge fixed, rectangular plate with all edges fixed and square plates with all edges fixed. Mechanical vibration - resonant vibration – microaccelerometers – design theory and damping coefficients. Thermomechanics – thermal stresses. Fracture mechanics – stress intensity factors, fracture toughness and interfacial fracture mechanics.

Module III (16 hours)
Basics of fluid mechanics in macro and mesco scales: Viscosity of fluids – flow patterns Reynolds number. Basic equation in continuum fluid dynamics – laminar fluid flow in circular conduits – computational fluid dynamics – incompressible fluid flow in microconducts, surface tension, capillary effect and micropumping - Fluid flow in submicrometer and nanoscale – rarefield gas, Kundsen and Mach number and modelling of microgas flow – heat conduction in multilayered thin films – heat conduction in solids in submicrometer scale - Thermal conductivity of thin films - heat conduction equation for thin films.
Microsystem fabrication process: Photolithography – photoresist and applications – light sources. Ion implanation – diffusion process – oxidation – thermal oxidation – silicon diode – thermal oxidation rates – oxide thickness by colour - Chemical vapour deposition - principle – reactants in CVD – enhanced CVD physical vapour deposion – sputtering – deposition by epitaxy – etching – chemcial and plasma etching.

Module IV (12 hours)
Micromanufacturing and microsystem packaging: Bulk Micromachining - Isotropc And Danisotropic Etching, Wet etchants, etch stops, dry etching comparison of wet and dry etching - Surface micromachining, process in general – problems associated surface micromachining - The LIGA process – description – materials for substrates and photoresists – electroplating – The SLIGA process.

Microsystem packaging - General considerations - The three levels of microsystem packaging – die level, device level and system level – essential packaging technologies – die preparation – surface bonding wire bonding and sealing - Three dimensional packaging, assembly of microsytems – selection of packaging materials.

Text Book

1. Tai-Ran Hsu, *MEMS and Microsystems Design and Manufacture*, Tata McGraw Hill, New Delhi, 2002

Reference Books

2 Mark Madou, *Fundamentals of Microfabrication*, CRC Press, 1997.

3 J. W. Gardner, *Microsensors: Principles and Applications*

4 S. M. Sze, *Semiconductor Sensors*, McGraw Hill, New York, 1994

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

AN09 L25: Research Methodology

Teaching scheme
3 hours lecture and 1 hour tutorial per week **credits 4**

Objective:
To give an exposure to the major aspects of research and research approaches.

Module 1 (13hours)
Introduction – meaning of research- objectives of research-motivation in research- types of research-research approaches – significance of research- research methods Vs methodology – criteria for good research

Module II (14hours)
Defining research problem- what is a research problem- selecting the problem- necessity of defining the problem- literature review – importance of literature review in defining a problem-critical literature review – identifying gap areas from literature review

Module III (14hours)
Research design–meaning of research design-need–features of good design- important concepts relating to research design- different types – developing a research plan
Method of data collection–collection of data- observation method- interview method-questionnaire method – processing and analyzing of data- processing options- types of analysis-interpretation of results

Module IV (13hours)
Report writing – types of report – research report , research proposal, technical paper- significance-different steps in the preparation – lay out, structure and language of typical reports- simple exercises - oral presentation – planning, preparation, practice- making presentation – answering questions-use of visual aids-quality and proper usage-Importance of effective communication with illustrations.

Reference books

1. Coley.S.M and Scheinberg C.A 1990 , *Proposal writing*, Newbury-Sage Publications.
2. Leedy.P.D, *Practical research planning and Design*, 4th edition ,MW Macmillan publishing company.
3. Day Ra,1989 "*How to write and publish a scientific paper*", Cambridge University Press .
4. Earl Babbie,1994, *The practice and Social Research*,Wordsworth Publishing Company,
5. J.H. Ansari, Mahavir – ITPI Reading Material on Planning Techniques

Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70