Syllabus for B.Tech(Mechanical Engineering) up to Third Year

Revised Syllabus of B.Tech in ME for the students who were admitted in Academic Session 2010-2011)

Second Year – Third Semester

A. THEORY							
Sl.No.	**Paper Code**	**Subjects**	**Contact Hours / Week**				**Cr.Points**
			L	**T**	**P**	**Total**	
1.	**HU-301**	Values & Ethics in Profession	3	0	0	3	3
2.	**PH-301**	Physics-2	3	1	0	4	4
3.	**CH301**	Basic Environmental Engineering & Elementary Biology	3	0	0	3	3
4.	**ME 301**	Applied Thermodynamics	4	0	0	4	4
5.	**ME 302**	Strength of Materials	3	0	0	3	3
6.	**ME 303**	Engineering Materials	3	0	0	3	3
		Total Theory	19	1	0	20	20
B. PRACTICAL							
Sl.No.	**Field**	**Subjects**	**Contact Hours / Week**				**Cr.Points**
			L	**T**	**P**	**Total**	
7.	**HU-381**	Technical Report Writing & Language Lab Practice	0	0	3	3	2
	PH391	Physics Lab-2	0	0	3	3	2
8.	**ME 391**	Machine Drawing –I	0	0	3	3	2
9.	**ME 392**	Workshop Practice-II	0	0	3	3	2
10.	**ME 393**	Applied Mechanics Lab	0	0	3	3	2
		Total Practical	0	0	15	15	10
		Total Semester	19	1	15	35	30

Second Year – Fourth Semester

A. THEORY							
Sl.No.	**Field**	**Subjects**	**Contact Hours / Week**				**Cr.Points**
			L	**T**	**P**	**Total**	
1.	**M(CS)401**	Numerical Methods	2	1	0	3	2
2.	**M-402**	Mathematics-3	3	1	0	4	4
3.	**ME 401**	Fluid Mechanics & Hydraulic Machines	4	0	0	4	4
4.	**ME 402**	Mechanisms	3	0	0	3	3
5.	**ME 403**	Primary Manufacturing Processes	4	0	0	4	4
		Total Theory	16	2	0	18	17
B. PRACTICAL							
Sl.No.	**Field**	**Subjects**	**Contact Hours / Week**				**Cr.Points**
			L	**T**	**P**	**Total**	
6.	**M(CS)491**	Numerical Methods Lab	0	0	2	2	1
7.	**ME491**	Fluid Mechanics & Hydraulics Lab	0	0	3	3	2
8.	**ME 492**	Manufacturing Technology Lab	0	0	3	3	2
9.	**ME493**	Material Testing Lab	0	0	3	3	2
10.	**ME 494**	Machine Drawing-II	0	0	3	3	2
		Total Practical	0	0	14	14	9
		Total Semester	16	2	12	32	26

Syllabus for B.Tech(Mechanical Engineering) up to Third Year

Revised Syllabus of B.Tech in ME for the students who were admitted in Academic Session 2010-2011)

Third Year– Fifth Semester

A. THEORY							
Sl.No.	**Field**	**Subjects**	**Contact Hours / Week**				**Credit Points**
			L	**T**	**P**	**Total**	
1.	**HU511**	Principles & Practices of Management	2	0	0	2	2
2.	**ME 501**	Dynamics of Machines	3	0	0	3	3
3.	**ME 502**	Heat Transfer	4	0	0	4	4
4.	**ME 503**	Design of Machine Elements	4	0	0	4	4
5.	**ME504**	Metrology & Measurement	3	0	0	3	3
6.	**ME 505**	* Professional Elective-I	3	0	0	3	3
		Total Theory	19	0	0	19	19
B. PRACTICAL							
Sl.No.	**Field**	**Subjects**	**Contact Hours / Week**				**Credit Points**
			L	**T**	**P**	**Total**	
7.	**ME 581 (Sessional)**	Seminar-I	0	0	3	3	2
8.	**ME 592**	Applied Thermodynamics & Heat Transfer Lab	0	0	3	3	2
9.	**ME 593**	Design Practice-I	0	0	3	3	2
10.	**ME594**	Metrology & Measurement Lab	0	0	2	2	1
11.	**ME 595**	Professional Elective Lab-I	0	0	3	3	2
		Total Practical	0	0	14	14	9
		Total Semester	19	0	14	33	28

* List of Professional Elective 1:

1. ME505A-Electrical Machines
2. ME505B-Applied Fluid Mechanics

Third Year – Sixth Semester

A. THEORY							
Sl.No.	**Field**	**Subjects**	**Contact Hours / Week**				**Credit Points**
			L	**T**	**P**	**Total**	
1.	**HU 611**	Production & Operations Management	2	0	0	2	2
2.	**ME 601**	IC Engines and Gas Turbines	3	0	0	3	3
3.	**ME 602**	Machining Principles & Machine Tools	3	0	0	3	3
4.	**ME 603**	Machine Design	3	0	0	3	3
5.	**ME 604**	@ Professional Elective-II	3	0	0	3	3
6.	**ME 605**	@@ Professional Elective-III	3	0	0	3	3
		Total Theory	17	0	0	17	17
B. PRACTICAL							
Sl.No.	**Field**	**Subjects**	**Contact Hours / Week**				**Credit Points**
			L	**T**	**P**	**Total**	
7.	**ME 691**	Machining & Machine Tools Lab	0	0	3	3	2
8.	**ME 692**	IC Engine Lab	0	0	3	3	2
9.	**ME 693**	Design Practice-II	0	0	3	3	2
10.	**ME 694**	Dynamics of Machines Lab	0	0	3	3	2
11.	**ME 695**	Professional Elective-II Lab	0	0	3	3	2
		Total Practical	0	0	15	15	10
		Total Semester	17	0	15	32	27

@ List of Prof. Elective-II:

1. ME604A- Air Conditioning & Refrigeration
2. ME604B- Mechatronics
3. ME604C- Fluid Power Control

@@ List of Prof. Elective-III:

1. ME605A- Materials Handling
2. ME605B- Finite Element Method
3. ME605C- Turbo Machinery

Note: Vacational Training to be conducted after sixth semester and to be evaluated in seventh semester

Syllabus for B.Tech(Mechanical Engineering) up to Third Year

Revised Syllabus of B.Tech in ME for the students who were admitted in Academic Session 2010-2011)

Proposed

Fourth Year– Seventh Semester

A. THEORY							
Sl.No.	**Field**	**Subjects**	**Contact Hours / Week**				**Cr.Points**
			L	**T**	**P**	**Total**	
1.	**ME 701**	Power Plant Engineering	4	0	0	4	4
2.	**ME 702**	Advanced Manufacturing Technology	4	0	0	4	4
3.	**ME 703**	^Professional Elective-IV	3	0	0	3	3
4.	**ME 704**	^^Professional Elective-V	3	0	0	3	3
5.	**ME 705**	^^^Free Elective-I	3	0	0	3	3
		Total Theory	17	0	0	17	17
B. PRACTICAL / SESSIONAL							
Sl.No.	**Field**	**Subjects**	**Contact Hours / Week**				**Cr.Points**
			L	**T**	**P**	**Total**	
6.	**ME 791**	Advanced Manufacturing Lab	0	0	3	3	2
7.	**ME 781**	Project : Part 1	0	0	4	4	2
8.	**ME 782**	Viva Voce on Vacational Training	0	0	0	0	2
9.	**ME783**	Group Discussion	0	0	0	0	2
		Total Practical	0	0	10	7	8
		Total Semester	17	0	10	24	25

^List of Prof. Elective-IV

ME703A- Maintenance Engineering
ME703B-Renewable Energy Systems
ME703C-Tribology

^^List of Prof. Elective-V:

ME704A- Quantity Production Method
ME704B- Advanced Welding Technology
ME704C- Computational Methods in Engineering

^^^ List of Free Elective-I:

ME705A-Software Engineering
ME705B-Industrial Instrumentation
ME705C-Operations Research
ME705D-Biomechanics & Biomaterials

Fourth Year – Eighth Semester

A. THEORY							
Sl.No.	**Field**	**Subjects**	**Contact Hours / Week**				**Cr.Points**
			L	**T**	**P**	**Total**	
1.	**ME 801 (HU)**	Economics for Engineers	3	0	0	3	3
2.	**ME 802**	* Professional Elective-VI	3	0	0	3	3
3.	**ME 803**	@ Free Elective-II	3	0	0	3	3
		Total Theory	9	0	0	9	9
B. PRACTICAL / SESSIONAL							
Sl.No.	**Field**	**Subjects**	**Contact Hours / Week**				**Cr.Points**
			L	**T**	**P**	**Total**	
4.	**ME 881**	Deign of a Mechanical System	0	0	6	6	4
5.	**ME 882**	Project : Part II	0	0	12	12	6
6.	**ME 883**	Comprehensive viva	0	0	0	0	2
		Total Practical			18	18	12
		Total Semester	9		18	27	21

***List of Prof. Elective-VI:**

ME802A-CAD/CAM
ME802B-Industrial Robotics
ME802C-Energy Conservation & Management
ME802D- Quality & Reliability Engineering

@List of Free Elective-II:

ME803A-Safety & Occupational Health
ME803B-Automation & Control
ME803C-Water Resource Engineering
ME803D-Automobile Engineering

SEMESTER - III

Theory

VALUES & ETHICS IN PROFESSION
HU-301
Contracts:3L

Credits- 3

Science, Technology and Engineering as knowledge and as Social and Professional Activities

Effects of Technological Growth:

Rapid Technological growth and depletion of resources, Reports of the Club of Rome. Limits of growth: sustainable development
Energy Crisis: Renewable Energy Resources
Environmental degradation and pollution. Eco-friendly Technologies. Environmental Regulations, Environmental Ethics
Appropriate Technology Movement of Schumacher; later developments
Technology and developing notions. Problems of Technology transfer, Technology assessment impact analysis.
Human Operator in Engineering projects and industries. Problems of man, machine, interaction, Impact of assembly line and automation.
Human centered Technology.

Ethics of Profession:

Engineering profession: Ethical issues in Engineering practice, Conflicts between business demands and professional ideals. Social and ethical responsibilities of Technologists. Codes of professional ethics. Whistle blowing and beyond, Case studies.

Profession and Human Values:

Values Crisis in contemporary society
Nature of values: Value Spectrum of a good life
Psychological values: Integrated personality; mental health
Societal values: The modern search for a good society, justice, democracy, secularism, rule of law, values in Indian Constitution.
Aesthetic values: Perception and enjoyment of beauty, simplicity, clarity
Moral and ethical values: Nature of moral judgements; canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility.

Books:

1. Stephen H Unger, Controlling Technology: Ethics and the Responsible Engineers, John Wiley & Sons, New York 1994 (2nd Ed)
2. Deborah Johnson, Ethical Issues in Engineering, Prentice Hall, Englewood Cliffs, New Jersey 1991.
3. A N Tripathi, Human values in the Engineering Profession, Monograph published by IIM, Calcutta 1996.

Ph 301 : :Physics2
Contacts : 3L + 1T
Credits : 4

Module 1:

Vector Calculus:

1.1 Physical significances of grad, div, curl. Line integral, surface integral, volume integral- physical examples in the context of electricity and magnetism and statements of Stokes theorem and Gauss theorem [No Proof]. Expression of grad, div, curl and Laplacian in Spherical and Cylindrical co-ordinates. 2L

Module 2 :

Electricity

2.1 Coulumbs law in vector form. Electrostatic field and its curl. Gauss's law in integral form and conversion to differential form . Electrostatic potential and field, Poisson's Eqn. Laplace's eqn (Application to Cartesian, Spherically and Cylindrically symmetric systems – effective 1D problems) Electric current, drift velocity, current density, continuity equation, steady current.

5L

2.2 Dielectrics-concept of polarization, the relation $D=\varepsilon_0 E+P$, Polarizability. Electronic polarization and polarization in monoatomic and polyatomic gases. 3L

Module 3:

Magnetostatics & Time Varying Field:

3. Lorentz force, force on a small current element placed in a magnetic field. Biot-Savart law and its applications, divergence of magnetic field, vector potential, Ampere's law in integral form and conversion to differential form. Faraday's law of electro-magnetic induction in integral form and conversion to differential form. 3L

Module 4:

Electromagnetic Theory:

4.1 Concept of displacement current Maxwell's field equations, Maxwell's wave equation and its solution for free space. E.M. wave in a charge free conducting media, Skin depth, physical significance of Skin Depth, E.M. energy flow, & Poynting Vector.

6L

Module 5:

Quantum Mechanics:

5.1 Generalised coordinates, Lagrange's Equation of motion and Lagrangian, generalised force potential, momenta and energy. Hamilton's Equation of motion and Hamiltonian. Properties of Hamilton and Hamilton's equation of motion. 4L

Course should be discussed along with physical problems of 1-D motion

5.2 Concept of probability and probability density, operators, commutator. Formulation of quantum mechanics and Basic postulates, Operator correspondence, Time dependent Schrödinger's equation, formulation of time independent Schrödinger's equation by method of separation of variables, Physical interpretation of wave function ψ (normalization and probability interpretation), Expectation values, Application of Schrödinger equation – Particle in an infinite square well potential (1-D and 3-D potential well), Discussion on degenerate levels. 9L

Module 6:

Statistical Mechanics:

3.1 Concept of energy levels and energy states. Microstates, macrostates and thermodynamic probability, equilibrium macrostate. MB, FD, BE statistics (No deduction necessary), fermions, bosons (definitions in terms of spin, examples), physical significance and application, classical limits of quantum statistics Fermi distribution at zero & non-zero temperature, Calculation of Fermi level in metals, also total energy at absolute zero of temperature and total number of particles, Bose-Einstein statistics – Planck's law of blackbody radiation..

7L

Basic Environmental Engineering and Elementary Biology
CH-301
L-T-P = 3-0-0
At least 30 Hrs/Sem

General

Basic ideas of environment, basic concepts, man, society & environment, their interrelationship.

1L

Mathematics of population growth and associated problems, Importance of population study in environmental engineering, definition of resource, types of resource, renewable, non-renewable, potentially renewable, effect of excessive use vis-à-vis population growth, Sustainable Development. 2L

Materials balance: Steady state conservation system, steady state system with non conservative pollutants, step function.

1L

Environmental degradation: Natural environmental Hazards like Flood, earthquake, Landslide-causes, effects and control/management; Anthropogenic degradation like Acid rain-cause, effects and control. Nature and scope of Environmental Science and Engineering.

2L

Ecology

Elements of ecology: System, open system, closed system, definition of ecology, species, population, community, definition of ecosystem-components types and function. 1L

Structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems, Mangrove ecosystem (special reference to Sundar ban); Food chain [definition and one example of each food chain], Food web. 2L

Biogeochemical Cycle- definition, significance, flow chart of different cycles with only elementary reaction [Oxygen, carbon, Nitrogen, Phosphate, Sulphur]. 1L

Biodiversity- types, importance, Endemic species, Biodiversity Hot-spot, Threats to biodiversity, Conservation of biodiversity. 2L

Air pollution and control

Atmospheric Composition: Troposphere, Stratosphere, Mesosphere, Thermosphere, Tropopause and Mesopause. 1L

Energy balance: Conductive and Convective heat transfer, radiation heat transfer, simple global temperature model [Earth as a black body, earth as albedo], Problems. 1L

Green house effects: Definition, impact of greenhouse gases on the global climate and consequently on sea water level, agriculture and marine food.Global warming and its consequence, Control of Global warming. Earth's heat budget. 1L

Lapse rate: Ambient lapse rate Adiabatic lapse rate, atmospheric stability, temperature inversion (radiation inversion). 2L

Atmospheric dispersion: Maximum mixing depth, ventilation coefficient, effective stack height, smokestack plumes and Gaussian plume model. 2L

Definition of pollutants and contaminants, Primary and secondary pollutants: emission standard, criteria pollutant.

Sources and effect of different air pollutants- Suspended particulate matter, oxides of carbon, oxides of nitrogen, oxides of sulphur, particulate, PAN. 2L

Smog, Photochemical smog and London smog.

Depletion Ozone layer: CFC, destruction of ozone layer by CFC, impact of other green house gases, effect of ozone modification. 1L

Standards and control measures: Industrial, commercial and residential air quality standard, control measure (ESP. cyclone separator, bag house, catalytic converter, scrubber (ventury), Statement with brief reference). 1L

Water Pollution and Control

Hydrosphere, Hydrological cycle and Natural water.

Pollutants of water, their origin and effects: Oxygen demanding wastes, pathogens, nutrients, Salts, thermal application, heavy metals, pesticides, volatile organic compounds. 2L

River/Lake/ground water pollution: River: DO, 5 day BOD test, Seeded BOD test, BOD reaction rate constants, Effect of oxygen demanding wastes on river[deoxygenation, reaeration], COD, Oil, Greases, pH. 2L

Lake: Eutrophication [Definition, source and effect]. 1L

Ground water: Aquifers, hydraulic gradient, ground water flow (Definition only) 1L

Standard and control: Waste water standard [BOD, COD, Oil, Grease],

Water Treatment system [coagulation and flocculation, sedimentation and filtration, disinfection, hardness and alkalinity, softening]

Waste water treatment system, primary and secondary treatments [Trickling filters, rotating biological contractor, Activated sludge, sludge treatment, oxidation ponds] tertiary treatment definition. 2L

Water pollution due to the toxic elements and their biochemical effects: Lead, Mercury, Cadmium, and Arsenic 1L

Land Pollution

Lithosphere; Internal structure of earth, rock and soil 1L

Solid Waste: Municipal, industrial, commercial, agricultural, domestic, pathological and hazardous solid wastes; Recovery and disposal method- Open dumping, Land filling, incineration, composting, recycling.

Solid waste management and control (hazardous and biomedical waste). 2L

Noise Pollution

Definition of noise, effect of noise pollution, noise classification [Transport noise, occupational noise, neighbourhood noise] 1L

Definition of noise frequency, noise pressure, noise intensity, noise threshold limit value, equivalent noise level, $L_{10}\,(18\,\text{hr Index})$, Ld_n.

Noise pollution control. 1L

Environmental Management:

Environmental impact assessment, Environmental Audit, Environmental laws and protection act of India, Different international environmental treaty/ agreement/ protocol. 2L

References/Books

1. Masters, G. M., "Introduction to Environmental Engineering and Science", Prentice-Hall of India Pvt. Ltd., 1991.

De, A. K., "Environmental Chemistry", New Age International.

ME301 : Applied Thermodynamics
Contacts : 4L
Credits : 3

Module No.	Syllabus	Contact Hrs
1	**1.** Review of fundamentals; Heat and work, First law for unsteady flow system.	03
	2. Pure Substance, Properties of pure substance; Phases of pure substances- Phase rule; Phase Change Processes of Pure Substances – triple pt., critical pt.; Property diagrams of Phase change Processes; P-V-T surface for phase change; Property tables of real substances - compressed liquid, saturated, wet & superheated vapour.	04
2	**3.** The 2nd Law of Thermodynamics; the corollaries & their proofs; the property of entropy; entropy change of a pure substance; Tds equations and calculation of entropy change; concept and uses of entropy; the entropy generation principle. The second law of thermodynamics for an open system.	07
	4. Exergy analysis, Reversible work and irreversibility, Exergy change of a system, 2nd Law efficiency.	04
3	**5.** Maxwell relations; Clapeyron Equation, Joule Thompson co-efficient	04
4	**6.** I.C.Engine, Air Standard cycles; Otto, Diesel, Dual Combustion.	03
	7. Reciprocating air compressors; the compressor cycle with and without clearance, efficiencies; volumetric efficiency & its effect on performance; multistaging.	03
5	**8.** Vapour power cycles & its modifications, Reheat & Regenerative cycle for steam, Binary cycle and cogeneration.	04
6	**9.** Refrigeration cycles, reversed carnot cycle; components and analysis of simple vapour compression Refrigeration cycle, Actual Refrigeration cycles, Vapour Absorption Refrigeration cycle.	05
	10. Use of psychometric charts & processes for air conditioning	03

Total=40L

Books recommended:

1. Engineering Thermodynamics - P.K Chattopadyay, OUP
2. Fundamentals of Thermodynamics - 6e by Sonntag, Borgnakke & Van Wylen, John Wiley.
3. Engineering Thermodynamics-4e by P.K .Nag, TMH
4. Thermodynamics- an Engineering approach - 6e, Cengel & Boles,TMH
5. Engineering Thermodynamics- M. Achyuthan, PHI

6. Basic Engineering Thermodynamics- R. Joel, 5th ed, Pearson
7. Engineering Thermodynamics (Indian edition) – Russel & Adeliyi, OUP
8. Thermodynamics (Schaum's) – 2nd ed, Potter & Somerton, TMH

ME : Strength of Materials

Contact Week / Semester= 12 minimum

Contact per week: 3L **Credit: 3**

Module	Syllabus	Contact Hrs.
1A.	Concept of mechanics of deformable solids; concept of stress developed against external force/pressure; brief review of normal and shearing stress and strain;	1L
B.	Deformation of axially loaded members, statically determinate and indeterminate problems.	4L
C.	Strain energy in tension and compression	1L
2.	Analysis of Biaxial stresses-Mohr's circle for biaxial stress; concept of normal stress, principal stress and pure shear. Shear strain and shear strain energy. Stresses in thin walled pressure vessels- tangential and Hoop stress. Relation between shear modulus and Young's modulus.	6L
3.	Stresses in beams; shear force (SF), axial force and bending moment (BM); differential relations for BM, SF and load; SF and BM diagrams; bending stresses in straight beams – symmetric loading; stresses in beams of various cross sections; stresses in built-up beams and beams of different materials.	7L
4.	Torsion of a circular shaft, shear energy in torsion. Concept of closed and open coiled helical springs, Stresses and deflection of helical springs under axial pull.	4L
5.	Deflection of statically determinate and indeterminate beams due to bending moment, differential equation of elastic line, Area-moment method, Strain energy method- Catigliano's theorem, superposition method.	7L
6.	Theory of columns; eccentric loading of short strut; column buckling: Euler load for columns with pinned ends and other end restraints; Euler's curve; emperical column formulae – (i) straight line, (ii) parabolic and (iii) Rankine Gordon.	6L

Note for Teachers:

1. Stress should be given to clarify different concepts of the subject.
2. Deduction of all relevant equations should be worked out and explained.
3. Sufficient number of problems from each topic should be worked out during class and as home assignment.

Note for examination paper setter:

At least one question should be set from each module.

Books Recommended

1. *Elements of Strength of Materials* by Timoshenko & Young, 5th Ed.- East west press.
2. *Introduction to Solid Mechanics* by Shames & Pitarresi, 3rd Ed., Prentice Hall India.
3. *Mechanics of Materials* by Beer & Johnston, TMH
4. *Engineering Mechanics of Solids* by E.P. Popov; 2nd Ed., Prentice Hall India
5. *Fundamentals of Strength of Materials* by Nag & Chanda, Wiley India
6. *Strength of Materials* by R.Subramanian, 2nd Ed., Oxford Univ. Press
7. Strength of Materials by Ryder, Mcmillan press

ME303 : Engineering materials

Contacts : 3L **Contact week/ semester = 12 minimum**

Credits : 3

Sl.No.	Syllabus	Contact Hrs.
1.	**Introduction:** Material Science—its importance in engineering; Classification of Materials—metals, polymers, ceramics, composites; Advanced materials—semiconductors, smart materials, nano-materials; Review atomic structure, Atomic bonding in solids—bonding forces and energies; ionic/covalent/metallic bonding.	2
2.	**Crystal Structure:** Fundamental concepts; Unit cells; seven crystal systems; single crystal, polycrystalline and non-crystalline materials; Metallic crystal structures—FCC, atomic packing factor, BCC & HCP structures.	2
3.	**Imperfections in Metals:** Point defects due to vacancy & impurities, alloys, solid solutions; Dislocations—linear defects, interfacial defects, grain boundaries.	2
4.	**Phase Diagrams:** Definition and basic concepts; solubility limit; Phase equilibria, one-component phase diagram, binary phase diagram, interpretation of phase diagrams.	3
5.	**Iron-carbon System:** allotropy of iron, iron-iron carbide phase diagram, properties and uses of plain carbon steel	2
6.	**Classification of Metals and Alloys- compositions, general properties and uses:** **6.1 Ferrous alloys:** Classification –low carbon steels, medium carbon steels, high carbon steels,	6

Sl.No.	Syllabus	Contact Hrs.
	stainless steels, alloy steels, tool and die steel, cast irons. **6.2 Non-ferrous alloys:** Copper & Copper alloys; Aluminum alloys; Zinc alloys; Nickel alloys; Lead & Tin alloys;	
7.	**Mechanical Properties of Materials:** Elastic properties of materials—tensile and compressive stress and strain, stress-strain behaviour, modulus of elasticity (Young's modulus), yield strength, tensile strength, plastic deformation, true stress and strain; Ductility; Resilience; Toughness, impact tests; Hardness- Brinell, Rockwell and Vickers hardness and their testing procedures, correlation between hardness and tensile strength; Fatigue strength; Effect of temperature on tensile strength & impact properties, creep failure.	6
8.	**Heat Treatment:** Definition and purposes; Heat treatment processes for steels—Hardening, structural change during heating and cooling, factors affecting hardening; Tempering; Austempering; Normalizing; Annealing—full annealing, spheroidising annealing, stress–relieving, recrystallisation annealing; Preciptation or Age Hardening of non-ferrous alloys.	4
9.	**Polymers & Elastomers:** Definition; How polymers are made- polymerization; Polymer molecular structures; Thermoplastics & Thermosets; Special characteristics like low sp. gravity, optical, electrical & thermal property, decorative color, easy formability, low corrosion etc; Uses of polymers and elastomers.	2
10.	**Ceramic Materials:** What is ceramics; common ceramic materials and their characteristics; How ceramics are made—sintering and vitrification process; Ceramic structures; Properties and applications.	2
11.	**Composite materials:** What is composites; Polymers matrix and their applications; Metal matrix and ceramic matrix composites and their applications; How composites are made.	2
12.	**Corrosion and Degradation of Engineering Materials:** Definition; Types of corrosion—uniform, pitting, crevice, galvanic, stress corrosion cracking and erosion; Corrosion control — material selection, environment control, proper design.	2
13.	**Materials Selection Methodology:** Selection of material based on required properties, availability and cost of material, environmental issues.	1

Note for Teachers:

1. Stress should be given to clarify different concepts.
2. Industrial examples must be cited regarding use of various materials and the specific properties involved for selection of these materials.

Note for examination paper setter:

1. Question should be set covering all the 13 topics of the syllabus.
2. Marks of questions from each topic should be proportionate to the recommended contact hours allotted, as far as possible.

Books Recommended

1. Materials Science and Engineering by W.D. Callister and adapted by R. Balasubramaniam, Willey India, 2010 Ed.
2. Engineering Materials: properties and selection by Budinski & Budinski, 9th Ed., Prentice Hall India
3. Engineering Materials and Metallurgy by R.Srinivasan, 2nd Ed., Tata McGraw Hill.
4. Materials & Processes in Manufacturing by E.P.Degarmo and adapted by Black & Kosher, 10th Ed., Wiley India.
5. Materials Science and Engineering by V.Raghavan, 5th Ed., Prentice Hall India.

Practical

Technical Report Writing & Language Lab Practice
Code: HU-381
Cr-2
Guidelines for Course Execution:

Objectives of this Course: This course has been designed:

1. To inculcate a sense of confidence in the students.
2. To help them become good communicators both socially and professionally.
3. To assist them to enhance their power of Technical Communication.

Detailed Course Outlines:

A. ***Technical Report Writing*** : 2L+6P

1. Report Types (Organizational / Commercial / Business / Project)
2. Report Format & Organization of Writing Materials
3. Report Writing (Practice Sessions & Workshops)

B. ***Language Laboratory Practice***

I. Introductory Lecture to help the students get a clear idea of Technical Communication & the need of Language Laboratory Practice Sessions 2L

2. Conversation Practice Sessions: (To be done as real life interactions) 2L+4P

a) Training the students by using Language Lab Device/Recommended Texts/cassettes /cd's to get their Listening Skill & Speaking Skill honed

b) Introducing Role Play & honing over all Communicative Competence

3. Group Discussion Sessions: 2L+6P

a) Teaching Strategies of Group Discussion

b) Introducing Different Models & Topics of Group Discussion

c) Exploring Live /Recorded GD Sessions for mending students' attitude/approach & for taking remedial measure

Interview Sessions; 2L+6P

- ***a) Training students to face Job Interviews confidently and successfully***
- ***b) Arranging Mock Interviews and Practice Sessions for integrating Listening Skill with Speaking Skill in a formal situation for effective communication***

4. Presentation: 2L+6P

- ***a) Teaching Presentation as a skill***
- ***b) Strategies and Standard Practices of Individual /Group Presentation***
- ***c) Media & Means of Presentation: OHP/POWER POINT/ Other Audio-Visual Aids***

5. Competitive Examination: 2L+2P

- ***a) Making the students aware of Provincial /National/International Competitive Examinations***
- ***b) Strategies/Tactics for success in Competitive Examinations***
- ***c) SWOT Analysis and its Application in fixing Target***

Books – Recommended:

Nira Konar: English Language Laboratory: A Comprehensive Manual
PHI Learning, 2011

D. Sudharani: Advanced Manual for Communication Laboratories & Technical Report Writing
Pearson Education (W.B. edition), 2011

References:

Adrian Duff et. al. (ed.): Cambridge Skills for Fluency
A) Speaking (Levels 1-4 Audio Cassettes/Handbooks)
B) Listening (Levels 1-4 Audio Cassettes/Handbooks)
Cambridge University Press 1998

Mark Hancock: English Pronunciation in Use
4 Audio Cassettes/CD'S OUP 2004

Physics Lab-2

Code: PH-391

Contacts: (3P)
Credit: (2)

Group 1: Experiments on Electricity and Mangentism

1. Determination of dielectric constant of a given dielectric material.
3. Determination of resistance of ballistic galvanometer by half deflection method and study of variation of logarithmic decrement with series resistance.
4. Determination of the thermo-electric power at a certain temperature of the given thermocouple.
5. Determination of specific charge (e/m) of electron by J.J. Thomson's method.

Group 2: Quantum Physics

6. Determination of Planck's constant using photocell.
7. Determination of Lande'g factor using Electron spin resonance spetrometer.
8. Determination of Stefan's radiation constant
9. Verification of Bohr's atomic orbital theory through Frank-Hertz experiment.
10. Determination of Rydberg constant by studying Hydrogen/ Helium spectrum

Group 3: Modern Physics

11. Determination of Hall co-efficient of semiconductors.
12. Determination of band gap of semiconductors.

13. To study current-voltage characteristics, load response, areal characteristics and spectral response of photo voltaic solar cells.

a) A candidate is required to perform 3 experiments taking one from each group. Initiative should be taken so that most of the Experiments are covered in a college in the distribution mentioned above. Emphasis should be given on the estimation of error in the data taken.

b) In addition a student should perform one more experiments where he/she will have to transduce the output of any of the above experiments or the experiment mentioned in c] into electrical voltage and collect the data in a computer using phoenix or similar interface.

c) Innovative experiment: One more experiment designed by the student or the concerned teacher or both.

Note:

i. **Failure to perform each experiment mentioned in b] and c] should be compensated by *two* experiments mentioned in the above list.**
ii. **At the end of the semester report should sent to the board of studies regarding experiments, actually performed by the college, mentioned in b] and c]**
iii. **Experiment in b] and c] can be coupled and parts of a single experiment.**

Recommended Text Books and Reference Books:

For Both Physics I and II

1. B. Dutta Roy (Basic Physics)
2. R.K. Kar (Engineering Physics)
3. Mani and Meheta (Modern Physics)
4.. Arthur Baiser (Perspective & Concept of Modern Physics)

Physics I (PH101/201)

Vibration and Waves

1. Kingsler and Frey
2. D.P. Roychaudhury
3. N.K. Bajaj (Waves and Oscillations)
4. K. Bhattacharya
5. R.P. Singh (Physics of Oscillations and Waves)
6. A.B. Gupta (College Physics Vol.II)
7. Chattopadhya and Rakshit (Vibration, Waves and Acoustics)

Optics

1. Möler (Physical Optics)
2. A.K. Ghatak
3. E. Hecht (Optics)
4. E. Hecht (Schaum Series)
5. F.A. Jenkins and H.E. White
6. 6. Chita Ranjan Dasgupta (Degree Physics Vol 3)

Quantum Physics

1. Eisberg and Resnick
2. A.K. Ghatak and S. Lokenathan
3. S.N. Ghoshal (Introductory Quantum Mechanics)
4. E.E. Anderson (Modern Physics)
5. Haliday, Resnick and Crane (Physics vol.III)
6. Binayak Dutta Roy [Elements of Quantum Mechanics]

Crystallography

1. S.O. Pillai (a. Solid state physics b. Problem in Solid state physics)
2. A.J. Dekker
3. Aschroft and Mermin
4. Ali Omar
5. R.L. Singhal
6. Jak Tareen and Trn Kutty (Basic course in Crystallography

Laser and Holography

1. A.K. Ghatak and Thyagarajan (Laser)
2. Tarasov (Laser)
3. P.K. Chakraborty (Optics)
4. B. Ghosh and K.G. Majumder (Optics)
5. B.B. Laud (Laser and Non-linear Optics)
6. Bhattacharyya [Engineering Physics] Oxford

Physics II(PH 301)

Classical Mechanics (For Module 5.1 in PH 301)
H. Goldstein
A.K. Roychaudhuri
R.G. Takwal and P.S. Puranik
Rana and Joag
M. Speigel (Schaum Series)
J.C. Upadhya (Mechanics)

Electricity and Magnetism
1. Reitz, Milford and Christy
2. David J. Griffith
3. D. Chattopadhyay and P.C. Rakshit
4. Shadowitz (The Electromagnetic Field)

Quantum Mechanics
7. Eisberg and Resnick
8. A.K. Ghatak and S. Lokenathan
9. S.N. Ghoshal (Introductory Quantum Mechanics)
10. E.E. Anderson (Modern Physics)
11. Haliday, Resnick and Crane (Physics vol.III)
12. Binayak Dutta Roy [Elements of Quantum Mechanics]

Statistical Mechanics
1. Sears and Sallinger (Kinetic Theory, Thermodynamics and Statistical Thermodynamics)
2. Mondal (Statistical Physics)
3. S.N. Ghoshal (Atomic and Nuclear Physics)
4. Singh and Singh
5. B.B. Laud (Statistical Mechanics)
6. F. Reif (Statistical Mechanics)

Dilectrics
7. Bhattacharyya [Engineering Physics] Oxford

ME 391 : Machine Drawing-I
Credit : 2

Schematic product symbols for standard components in mechanical, electrical and electronic systems, welding symbols and pipe joints;
Orthographic projections of machine elements, different sectional views- full, auxiliary sections;
Isometric projection of components;
Assembly and detailed drawings of a mechanical assembly, such as a plummer block, tool head of a shaping machine, tailstock of a lathe, welded pipe joints indicating work parts before welding, etc.
(At least six sheets must be drawn)

Books:
1. Text Book on Engineering Drawing, Narayana/ Kannaia H, Scitech
2. Mechanical Engineering Drawing and Design, S. Pal and M. Bhattacharyya
3. Machine Drawing by N.D. Bhatt
4. Machine Drawing by P.S. Gill

Workshop Practice-II
Code: ME-392
Cr-2

Pattern Making; pattern material, pattern allowances and types of patterns; (5P)
Mould making Practice: Uses of moulding tools: green sand moulding, gating system, risering system, core making; (6P)
Making a typical product using sheet metal; (3P)
Basic Forging processes like upsetting, drawing down and forge welding; (5P)
Practicing Resistance Spot Welding, Shielded Metal Arc Welding and Gas Welding; (7P)
Machining of typical products involving lathe, milling/shaping operations and finishing process(es); Machining of gears. (10P)

Applied Mechanics Lab
Code: ME-393
Cr-2
N.B: Minimum six(6) experiments from the list to be conducted by the students.
Verification of Varignon's theorem;
Determining spring stiffness under tension and compressive loads; Strain gauge based strain/ deflection/ force measurement of a cantilever beam;

Tension Test and Compression Test of ductile and brittle materials: stress-strain diagram, determination of yield strength, ultimate strength, modulus of elasticity, percentage elongation and percentage reduction in areas, observation of fractured surfaces;
Bend and rebend test of flat test pieces, determination of bending stresses;
Torsion Test;
Hardness Tests: Brinnel/ Vickers and Rockwell tests, Shore hardness test;
Experiments on friction: determination of coefficient of friction;
Experiments to observe speed ratios obtained using belt pulley and gears, and to evaluate torque and energy required.

SEMESTER - IV

Theory

NUMERICAL METHODS
Code : M(CS) 401
Contacts : 2L+1T
Credits :2

Approximation in numerical computation: Truncation and rounding errors, Fixed and floating-point arithmetic, Propagation of errors. (4)

Interpolation: Newton forward/backward interpolation, Lagrange's and Newton's divided difference Interpolation. (5)

Numerical integration: Trapezoidal rule, Simpson's 1/3 rule, Expression for corresponding error terms. (3)

Numerical solution of a system of linear equations:
Gauss elimination method, Matrix inversion, LU Factorization method, Gauss-Seidel iterative method. (6)

Numerical solution of Algebraic equation:
Bisection method, Regula-Falsi method, Newton-Raphson method. (4)

Numerical solution of ordinary differential equation: Euler's method, Runge-Kutta methods, Predictor-Corrector methods and Finite Difference method. (6)

Text Books:
1. C.Xavier: C Language and Numerical Methods.
2. Dutta & Jana: Introductory Numerical Analysis.
3. J.B.Scarborough: Numerical Mathematical Analysis.
4. Jain, Iyengar , & Jain: Numerical Methods (Problems and Solution).

References:
1. Balagurusamy: Numerical Methods, Scitech.
2. Baburam: Numerical Methods, Pearson Education.
3. N. Dutta: Computer Programming & Numerical Analysis, Universities Press.
4. Soumen Guha & Rajesh Srivastava: Numerical Methods, OUP.
5. Srimanta Pal: Numerical Methods, OUP.

MATHEMATICS

Code: M 402

Contacts: 3L +1T = 4

Credits: 4

Note 1: The entire syllabus has been divided into four modules.
Note 2: Structure of Question Paper
There will be two groups in the paper:

Group A: Ten questions, each of 2 marks, are to be answered out of a total of 15 questions, covering the entire syllabus.

Group B: Five questions, each carrying 10 marks, are to be answered out of (at least) 8 questions.
Students should answer at least one question from each module.
[At least 2 questions should be set from each of Modules II & IV.

At least 1 question should be set from each of Modules I & III. Sufficient questions should be set covering the whole syllabus for alternatives.]

Module I: Fourier Series & Fourier Transform [8L]
Topic: Fourier Series:
Sub-Topics: Introduction, Periodic functions: Properties, Even & Odd functions: Properties, Special wave forms: Square wave, Half wave Rectifier, Full wave Rectifier, Saw-toothed wave, Triangular wave. (1)

Euler's Formulae for Fourier Series, Fourier Series for functions of period 2π, Fourier Series for functions of period 2l, Dirichlet's conditions, Sum of Fourier series. Examples. (1)

Theorem for the convergence of Fourier Series (statement only). Fourier Series of a function with its periodic extension. Half Range Fourier Series: Construction of Half range Sine Series, Construction of Half range Cosine Series. Parseval's identity (statement only). Examples. (2)

Topic: Fourier Transform:
Sub-Topics: Fourier Integral Theorem (statement only), Fourier Transform of a function, Fourier Sine and Cosine Integral Theorem (statement only), Fourier Cosine & Sine Transforms. Fourier, Fourier Cosine & Sine Transforms of elementary functions. (1)

Properties of Fourier Transform: Linearity, Shifting, Change of scale, Modulation. Examples. Fourier Transform of Derivatives. Examples. (1)

Convolution Theorem (statement only), Inverse of Fourier Transform, Examples. (2)

Module II : Calculus of Complex Variable [13L]

Topic: Introduction to Functions of a Complex Variable.

Sub-Topics: Complex functions, Concept of Limit, Continuity and Differentiability. (1)

Analytic functions, Cauchy-Riemann Equations (statement only). Sufficient condition for a function to be analytic. Harmonic function and Conjugate Harmonic function, related problems. (1)

Construction of Analytic functions: Milne Thomson method, related problems**.** (1)

Topic: Complex Integration.

Sub-Topics: Concept of simple curve, closed curve, smooth curve & contour. Some elementary properties of complex Integrals. Line integrals along a piecewise smooth curve. Examples. (2)

Cauchy's theorem (statement only). Cauchy-Goursat theorem (statement only). Examples. (1)

Cauchy's integral formula, Cauchy's integral formula for the derivative of an analytic function, Cauchy's integral formula for the successive derivatives of an analytic function. Examples. (2)

Taylor's series, Laurent's series. Examples (1)

Topic: Zeros and Singularities of an Analytic Function & Residue Theorem.

Sub-Topics: Zero of an Analytic function, order of zero, Singularities of an analytic function. Isolated and non-isolated singularity, essential singularities. Poles: simple pole, pole of order m.
Examples on determination of singularities and their nature. (1)

Residue, Cauchy's Residue theorem (statement only), problems on finding the residue of a given function, evaluation of definite integrals: $\int_0^{\infty} \frac{\sin x}{x} dx$, $\int_0^{2\pi} \frac{d\theta}{a + b\cos\theta + c\sin\theta}$, $\oint_C \frac{P(z)}{Q(z)} dz$ (elementary cases, P(z) & Q(z) are polynomials of 2nd order or less). (2)

Topic: Introduction to Conformal Mapping.

Sub-Topics: Concept of transformation from z-plane to w-plane. Concept of Conformal Mapping. Idea of some standard transformations. Bilinear Transformation and determination of its fixed point. (1)

Module III: Probability [8L]
Topic: Basic Probability Theory
Sub-Topics: Classical definition and its limitations. Axiomatic definition.

Some elementary deduction: i) P(O)=0, ii) $0 \leq P(A) \leq 1$, iii) P(A')=1-P(A) etc. where the symbols have their usual meanings. Frequency interpretation of probability. (1)

Addition rule for 2 events (proof) & its extension to more than 2 events (statement only). Related problems.
Conditional probability & Independent events. Extension to more than 2 events (pairwise & mutual independence). Multiplication Rule. Examples. Baye's theorem (statement only) and related problems. (3)

Topic: Random Variable & Probability Distributions. Expectation.
Sub-Topics: Definition of random variable. Continuous and discrete random variables. Probability density function & probability mass function for single variable only. Distribution function and its properties (without proof). Examples. Definitions of Expectation & Variance, properties & examples. (2)

Some important discrete distributions: Binomial & Poisson distributions and related problems.
Some important continuous distributions: Uniform, Exponential, Normal distributions and related problems. Determination of Mean & Variance for Binomial, Poisson & Uniform distributions only.
(2)

Module IV: Partial Differential Equation (PDE) and Series solution of Ordinary Differential Equation (ODE) [13L]

Topic: Basic concepts of PDE.
Sub-Topics: Origin of PDE, its order and degree, concept of solution in PDE. Introduction to different methods of solution: Separation of variables, Laplace & Fourier transform methods. (1)

Topic: Solution of Initial Value & Boundary Value PDE's by Separation of variables, Laplace & Fourier transform methods.

Sub-Topics:
PDE I: One dimensional Wave equation. (2)
PDE II: One dimensional Heat equation. (2)
PDE III: Two dimensional Laplace equation. (2)

Topic: Introduction to series solution of ODE.

Sub-Topics: Validity of the series solution of an ordinary differential equation.
General method to solve $P_0 y''+P_1 y'+P_2 y=0$ and related problems. (2)
Topic: Bessel's equation.

Sub-Topics: Series solution, Bessel function, recurrence relations of Bessel's Function of first kind. (2)
Topic: Legendre's equation.
Sub-Topics: Series solution, Legendre function, recurrence relations and orthogonality relation. (2)

TOTAL LECTURES : 42

Text Books:

2. Brown J.W and Churchill R.V: Complex Variables and Applications, McGraw-Hill.
3. Das N.G.: Statistical Methods, TMH.
4. Grewal B S: Higher Engineering Mathematics, Khanna Publishers.
5. James G.: Advanced Modern Engineering Mathematics, Pearson Education.
6. Lipschutz S., and Lipson M.L.: Probability (Schaum's Outline Series), TMH.

References:

1. Bhamra K. S.: Partial Differential Equations: An introductory treatment with applications, PHI
2. Dutta Debashis: Textbook of Engineering Mathematics, New Age International Publishers.
3. Kreyzig E.: Advanced Engineering Mathematics, John Wiley and Sons.
4. Potter M.C, Goldberg J.L and Aboufadel E.F.: Advanced Engineering Mathematics, OUP.
5. Ramana B.V.: Higher Engineering Mathematics, TMH.
6. Spiegel M.R. , Lipschutz S., John J.S., and Spellman D., : Complex Variables, TMH.

ME-401: Fluid mechanics & Hydraulic Machines
Contacts: 4L
Credit: 4

Fluid mechanics

Module No.	Syllabus	Contact Hrs
1	**1.** Review of fluid properties and fluid statics. Hydraulic forces on submerged surfaces; forces or vertical, horizontal, inclined and curved surfaces. **2.** Kinematics of fluid flow: fluid flow and classifications. Continuity equation in 1D & 3D. Potential flow & Stream function; types of flow lines.	02 03
2	**3.** Dynamics of fluid: equations of motion; Euler's equation; Bernoulli's equation; Applications of Bernoulli's equation. **4.** Momentum Analysis of flow systems; the linear momentum equation for steady flow, differential approach.	04 03
3	**5.** Flow through pipes; Darcy – Weisbach equation of friction loss; hydraulic grade line and total energy line.	03
4	**6.** Basic principle for flow through orifices, V-notches ~~(rectangular v),~~ weirs (rectangular). Flow through open channels; use of Chezy's formula.	04
5	**7.** Dimensional Analysis & Model investigation applied to flow systems – Buckingham Pi theorem. Dimensionless numbers in fluid flow. **8.** Flow of fluid around submerged bodies; basic concepts of drag and lift. **9.** Boundary layer – definition; Boundary layer separation – basic concept.	02 02 02

Hydraulic Machines

Module No.	Syllabus	Contact Hrs
6	Hydraulic Turbines; Principles and Classifications; Design & working principle of a Pelton Wheel, efficiency and performance curves. Francis Turbine, Kaplan Turbine. Function of Draft Tube. Cavitation in Turbines.	05
7	Reciprocating Pumps: Components & Principles, Classification, discharge, work done, power requirement.	05
8	Centrifugal pumps: Components, working principle, head & efficiency. Multistage Centrifugal pumps. Pump characteristics, NPSH & Cavitation.	05

Total=40

Books Recommended

1. Fluid Mechanics & Turbo Machines – M.M.Das, PHI, 2010.
2. Fluid Mechanics & Machinery – R.K.Bansal, Luxmi Publications.
3. Fluid Mechanics & Machinery – C.Ratnam, A.V.Kothapalli, I.K. International Publishing House Ltd, 2010.
4. Introduction to Fluid Mechanics & Fluid Machines – Som & Biswas, TMH.
5. Fluid Mechanics & Machinery – C.S.P Ojha, R.Berndtsson, P.N. Chandramouli, OUP.
6. Introduction to Fluid Mechanics – Fox & Macdonald, Wiley.
7. Fluid Mechanics – Fundamentals & Applications – Cengel & Cimbala, TMH.
8. Ojha,C S P,Berndtsson. R,Chandramouli. P. N.

ME-402 Mechanisms

Contact Week / Semester= 12 minimum

Contact per week: 3L **Credit: 3**

Module	Syllabus	Contact Hrs.
1.A	Introduction to mechanisms, Difference between Machine and Mechanism; Classification of Pairs of Elements, Kinematic chain, types of joints in a chain; Four-bar linkage: motions of links, Grashof's criterion of movability.	2L
B	Degrees of freedom for plane Mechanisms, Gruebler's criterion for plane mechanism, Kinematic inversions – four Inversions of a Slider-Crank Chain.	3L
2.	Velocity analysis in Mechanisms: Relative velocity method – slider crank mechanism, four bar mechanism, Crank and slotted lever mechanism; Instantaneous centre method –kennedy's theorem; Acceleration analysis: Acceleration Images, Klein's construction, analytical expression of velocity & acceleration.	7L
3.	Belt-drive – introduction; Law of belting, Length of flat belt for open and cross belt connections; Stepped pulley for open flat belt; Tension in flat belt and V-belts; Power transmitted in belt drive	4L
4.	Gear terminology, Laws of gearing, types of gears – Spur, Bevel, Helical, Worm; tooth profile, interference; Gear trains – simple, compound, epicyclic gear train; Speed-torque analysis of gear trains.	6L
5.	Classification of Cams and followers; Radial Cam, Analysis of knife-edge, roller and flat face follower motion – constant velocity, simple harmonic, constant acceleration & deceleration; Offset follower.	6L
6. A	Kinematic Synthesis: Introduction to problems of function generation, path generation and rigid body guidance; Type, Number and Dimensional Synthesis; Two and three position synthesis of four bar mechanism and slider –crank mechanism : Graphical – pole, Relative pole and Inversion method; Analytical solution - Freudenstein's Method.	5L
B	Study of lower pair Mechanisms- Pantograph, Parallel linkage mechanisms, Straight line mechanism, Automobile steering mechanism, Hooks joint.	3L

Note to the Teachers :

1. Stress should be given on the concept of different topics.
2. All relevant deductions should be worked out and explained.
3. Sufficient number of problems from each topic should be worked out during the class and should also be assigned as home assignment.

Note for the Paper setter

At least two questions must be set from Kinematic Synthesis (section 6) and at least one from each of the remaining sections.

Books Recommended :

1. Elements of Mechanism – Daughty and James, McGraw Hill
2. Theory of Machines – S S Rattan, Tata McGraw Hill
3. Theory of Mechanisms & Machines – A.Ghosh & A.K.Mallik, AEWP
4. Design of Machinery – R.L.Norton, Tata McGraw Hill
5. Mechanism & Machine Theory – Rao, R.V. Dukkipati, Wiley
6. Theory of Machines, V.P.Singh, Dhanpat Rai & Co

ME403 : Primary Manufacturing Processes

Contacts : 4L
Credits : 4

S/L	Module/Sub module	Contact Hours	
		Sub module	Module
1.	**Introduction**		
	❑ Manufacturing; Definitions and broad grouping	1	**1**
2.	**Casting**		
	❑ Introduction History Definition Major Classification Casting Materials	1	**15**

	❑ Sand mould casting Moulding sands: composition, properties & testing Design of gating system: sprue, runner, ingate & riser Estimation of powering time Foundry equipments, Furnaces Melting, pouring and solidification Type of patterning, use of a core Different type of sand mould casting Floor mould casting Centrifugal casting Shell mould & CO2 casting Investment casting	12	
	❑ Permanent mould casting Die casting, types, methods, advantages & applications Slush casting, principle & use	1	
	❑ Casting defects, types, causes & remedy	1	
3.	**Welding**		
	❑ Introduction to metallic parts Major grouping of joining processes, welding, brazing and soldering Broad classification of welding processes, types and principles	1	**12**
	❑ Fusion welding, types, principles, equipments, characteristics & applications Sources of heat-chemical action, Gas welding & thermit welding Sources of heat-electrical energy, Arc welding Submerged arc welding TIG & MIG; Plasma arc welding Resistance welding; Spot & butt welding	6	
	❑ Solid state welding Principles, advantages & applications of: Hot forge welding, Friction welding Pressure & percussion welding	2	
	❑ Precision welding processes: Ultrasonic welding Laser beam welding Electron beam welding	2	
	❑ Welding defects, types, causes & remedy	1	
4.	**Forming Processes**		
	❑ Forging Introduction, definition, classification, hot forging & cold forging, characteristics & applications Forging material operations, equipments & tools: Smith forging Drop forging Pressing or press forging Forging dies, materials & design	3	**12**
	❑ Rolling Introduction, basic principles, hot rolling & cold rolling, characteristics & applications Rolling processes & applications, operations, equipments & roll stands	3	
	❑ Wire drawing & extensions Basic principles & requirements Classification, methods & applications	2	

	❑ Press tool works Basic principles, systems, operations & applications Shearing, parting, blanking, piercing & notching Cupping(drawing), Spinning & deep drawing Blanks & forces needed for shearing & drawing operations Coining & embossing	4	
Total Contact Hrs=40			

Text Books:

1. Manufacturing technology, Foundry, Forming & Welding-P.N Rao.
2. Manufacturing Science-A Ghosh & A Mullick.
3. Manufacturing Engineering & Technology-S Kalpakjian; Pub:Addison Wesley.
4. Principles of manufacturing materials & processes-James & Campbell.

Reference Books:

1. Manufacturing engineering & technology-K Jain.
2. Materials & processes in manufacturing-E.P Degarmo, Black & Kohser, Pub: Wiley(10^{th} ed.)
3. Processes & materials of manufacturing-R.A Lindberg.
4. Introduction to manufacturing technology-PP Date, Pub: Jaico.
5. Manufacturing processes-S.K Sharma & S Sharma, Pub: I.K International.

Practical

NUMERICAL METHODS
Code : M(CS) 491
Credits :1

1. Assignments on Newton forward /backward, Lagrange's interpolation.
2. Assignments on numerical integration using Trapezoidal rule, Simpson's 1/3 rule, Weddle's rule.
3. Assignments on numerical solution of a system of linear equations using Gauss elimination and Gauss-Seidel iterations.
4. Assignments on numerical solution of Algebraic Equation by Regular-falsi and Newton Raphson methods.
5. Assignments on ordinary differential equation: Euler's and Runga-Kutta methods.
6. Introduction to Software Packages: Matlab / Scilab / Labview / Mathematica.

ME 491: Fluid mechanics & Hydraulic Machines Lab
Contacts: 3L
Credit: 2

Fluid flow measurements: Determining coefficient of discharge for venturimeter, orificemeter, weirs;
Experiment to verify Bernouli's theorem;
Flow through pipes: Reynold's experiments; Pipe friction in laminar and turbulent flow regimes; Pitot tube experiments on viscous flow and boundary layer theory;
Determination of metacentric height of a floating vessel;
Experiments on Fluid Machinery : Pumps, jet pumps, Blowers, Compressors;
Experiments on Hydro-Turbines: Francis and Pelton turbines.
(At least six experiments must be conducted)

ME 492: Manufacturing Technology Lab
Contacts: 3L
Credit: 2

Sand preparation and testing: specimen preparation for testing permeability, clay content, grain fineness number, moisture content, green compression strength, green shear strength, splitting strength, hardness, etc.;
Casting of metals after preparation of suitable moulds; Experiments on properties of post casting, fettling, cleaning, deburring, and polishing operations;
Practicing smithy or forging of carbon steels and testing for its property changes;
Laboratory experiments in Fabrication processes to observe effects of varying process parameters in GMAW and SMAW and Testing for Joint defects.
(At least six experiments must be conducted)

ME 493: Material Testing Lab
Contacts: 3L
Credit: 2

Impact tests: Charpy and Izod tests;
Test for drawability of sheet metals through cupping test;

Fatigue test of a typical sample.

Sample preparation and etching of ferrous and non-ferrous metals and alloys for metallographic observation;

Experiments on heat treatment of carbon steels under different rates of cooling including quenching, and testing for the change in hardness and observing its microstructural changes through metallographic studies.

Observation of presence of surface/ sub-surface cracks using different non-destructive techniques, such as dye penetration (DP) test, magnaflux test, ultrasonic or eddy current test.

(At least six experiments must be conducted)

ME 494: Machine Drawing-II
Contacts: 3L
Credit: 2

Assembly and detailed drawings of a mechanical assembly, such as a simple gear box, flange coupling, welded bracket joined by stud bolt on to a structure, etc.

Practicing AutoCAD or similar graphics softwares and making orthographic and isometric projections of different components.

(At least six assignments must be conducted)

References:

1. Text Book on Engineering Drawing, Narayana and Kannaia H, Scitech.
2. Mechanical Engineering Drawing and Design, S. Pal and M. Bhattacharyya.
3. Machine Drawing by N.D. Bhatt.
4. Machine Drawing by P.S. Gill.
5. Engineering Drawing and Graphics + AutoCAD by K. Venugopal, New Age International Pub.
6. Engineering Drawing with an Introduction to AutoCAD by D.A. Jolhe, Tata-McGraw-Hill Co.

SEMESTER - V

Theory

Principles & Practices of Management
HU-511
Contacts: 2L

Credits- 2

Module I: Management **(4 hours)**

Definition, nature, importance, evolution of management thoughts – pre & post scientific era, contributions made by Taylor, Fayol, Gilbreth, Elton Mayo, McGregor, Maslow –covering Time & Motion Study, Hawthrone Experiments; Is management a science or art? Functions of manager, ethics in managing and social responsibility of managers.

Module II: Planning & Control **(4 hours)**

Why Management process starts with planning, steps in planning, planning premises, types of planning, barriers to effective planning, operational plan, strategic planning, Mckinsey's 7's

Approach, SWOT analysis, Controlling- concept, Planning- control relationship, process of control, human response to control, dimensions of control, MBO.

Module III: Decision Making & Organizing **(4 hours)**

Nature, process of decision making, decision making under Certainty and Uncertainty, decision-tree, group-aided decision, brain-storming.

Organizing – concept, nature and process of organizing, authority and responsibility, delegation and empowerment, centralization and decentralization, concept of departmentation.

Module IV: Staffing & Motivation **(3 hours)**

Concept, Manpower planning, Job design, recruitment & selection, training and development, performance appraisal, motivation, motivators and satisfaction, motivating towards organizing objectives, morale building.

Module V: Leadership & Communication **(3 hours)**

Defining leadership and its role, should managers lead, leadership style, leadership development, Leadership behavior. Communication- Process, Bridging gap-using tools of communication, electronic media in Communication.

Module VI: Financial Management **(3 hours)**
Financial functions of management, Financial Planning, Management of Working Capital, Sources of Finance.

Module VII: Marketing Management **(3 hours)**
Functions of Marketing, Product Planning & Development, Marketing Organization, Sales Organization, Sales Promotion, Consumer Behaviour, Marketing Research and Information.

Suggested Text Books & References:

1. Robbins & Caulter, Management, Prentice Hall of India.
2. John R.Schermerhorn, Introduction to Management, Wiley-India Edition.
3. Koontz, Principles of Management, Tata-McGrew Hill.
4. Richard L. Daft, New Era of Management, Cengage Learning.
5. Stoner, Freeman and Gilbert. Jr., Management, Prentice Hall of India.
6. Koontz, Weihrich, Essentials of Management, Tata-McGrew Hill.
7. D.C. Bose, Principles of Management and Administration, Prentice Hall of India.
8. Kiran Nerkar, Vilas Chopde & Kogent Learning Inc, Principles and Practices of Management, Dreamtech Press.
9. Parag Diwan, Management Principles and Practices, Excel Books, New Delhi.
10. Joseph M Putty, Management of Principles and Practices.
11. Richard. L.Daft, Principles of Management, Cengage Learning.

Dynamics of Machines
ME-501
Contacts: 3L
Credits- 3

Module No.	Syllabus	Contact Hrs.
1A.	Vibration: Definition & types of vibration; Differential equations of vibratory motions (longitudinal & torsional); Natural frequency of free longitudinal vibration-Equilibrium method, Energy method (Rayleigh's maximum energy principle); Effect of inertia in longitudinal vibration; Natural frequency of free transverse vibration of a beam due to point loads - Rayleigh's method.	6
1B.	Whirling of shaft, synchronous whirling; critical speed - Dunkerley's method.	2
2.	Free damped vibration; Damping factor; Logarithmic decrement.	2
3.	Forced vibration, concept of under damped, critically damped and over damped system; Dynamic magnifier (magnification factor); Vibration isolation and transmissibility.	4
4.	Inertia force and inertia torque in reciprocating engine; Equivalent dynamical system; correction couple (torque); Turning moment diagram and flywheel design.	6
5.	Balancing: Static balancing; Dynamic balancing of rotating masses - graphical and analytical methods; Balancing of inline single cylinder and four cylinder engine; Balancing of symmetric two cylinder V-engine; Swaying couple; Hammer blow.	9
6.	Governors: Use and classification; Study and analysis of Porter, Proell and Wilson-Hartnell governors; Sensitiveness, stability, isochronism, hunting, effort and power of governors; Controlling force diagram and stability criteria analysis; coefficient of insensitiveness.	5
7.	Gyroscope: Gyroscopic couple and precessional motion; Effect of gyroscopic couple on aeroplane and ship; Stability of two wheel and four wheel vehicles taking turn.	2

Recommended Books:

1. W.T. Thomson, Theory of vibration with Applications, McGraw Hill.
2. Uicker, Pennock & Shigley, Theory of Machines and Mechanisms, Oxford University Press.
3. A. Ghosh & A.K. Mallik, Theory of Mechanisms and Machines, Affiliated East-West Publication.
4. Rao & Dukkipati, Mechanism and Machine Theory, New Age Int. Pub.
5. J.S. Rao, The Theory of Machines Through Solved Problems, New Age Int. Pub.
6. S.S. Rattan, Theory of Machines, Tata McGraw Hill.

Heat Transfer
ME-502
Contacts: 4L

Credits- 4

Module- 1: Introduction to modes of Heat Transfer, Basic equations. [2]

Module- 2: Conduction: Fourier's law for isotropic materials. [4]

Thermal conductivity: 1-D and 3- D heat conduction equations, Boundary conditions. Solution of steady 1-D conduction problem with & without heat generation. Analogy with electrical circuits.

Critical thickness of insulation.

Module- 3: Fins- rectangular and pin fins, fin effectiveness and fin efficiency. [3]

Module- 4: Introduction to transient heat conduction, Lumped parameter approach, Time constant, Biot number: 1-D transient heat conduction solution without heat generation. [4]

Module- 5: Radiation: Physical mechanism of thermal radiation, laws of radiation, Definition of black body, emissive power, intensity of radiation, emissivity, reflectivity, transmittivity, irradiation, radiosity. [3]

Module- 6: Radiation exchange between black bodies, concept of Gray- Diffuse Isotropic (GDI) surface. Radiation exchange between GDI surfaces by radiation network and radiosity matrix method. Radiation shielding. [4]

Module- 7: Convective heat transfer, Newton's law of cooling and significance of heat transfer coefficients. Momentum and energy equation in 2-D. [3]

Module- 8: Non – dimensional quantities in heat transfer, importance and physical significant order of magnitudes, Analysis for a flow over a flat plate, order of magnitude analysis. [3]

Module- 9: Boundary layer concepts, Velocity and thermal boundary layer by integral method. [3]

Module- 10: 1-D solution for Coutte flow and Poiseullie flow. Concept of developing and developed flow. Introduction to the concept of similarity. [4]

Module- 11: Natural convection over a vertical plate. Concept and correlation. [3]

Module- 12: Heat exchangers: types of heat exchangers, parallel and counter flow types, Introduction to LMTD. Correction factors, fouling factor. E- NTU method for heat exchangers. [4]

Total : 40L

Recommended Books:

1. S.K. Som, Introduction to Heat Transfer, PHI.
2. Yunus A. Cengel, Heat and Mass Transfer, The McGraw-Hill Companies.
3. Sarif K. Das, Fundamentals of Heat & Mass Transfer, Narosa.
4. Incropera, DeWitt, Bergmam, & Lavine, Fundamentals of Heat and Mass Transfer, Wiley India Edn.
5. N.V. Suryanarayana, Engineering Heat Transfer, Penram International.
6. Kreith, Principles of Heat Transfer, Cengage learning.
7. P.K. Nag, Heat & Mass Transfer, TMH.
8. P.S. Ghoshdastidar, Heat Transfer, Oxford University Press.
9. M. Thirumaleshwar, Fundamentals of Heat & Mass Transfer, Pearson.
10. O.P. Single, Heat & Mass Transfer, Macmillan India.
11. J P Holman & Souvik Bhattacharyya, Heat Transfer, TMH.

Design of Machine Elements
ME-503
Contacts: 4L
Credits- 4

Module	Syllabus	Contact Hrs
1	Objective and scope of Mechanical Engineering Design; Design considerations; Review and selection of materials and manufacturing processes; codes and standards;	5
2	Modes of failure; Design/allowable stress; Factor of safety (FoS); Theories of failure – maximum normal stress theory, maximum shear stress theory, Distortion energy theory. Choice of Failure criteria; Design for stability : buckling analysis – Johnson and Euler columns	6
3	Fatigue in metals; S-N curve; Endurance limit and fatigue strength; Stress concentration factors – effect of discontinuity, fillets and notches; Effect of size, surface finish, stress concentration and degree of reliability on endurance limit; Design for finite and infinite life; Goodman, modified Goodman and Soderberg diagrams with respect to fatigue failure under variable stresses; Cumulative fatigue damage – Miner's equation.	6
4	Design of (i) Cotter joint; (ii) Knuckle joint and (iii) Fillet Welded joint of brackets under different types of loading.	6
5	Bolted joints : Metric thread, standard sizes, use of lock nuts and washers; Applications in structures including brackets, turn buckle; Pre-stressed bolts; Riveted joints : Unwin's formula; Brief discussion on single, double and triple row lap joints, butt joints with single or double strap / cover plate; simple strength design; joint efficiencies.	6
6	Design of : (i) Solid and hollow shafts, strength design of shafts, design based on torsional rigidity; (ii) Shaft coupling-rigid, pin-bush and geared flexible type, alignment of coupling; (iii) Belt drives-geometrical relations, derivation of torque and power transmission by flat and V-belt drives, selection of belt from manufacturers' catalogues, pulley (iv) Chain drives – roller chains, polygonal effect, power rating, sprocket wheel, silent chain	10
7	Design of: (i) Transmission screw, Screw jack, (ii) Helical compression spring - stress and deflection equations, stiffness, curvature effect : Wahl's factor, springs in parallel and series; (iii) Multi-leaf springs : load-stress and load-deflection equations, Nipping	9
	TOTAL	**48**

Books Recommended :

1. V. B. Bhandari, Design of Machine Elements, TMH.
2. Shigley and Mischke, Mechanical Engineering Design, TMH.
3. Hall, Holowenko and Laughlin, Theory and Problems of Machine Design, TMH.
4. P.C. Gope, Fundamentals of Machine Design, PHI.
5. M.F. Spotts, Design of Machine Elements, Prentice Hall.
6. P. Kannaiah, Machine Design, Scitech Publications.

Metrology & Measurement
ME-504
Contacts: 3L
Credits- 3

Module No.	Syllabus	Contact Hrs.
1.	Introduction: Definition and importance of Metrology Measurement; Methods of measurements – direct, indirect, comparison, substitution, transposition, deflection and null measurement; Errors in measurement – absolute, relative, parallax, alignment, loading, dynamic and calibration error; Units of measurements – SI base and derived units, SI prefixes of units.	3
2A.	Linear Metrology: Vernier scale; construction and use of Vernier calliper, Vernier height and depth gauge, micrometer; slip gauge.	3
2B.	Angular Metrology: Constructional features and use of protractor, Vernier bevel protractor, angle gauges, sine bar and slip gauges.	2
2C.	Measurements of : (i) Level using spirit-level; (ii) Flatness using straight edge, interferrometry (Newton's rings) and surface plate; Parallelism, cylindricity and concentricity using dial indicator.	3
3.	Interchangeability of components; concept of limits, tolerances and fits; Hole basis and shaft basis system of fits; Go and No Go limit gauges; plug, ring, snap, thread, radius and filler gauges.	5
4.	Definition, use and essential features of Comparators; working principle and application of (i) dial gauge, (ii) Cook optical comparator, (iii) back pressure Bourdon gauge pneumatic comparator, (iv) optical comparator-profile projector.	4
5.	Measuring Instruments: Functional elements of an instrument – sensing, conversion & manipulation, data transmission and presentation element; Characteristics – accuracy, precision, repeatability, sensitivity, reproducibility, linearity, threshold, calibration, response, dynamic or measurement error; Transducers – definition, primary and secondary, active and passive.	5
6.	Measurement of Surface Finish: Definition; Terminologies – geometrical surface, effective surface, surface roughness, roughness (primary texture), waviness (secondary texture), form, lay, sampling length; Numerical evaluation of surface roughness: peak-to-valley height (R_{max}), centre line average (CLA, R_a), average depth (R_m), smoothness value (G); Principle of operation of a Talysurf.	4
7.	Principle of operation of a few measuring instruments: displacement by LVDT; force by strain – gauge load cell and piezoelectric load cell; pressure by Bourdon – tube gauge; temperature by liquid-in-glass thermometer, thermocouples, optical pyrometer; liquid velocity by pitot tube; water flow by orifice meter.	7

Books Recommended:

1. E.O. Doebelin and D.N. Manik, Measurement Systems– Application and Design, Tata McGraw Hill.
2. R. Rajendra, Principles of Engineering Metrology, Jaico Pub. House.
3. Beckwith, Lienhard and Marangoni, Mechanical Measurements, Pearson.
4. Bewoor and Kulkarni, Metrology & Measurement, TMH.
5. R.K. Jain, Metrology, Khanna Publication, New Delhi.

Professional Elective-1

Electrical Machines
ME-505A
Contacts: 3L
Credits- 3

Topic	No of periods
Module-I: DC Machines:	
• EMF generated in the armature. Methods of Excitation, Armature reaction & its effect in the performance, Methods of decreasing the effects of Armature reaction, Effect of Brush shift. Commutation process.	3
• Operating Characteristics of DC Generators: Separately Excited generators, Shunt Generators, Series Generators and Compound Generators.	2
• Torque equation of D.C motor, Operating Characteristics of Shunt, Series & Compound motors.	2
• Losses and efficiency of DC machines, Hopkinson's and Swinburne's test	2
• D.C Machine application: Generator application, Motor application	1
Module-II: 3-Phase Induction machine:	
• Induction motor as a Transformer, Flux and MMF phasors in Induction motors,	1
• Equivalent circuit, Performance equations, Induction motor phasor diagram	2
• Toque-slip characteristic, Power slip characteristic.	1
• Speed control of Induction motor	2
• Polarity Test, Application of Polyphase Induction motor.	1
Module-III: Synchronous Machines:	
• Construction, Types, Excitation system, Generator & motor modes	2
• Armature reaction, Theory of salient pole machine, Two reaction theory, Voltage regulation	3
• Parallel operation of alternators, Synchronous machine connected to infinite bus, effect of change of excitation and speed of prime mover.	3
• Starting of Synchronous motor, V-Curve, Damper winding, Hunting.	2
Module-IV: Fractional Kilowatt motors:	
• Single phase Induction motor: Construction, Double revolving field theory. Starting methods, Speed - torque characteristics, Phasor diagram, Application	3
• Principle of operation of AC servo motors, Stepper motors, Techo generators, Brush less DC motors.	3

Numerical Problems to be solved in the tutorial classes.

Text Books:
1 P.S. Bhimra, Electrical Machinery, Khanna Publishers.
2 D.P. Kothari & I.J Nagrath, Electric machines, Tata Mc Graw-Hill Publishing Company Limited.
3 P.K. Mukherjee & S. Chakrabarty, Electrical Machines, Dhanpat Rai Publication.

Reference Books:
1. Bhag S. Guru and H.R. Hiziroglu, Electric Machinery & Transformers, Oxford University press.
2. R.K. Srivastava, Electrical Machines, Cengage Learning.
3. Alexander S Langsdorf, Theory of Alternating Current Machinery, Tata Mc Graw Hill.
4. M.G.Say, The performance and Design of Alternating Current Machines, CBS Publishers & Distributors.
5. Irving L Koskow, Electric Machinery & transformer, Prentice Hall India.

Applied Fluid Mechanics
ME-505B
Contacts: 3L
Credits- 3

Module	Syllabus	Contact hours
1.	**Specific energy, Hydraulic Jump**	**3**
2	Compressible Flow: speed of propagation of a small disturbance through a compressible fluid, sonic velocity, Mach number, mach cone and Mach wave; isentropic flow, stagnation properties of a compressible flow, isentropic pressure, temperature and density ratios; compressibility correction factor in the measurement of air speed; area – velocity relationship for compressible flow through a variable area duct, mass flow rate through a duct, critical condition and choking; flow through convergent-divergent nozzle.	**6**
3	Ideal Fluid Flow: rotation of a fluid particle, vorticity, rotational and irrotational motion; velocity potential function, circulation, stream function, flownet; governing equation for two dimensional irrotational motion, simple two dimensional irrotational flows like uniform flow, plane source, plane sink etc; superimposition of simple irrotational flows, combination of a source and a sink.	**5**
4	Analysis of flow through propellers and windmills – slip stream theory, actuated disc theory; jet propulsion devices – analysis of thrust and other performance parameters.	**5**
5	Similarity and model study in turbomachines: dimensional analysis of incompressible flow turbomachines,	**4**

	flow coefficient, head coefficient and power coefficient; non-dimensional plot of performance curves; specific speed; Cordier diagram; specific speed as a design parameter of imcompressible flow turbomachines; unit quantities for hydroturbines.	
6	Mechanical, hydraulic and volumetric loss in a turbo-pump; different types of losses in a hydroturbine installation; different efficiencies in turbomachines.	**3**
7	Interaction of a turbomachine with the pipeline system; system head curve and point of operation, surging, series and parallel operation of pumps and fans.	**4**
8	Testing of hydroturbines, different performance characteristics of hydroturbines like operating characteristics, main characteristics, Muschel curves; speed governing of hydroturbines – different methods.	**4**
9	Torque converter and fluid coupling – function and performance.	**2**
	Total	**36**

REFERENCES :

1. Massey, Mechanics of Fluids, Taylor & Francis.
2. M.M. Das, Fluid mechanics and turbo machines, PHI.
3. S.K. Some & G. Biswas, Introduction to Fluid Mechanics & Fluid Machines, TMH.
4. Fox & Mcdonald, Introduction to Fluid Mechanics, Wiley.
5. Bansal, Fluid Mechanics and Machinery, Laxmi.
6. C.S.P. Ojha, R. Berndtsson, P.N. Chandramouli, Fluid Mechanics & Machinery, Oxford University Press.
7. K. Subramanya, Fluid Mechanics & Hydraulic Machines, TMH.
8. Potter & Wiggert, Fluid Mechanics, Cengage Learning.
9. S. Pati, Fluid Mechanics and Machinery, TMH.

Practical

Applied Thermodynamics & Heat Transfer Lab
ME-592
Contacts: 3P
Credits: 2

At least 6 (six) of the following experiments to be conducted.

1) Determination of dryness fraction of steam by combined separating and throttling calorimeter.
2) Study and performance test of a single acting reciprocating air compressor.
3) Determination of thermal conductivity of a metal rod.
4) Determination of thermal conductivity of an insulating powder/or an insulating plate.
5) Determination of 'h' for forced convection over a pin fiN.
6) Verification of emissivity of a plate.
7) Study of a shell and tube heat exchanger and determination of LMTD.

Design Practice-1
ME-593
Contacts: 3P
Credits: 2

Drawing board exercises compatible to theory course on ME 503: Design of Machine Elements.
At least six assignments are to be completed from the following list:

1. Knuckle/Cotter joint
2. Bolted bracket/ turn buckle
3. Screw jack
4. Riveted joints
5. Welded joints
6. Shaft Couplings
7. Belt pulley drive
8. Helical compression spring/ Leaf spring.

Metrology & Measurement Lab
ME-594
Contacts: 2P
Credits: 1

At least 6 experiments to be conducted from the following :

1. Taking measurements using following instruments :
   (i) Vernier height & depth gauge, (ii) Dial micrometer, (iii) Thread gauge, (iv) Radius gauge, (v) Filler gauge, (vi) Slip gauge.
2. Measurement of angle of a component using :
   (i) Vernier bevel protractor, (ii) angle gauges , (iii) Sine-bar and slip gauges.
3. Checking / measuring parallelism, cylindricity and concentricity of components using dial indicator.
4. Measurement of a specific dimension for a lot of components, and prepare a histogram from the data obtained.
5. Measurement of surface finish by a Talysurf instrument.
6. Measurement of micro feature of a product (eg. Thread of a bolt or saw etc.) in a profile projector.
7. Determine natural cooling characteristics of a heated object by using a thermocouple.
8. Measurement of air velocity across an air duct using anemometer.
9. Fixing a strain gauge on a cantilevered flat section of steel. Then calibration of it as a force dynamometer using a Wheatstone bridge and loading arrangement.
   (NB.: This experiment has to be done over two days– one day for fixing and second day for calibration).

Professional Elective Lab- 1

Electrical Machines Lab
ME-595A
Contacts: 3P
Credits: 2

At least 6 (six) of the following experiments to be conducted.

1. Study of the characteristics of a separately excited DC generator.
2. Study of the characteristics of a DC motor
3. Study of the characteristics of a compound DC generator (short shunt).
4. Measurement of speed of DC series motor as a function of load torque.
5. Speed control of 3 phase Induction motor by different methods & their comparison.
6. Determination of regulation of Alternator by Synchronous Impedance method.
7. Determination of equivalent circuit parameters of a single phase motor.
8. Load test of single phase Induction motor to obtain the performance characteristics.
9. Study of equivalent circuit of three phase induction motor by no load and blocked rotor test.
10. Study of performance of three phase squirrel- cage Induction motor –determination of Iron-loss, friction & windage loss.

Reference Books:
1. Laboratory experiments on Electrical machines, C.K. Chanda, A. Chakrabarty, Dhanpat Rai & Co.

Applied Fluid Mechanics Lab
ME-595B
Contacts: 3P
Credits: 2

At least 6 (six) of the following experiments to be conducted.

1. Study of cavitation characteristics of centrifugal pump.
2. Study of the characteristics of submerged jet.
3. Study of characteristics of hydraulic jump.
4. Study of cavitation phenomenon.
5. Verification of Stokes law.
6. Determination of loss through pipes and fittings.
7. Performance test of pumps in series & parallel.

SEMESTER - VI

Theory

Production & Operations Management
HU-611
Contacts: 2L
Credits- 2

Module	Syllabus	Contact Hrs
1.	**Introduction** : System concept of production; Product life cycle; Types and characteristics of production system; Productivity; Process and product focused organization structures; Management decisions – strategic, tactical and operational.	3
2.	**Forecasting** : Patterns of a time series – trend , cyclical, seasonal and irregular; Forecasting techniques : moving average, simple exponential smoothing, linear regression; Forecasting a time series with trend and seasonal component.	4
3.	**Materials Management and Inventory Control** : Components of materials management; Inventory control : EOQ model, Economic lot size model, Inventory model with planned shortages, Quantity discounts for EOQ model; ABC analysis; Just-in-time inventory management.	4
4.	**Materials Requirement Planning** : MRP concept – bill of materials (BOM), master production schedule; MRP calculations.	3
5.	**Machine Scheduling** : Concept of Single machine scheduling – shortest processing time (SPT) rule to minimize mean flow time, Earliest due date (EDD) rule to minimize maximum lateness, Total tardiness minimizing model; Minimizing makespan with identical parallel machines; Johnson's rule for 2 and 3 machines scheduling.	3
6.	**Project Scheduling** : Activity analysis; Network construction; critical path method (CPM); Crashing of project network.	3
7.	**Quality Assurance** : Meaning of Quality; Quality assurance system; choice of process and quality; Inspection and control of quality; Maintenance function & quality; Process control charts : x-chart and R-chart, p-chart and c-chart; Acceptance sampling : Operating characteristic (O.C) curve, Single sampling plan, Double sampling plan, Acceptance sampling by variables; concept of Six Sigma.	4

Books Recommended :

1. Buffa and Sarin, Modern Production/Operations Management, John Wiley & Sons.
2. R. Panneerselvam, Production and Operations Management, PHI.
3. Russell & Taylor, Operations Management, PHI.
4. Adam and Ebert, Production and Operations Management, PHI.
5. Production & Operations Management by Starr, Cenage Learning India.

IC Engines & Gas Turbine
ME-601
Contacts: 3L
Credits- 3

Module- 1: Classification and working of basic engine types: 2-stroke, 4- stroke, C.I., S.I., etc. [3]
Module- 2: Analysis of air standard cycles: fuel- air cycles and actual cycles. [3]
Module- 3: Fuels: classification and desirable characteristics of I.C. engine fuels, Rating of S.I. and C.I. engine fuels, Alternative fuels (liquid, gaseous, etc.), Analysis of combustion product, HCV and LCV of the fuels. [4]
Module- 4: Combustion of fuels in I.C. engines, Combustion in S.I and C.I engines, Parameter influencing combustion, Detonation and knocking in S.I. and C.I. engines and their preventions, Combustion chamber types, Basic principles of combustion chamber in I.C. engines. [4]
Module- 5: Fuel- air mixing in S.I. engines, Working principle of a carburetor, Analysis of simple carburetor, Mechanical and electronic fuel injection system and their control in S.I. engines. Basic principles of MPFI in SI engines. [4]
Module- 6: Fuel-oil injection in C.I. engines, Fuel injection systems, Working principles, Injection pumps and nozzles. [4]
Module- 7: Ignition: ignition systems in I.C. engines (Battery, magneto and electronic), ignition timing and spark advance. [3]
Module- 8: Supercharging and scavenging of I.C. engines, supercharging limits, Turbo charging, Scavenging - ideal and actual, scavenging parameters, and scavenging pumps. [3]
Module- 9: Principles of lubrication in I.C. engines, Properties of lubricating oil. [2]
Module- 10: Air and liquid cooling of I.C. engines, Principles and systems. [2]

Module- 11: Performance and testing of I.C. engines; Measurement of speed, torque, fuel consumption, determination of IHP, BHP and FHP, specific fuel consumption, determination of indicated thermal efficiency, brake thermal efficiency and mechanical efficiency, plot of efficiency vs. speed curves. [4]

Module- 12: Pollution control of emissions of I.C. engines. [2]

Module- 13: Introduction to Gas Turbine Cycles & Performance. [2]

Total : 40L

Recommended Books:

1. V. Ganesan, Internal Combustion Engines, The McGraw-Hill Companies.
2. M.L. Mathur and R.P. Sharma, A course in Internal Combustion Engines, Dhanpat Rai & Sons.
3. H.N. Gupta, Fundamentals of Internal Combustion Engines, PHI Learning Private Ltd.

Machining Principles & Machine Tools
ME-602
Contacts: 3L
Credits- 3

Module No.	Syllabus/Lecture Schedule	Contact Hrs.
1.	**Introduction:** Machining: Basic principle, purpose, definition and requirements	1
2.	**Geometry of cutting tools:** 1. Geometry of single point turning(shaping, planning and boring) tools in ASA, ORS and NRS systems---1 2. Conversion of tool angles from one system to another by graphical and vector methods---2 3. Geometry of drills and milling cutters---1	4
3.	**Mechanism of machining:** 1. Chip formation mechanism, yielding and brittle fracture, chip reduction coefficient, cutting ratio, shear angle and cutting strain---1 2. Built-up edge formation, cause, type and effects, orthogonal cutting and oblique cutting---1 3. Machining chips: types and conditions, chip formation in drilling and milling---1	3
4.	**Mechanics of machining:** 1. Purposes of determination of cutting forces and basic two approaches, cutting force components in ORS and Merchant's circle diagram---1 2. Determination of cutting forces, analytical methods, measurement---1 3. Dynamometers, construction and working principles of strain gauge type and piezoelectric crystals type turning drilling, milling and grinding dynamometers---1	3
5.	**Cutting temperature:** 1. Heat generators and cutting zone temperature, sources, courses and effects on job and cutting tools, role of variation of the machining parameters on cutting temperature---1 2. Determination of cutting temperature by analytical and experimental methods---1 3. Control of cutting temperature and application of cutting fluids(purpose, essential properties, selection and methods of application)---1	3
6.	**Cutting tools-failure, life and materials:** 1. Methods of failure of cutting tools mechanisms, geometry and assessment of tool wear---1 2. Tool life, definition, assessment and measurement, Taylor's tool life equation and it's use---1 3. Cutting tool materials, essential properties, characteristics and applications of HSS, carbide(uncoated/coated), ceramic, diamond and CBN tools---1	3
7.	**Broaching and grinding:** 1. Modes and mechanisms of chip formation, selection and application---1 2. Grinding forces, surface roughness and wheel life---1	2
8.	**Machinability and machining economics:** 1. Machinability(and grindability), definition, assessment, improvement and evaluation of optimum cutting velocity and tool life---1	1
9.	**Machine tools – Introduction :** 1. Purpose of use , definition and general features of machine tools---1 2. Generatrix and Directrix and tool – work motions in different operations of conventional machine tools---1	2
10.	**General constructions function of machine tools :** 1. Major components and their functions in lathes ; shaping , planning and slotting machines ; drilling machines and melting machines---1 2. Machining operations and application of the common machine tools and their way of specification---1	2
11.	**Automation and classification :** 1. Purposes, degree, type and economy of machine tool automation ; broad classification of machine tools---1	1
12.	**Kinematic structure of machine tools :** 1. Kinematic structure of centre lathe ,shaping, planning and slotting machine---1 2. Kinematic structure of drilling (column /radial) and milling machines, capstan lathe, turret lathes---1	3

	3. Kinematic structure of single spindle automatic lathe, by hydraulically driven machine tools , hobbling machine and gear shaping machine---1	
13.	**Control of speed and feed machine tools :** 1. Need of wide ranges of speeds and feeds , and machine tool drive---1 2. Design of speed, gear box, speed layout, gear layout, ray diagrams , gears and spindle---1 3. Control (selection and change) of feed in centre lathes and by hydraulically driven machine tools---1	3
14.	**Machining time :** 1. Estimation of time required for various operations like turning , drilling , shaping , milling and gear teeth generation---1	1
15.	**Computer numerical controlled machine tools :** 1. NC and CNC system ; purpose, principle , advantages , limitations and application in machine tools---2 2. Basic features and characteristics of CNC , lathes , milling machines etc, machining centres and FMS with reference to construction, advantages and application--- 2	4
	Total	**36**

Books recommended:

1. A.B. Chattopadhyay, Machining and Machine Tools, Wiley India (P) Ltd., New Delhi.

3. G. Kuppuswamy, Principles of Metal Cutting, University Press, Hyderabad.
4. Stephenson & Agapion, Metal Cutting Theory and Practice, Taylor and Francis, NY.
5. M.C. Shaw, Metal Cutting Principles and Practices, Oxford University Press.
6. G.C. Sen and A. Bhattacharyya, Principles of Machine Tools, New Cantral Book Agency (P) Ltd., Kolkata.
7. Acharkan, Machine Tool Design, Vol. I, II, III and IV, Mir Publication, Moscow.

Machine Design
ME-603
Contacts: 3L
Credits- 3

Module	Syllabus	Contact Hrs
1	**Clutches:** Function, types; Friction clutches – torque capacity based on uniform pressure and uniform wear theory for disc and cone clutch; Centrifugal clutch; Friction materials; Considerations for heat dissipation.	**4**
2	**Brakes:** Function, types; pivoted block brake (single and double block brakes), internal expanding shoe brake, self energizing and self locking; Pivoted block brake; Band brake-simple and differential; Energy equation for braking time calculation; Magnetic and hydraulic thruster operated fail-safe brakes; Brake lining materials; Thermal considerations during braking.	**4**
3	**Gears:** Design objectives, types, terminologies, conjugate action and involute tooth profile, tooth systems, standard modules; Gear materials. Spur Gear : Strength design, static and dynamic considerations in strength design, Lewis formula, Lewis form factor, beam strength, Buckingham equation for dynamic tooth load; Endurance strength and wear strength; Designing a pinion based on above considerations; Helical Gear: Helix angle, minimum face width, virtual number of teeth; Strength design, Buckingham formulae for checking dynamic load and wear load.	**6**
4	**Bevel Gear:** Terminologies, formative number of teeth; Lewis equation, dynamic load, endurance strength and wear strength checking. **Worm- worm wheel:** Terminologies and their inter-relation; Preferred combination of various parameters; Efficiency; Materials.	**4**
5	Pressure vessels– thin cylinder, thick cylinder, Lame's equation, Clavarino's equation, Birnie's equation, Autofrettage– compound cylinders, End Covers, Opening in pressure vessel – area compensation method, Fired and unfired vessels – category, Industrial Code.	**6**
6	**Flywheel** design for application to: (i) Punching press; (ii) 2-stroke engine; (iii) 4-stroke engine, Torque analysis, Solid disc and rimmed flywheel	**2**
7	**Sliding contact bearings:** Bearing types and materials; Stribeck Curve, Petroff equation, Hydrodynamic lubrication theory - pressure development; Tower experiment, Reynolds equation, Finite bearings – Raimondi-Boyd charts, Design factors/variables, Heat generation & dissipation; Hydrostatic bearing; Plummer block.	**6**
8	**Rolling contact bearings:** Bearing types, nature of load; Static and dynamic load capacity, Stribeck equation, Load - Life relation; Bearing selection from manufacturers' catalogues; Methods of lubrication; Bearing mounting on journal and bearing block.	**4**
	TOTAL	**36**

Books Recommended :

1. V. B. Bhandari, Design of Machine Elements, TMH.
2. Shigley and Mischke, Mechanical Engineering Design, TMH.
3. Hall, Holowenko and Laughlin, Theory and Problems of Machine Design, TMH.
4. Hamrock, Schmid, Jacobson, Fundamentals of Machine Elements, Mcgraw Hill.
5. Burr and Cheatham, Mechanical Analysis and Design, Prentice Hall.
6. P. Kannaiah, Machine Design, Scitech Publications.
7. P.C. Gope, Fundamentals of Machine Design, PHI.

Professional Elective-II

Air Conditioning & Refrigeration
ME-604A
Contacts: 3L
Credits- 3

Module No.	Description of Topic	Lectures Hours
1	Introduction: Concepts of Refrigeration and Air-conditioning. Unit of refrigeration, Refrigerants– Desirable Properties, Nomenclature	**02**
2	Simple Vapour Compression Refrigeration System(Simple VCRS): Vapour compression cycle on p-h and T-s diagrams. Cycles with subcooling and superheating, their effects; Effect of changes in evaporator pressure and condenser pressure on the performance of a simple VCRS; dry compression and wet compression of refrigerant; actual Vapour Compression Cycle.	**06**
3	Air Refrigeration System (ARS): Bell-Coleman refrigerator. COP determination, actual air-refrigeration cycle.	**03**
4	Vapour Absorption Refrigeration System (VARS): Advantages of VARS over VCRS. Working principle of simple VARS, practical VARS. Limitations of VARS, maximum COP of a VARS, Lithiumbromide-water System; Aqua-ammonia systems.	**04**
5	Equipment and Control: Major Refrigeration Equipment - Compressors: Types; reciprocating, rotary & centrifugal, volumetric efficiency, Condensers: types used in refrigeration systems; Evaporators: expansion devices: capillary tubes and thermostatic expansion valves.	**06**
6	Ventilation – Definition & Requirement, Natural & Mechanical Ventilation, Ventilation Load Calculation	**03**
7	Basic definitions and principles related to Psychometry ; Psychometric Charts & Their Uses; Heating, Cooling, Heating & Humidification & Cooling & Dehumidification processes. Adiabatic Saturation, Cooling Coils, By-pass Factor.	**06**
8	Sensible Heat Factors. Heat Load estimation: Simple cases of Cooling and Dehumidification.	**04**
9	Duct Sizing & Design.	**02**
10	Air-conditioning equipment: Airhandling units, Cooling Towers.	**04**
	Total	**40**

Texts & References:

1. Stocker & Jones, Refrigeration and Air Conditioning, McGraw Hill.
2. C.P. Arora, Refrigeration and Air Conditioning.
3. P.L. Ballaney, Refrigeration and Air Conditioning.
4. R.C.Arora, Refrigeration and Air Conditioning, TMH.
5. Arora and Domkundwar, Refrigeration and Air Conditioning, Dhanpat Rai Publication.

Mechatronics
ME-604B
Contacts: 3L
Credits- 3

Module	Topic	Contact Hours
1	Introduction to Mechatronics: Definition, Mechatronics in design and manufacturing, Comparison between Traditional and Mechatronic approach; Concurrent engineering.	**3**
2	Review of fundamentals of electronics, Logic gates and their operations, Signal processing devices, Data conversion devices, Input and output devices. Sensors and Transducers, Actuators, Limit switches, Relays.	**6**
3	Control Systems: Open loop and closed loop control, block diagrams, transfer functions, Laplace transforms.	**3**
4	Electrical Drives: Stepper motors, servo drives.	**2**
5	Mechanical Drives: Different mechanisms, Ball screws, Linear motion bearings, Transfer systems.	**3**
6	Pneumatic and Hydraulic Drives: Elements of pneumatic and hydraulic drives, comparison between them. Design of pneumatic and hydraulic circuits, symbolic representations of such circuits indicating different valves, actuators, etc.,	**4**
7	Basics of 8085 microprocessor, programmable register architecture, buses, memory mapping, clock pulse and data transfer operations, and simple assembly and mnemonic programming on 8085 microprocessor.	**5**
8	Use of On-Off, PI and PID controllers to control different drives, Programming in PLC controller using Ladder diagram.	**4**
9	Mathematical modeling of physical systems, such as spring-mass vibration system, linear and rotory motion and its Laplace Transform.	**2**
10	Basics of time domain analysis, Introduction to discrete-time systems and Z-transform.	**2**
11	Introduction to Mechatronic systems, such as automatic brake, door closing and opening, robot, CNC machine, AGV, etc.	**2**

References:

2. N.P. Mahalik, Mechatronics, Tata McGraw Hill Publication
3. W. Bolton, Mechatronics, Pearson Education
4. A. Smaili and F. Arnold, Mechatronics, Oxford University Press, Indian Edition
5. M.D. Singh and J.G. Joshi, Mechatronics, Prentice Hall of India Pvt. Ltd.
6. K.K. Appuu Kuttan, Mechatronics, Oxford University Press, New Delhi
7. HMT Ltd., Mechatronics, Tata McGraw Hill Publication
8. F.H. Raven, Automatic Control Engineering, McGraw Hill International.
9. K. Ogata, Modern Control Engineering, Prentice Hall.
10. B.C. Kuo, Automatic Control Systems, Prentice Hall.

Fluid Power Control
ME-604C
Contacts: 3L
Credits- 3

Module	Syllabus	Contact Hours
1A	Fluid power; Applications and advantages; Components of a hydraulic and pneumatic system.	**1**
1B	Desired properties of a hydraulic fluid; advantage of mineral oil over water; definition of terms like pressure, head, force, density, specific gravity, kinematic and absolute viscosity, compressibility and incompressibility.	**2**
1C	Pascal's law; analysis of simple hydraulic jack, Mechanical advantage; continuity equation; hydraulic power of a cylinder.	**2**
2.	Hydraulic Pumps : positive displacement pumps; constructional features, working principle and volumetric capacity of external gear pump, vane pump, axial piston pump and radial piston pump.	**6**
3.	Hydraulic Actuators : (i) Constructional features of single acting and double acting hydraulic cylinders; mounting of cylinders, cushioning of cylinder; different application of cylinder through mechanical linkages; force, velocity and power from a cylinder. (ii) Hydraulic motors; torque, power and flow rate in a hydraulic motor.	**4**
4.	Hydraulic Valves : (i) Direction control valves – operation and graphical symbol of 3 way and 4 way valves; different modes of activation of valves; (ii) Operation and graphical symbols of check valves, pressure relief valve pressure reducing valve, unloading	**4**

	valve and flow control valve.	
5.	ANSI symbols for different hydraulic components. Analysis of hydraulic circuits for : i) single acting cylinder control, ii) double acting cylinder control, iii) regenerative circuit, iv) pump unloading circuit v) double pump hydraulic system, vi) cylinder synchronization circuit vii) speed control of a hydraulic motor viii) circuit to lift and hold heavy load, ix) automatic sequencing of two cylinders.	**7**
6.	Advantages & disadvantages of pneumatic system compared to hydraulic system; constructional details and operation of a reciprocating compressor; working principle and use of filter, pressure regulator, lubricator and silencer; symbols of different pneumatic components; compressed air distribution system in a plant; drawing pneumatic circuits for different operations.	**6**
7.	Use of electrical devices for controlling fluid circuits; function of electrical devices like push-button switches, limit switches, pressure switches, solenoids, relays and timers and their symbols; concept of ladder diagram; study of following circuits using electrical control devices : i) control of a solenoid actuated cylinder using one limit switch; ii) reciprocation of a cylinder using pressure or limit switches, iii) two cylinder sequencing circuit using two limit switches.	**4**

Books recommended :

1. Ilango and Soundararajan, Introduction to Hydraulics and Pneumatics, PHI.
2. A. Esposito, Fluid Power with Applications, Pearson.
3. S.R. Majumdar, Pneumatic Systems: Principles and Maintenance, Tata McGraw Hill.
4. E.C. Fitch Jr., Fluid Power and Control Systems, McGraw Hill Book Co.
5. Banks and Banks, Industrial Hydraulics, Prentice Hall.

Professional Elective-III

Materials Handling
ME-605A
Contacts: 3L
Credits- 3

Module	Syllabus	Contact Hrs

1.	**Introduction :** Definition, importance and scope of materials handling (MH); classification of materials; codification of bulk materials ; utility of following principles of MH – (i) materials flow, (ii) simplification, (iii) gravity, (iv) space utilization, (v) unit size, (vi) safety, (vii) standardization, (viii) dead-weight, (ix) idle time, (x) motion.	**4**
2A.	**Unit load :** Definition; advantages & disadvantages of unitization; unitization by use of platform, container, rack, sheet, bag and self contained unit load; descriptive specification and use of pallets, skids, containers, boxes, crates and cartons; shrink and stretch wrapping.	**3**
2B	**Classification of MH Equipment :** Types of equipment – (i) industrial trucks & vehicles, (ii) conveyors, (iii) hoisting equipment, (iv) robotic handling system and (v) auxiliary equipment; Independent equipment wise sub classification of each of above type of equipment.	**3**
3.	**Industrial trucks & vehicles :** Constructional features and use of the following equipment – (i) wheeled hand truck, (ii) hand pallet truck, (iii) fork lift truck; Major specifications, capacity rating and attachments of fork lift truck.	**5**
4.	**Conveyors :** Use and characteristics of belt conveyor, constructional features of flat and troughed belt conveyor; Use and constructional features of Flg. types of chain conveyors – (i) apron, car and trolley type; Construction of link-plate chains; Dynamic phenomena in chain drive; Use and constructional features of roller conveyors; Gravity and powered roller conveyor; Pneumatic conveyor-use and advantages; Positive, negative and combination system of pneumatic conveyors; constructional feature, application and conveying capacity of screw conveyor.	**8**
5.	**Hoisting Equipment :** Advantage of using steel wire rope over chain; constructional features of wire ropes; Rope drum design; Pulley system-simple vs. multiple pulley; Load handling attachments : hooks, grabs, tongs, grab bucket; Arrangement of hook suspension with cross piece and pulleys (sheaves); Use and constructional features of (i) hand operated trolley hoist , (ii) winch; (iii) bucket elevator, (iv) Jib crane, (v) overhead traveling crane and (vi) wharf crane; Level luffing system of a wharf crane; Utility of truck mounted and crawler crane.	**8**
6A.	**Robotic handling :** Materials handling at workplace; Major components of a robot; Applications of robotic handling.	**2**
6B.	**Auxiliary Equipment :** Descriptive specification and use of – (i) Slide and trough gates, (ii) belt, screw and vibratory feeders, (iii) Chutes, (iv) positioners like elevating platform, ramps, universal vise; (v) ball table.	**3**

Books Recommended :

1. S. Ray, Introduction to Materials Handling, New Age Int. Pub.
2. T. K. Ray, Mechanical Handling of Materials, Asian Books Pvt. Ltd.
3. T.H. Allegri, Materials Handling: Principles and Practices, CBS Publishers and Distributors.
4. J.A. Apple, Material Handling System Design, John Wiley & Sons.

Finite Element Method
ME-605B
Contacts: 3L
Credits- 3

Module	Syllabus	Contact Hours
1	**Introduction**: Historical background, Relevance of FEM to design problems, Application to the continuum– Discretisation, Matrix approach, Matrix algebra– Gaussian elimination, Governing equations for continuum, Classical Techniques in FEM, Weighted residual method, Ritz method, Galerkin method	**8**
2	**One dimensional problems:** Finite element modeling– Coordinates and shape functions, Potential energy approach– Element matrices and vectors, Assembly for global equations, Boundary conditions, Higher order elements- Shapes functions, Applications to axial loadings of rods– Extension to plane trusses, Bending of beams– Finite element formulation of stiffness matrix and load vectors, Assembly to Global equations, boundary conditions, Solutions and Post processing, Example Problems.	**8**
3	**Two dimensional problems– scalar variable problems:** Finite element modeling– CST element, Element equations, Load vectors and boundary conditions, Assembly, Application to heat transfer, Examples	**4**
4	**Two dimensional problems– vector variable problems:** Vector Variable problems, Elasticity equations–	**8**

	Plane Stress, Plane Strain and Axisymmetric problems, Formulation, element matrices, Assembly, boundary conditions and solutions Examples	
5	**Isoparametric elements for two dimensional problems:** Natural coordinates, Iso parametric elements, Four node quadrilateral element, Shape functions, Element stiffness matrix and force vector, Numerical integration, Stiffness integration, Displacement and Stress calculations, Examples.	**6**
6	**Computer implementation**: Pre-processor, Processor, Post-processor. Discussion about finite element packages.	**2**
	Total	**36**

REFERENCES:

1. R.D. Cook, D.S. Malkus and M.E. Plesha, Concepts and Applications of Finite Element Analysis, Prentice Hall-India, New Delhi.
2. T.R. Chandrupatla and A.D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall of India.
3. C.S. Krishnamoorthy, Finite Element Analysis, TMH.
4. K-J. Bathe, Finite Element Procedures, Prentice Hall.
5. O.C. Zienkiewicz, R.L. Taylor, J.Z. Zhu, The Finite Element Method: Its Basis and Fundamentals, Elsevier.
6. J.N. Reddy, An Introduction to the Finite Element Method, McGraw-Hill.

Turbo Machinery
ME-605C
Contacts: 3L
Credits- 3

Module	Syllabus	Contact Hours
1	**Introduction:** **Classification**: **Incompressible and compressible flow machines; Radial, axial and mixed flow machines;** Turbines vs pumps, fans and compressors. **Applications**: Water supply, ventilation, power generation, propulsion.	**1** **1**
2	**Incompressible- Flow Machines:** **Hydraulic Turbines**: Headrace, penstock, nozzle, runner, draft tube and tail race; Gross head and net head; Velocity diagrams for impulse and reaction turbines; Discharge, head, power and efficiencies. **Pumps**: Reservoir, foot valve, suction line, pump, delivery line and overhead tank; Static head and losses; Velocity diagrams; Discharge, head, power and efficiencies.	**8** **8**
3	**Compressible-Flow Machines:** Static and stagnation states; Isentropic and adiabatic expansion and compression processes; Nozzle, diffuser and rows of stationary and moving blades; Efficiencies.	**10**
4	**Dimensional Analysis:** **Similarity laws,** Volume-flow, mass-flow head and power coefficients, pressure ratio, enthalpy ratio, Reynolds number, Mach number; Specific speed and machine selection.	**4**
5	**Testing and Performance Analysis:** Measurement devices; affinity laws and unit quantities. Set up and operating characteristics of pumps, turbines; fans and turbo-compressors. Cavitation– **cause of cavitation and definition of Thoma's cavitation parameter,** surge and choking.	**8**
	Total	**40**

Suggested Text:

1. S.M. Yahya, Turbine, Compressors and Fans.
2. J. Lal, Hydraulic Machines.
3. S.K. Som, G. Biswas and S. Chakraborty, Introduction to Fluid Mechanics & Fluid Machines, TMH.
4. M.M. Das, Fluid Mechanics & Turbo Machines, PHI, 2010.
5. R.K. Bansal, Fluid Mechanics & Machinery, Luxmi Publications.
6. C. Ratnam, A.V. Kothapalli, Fluid Mechanics & Machinery, I.K. International Publishing House Ltd, 2010.
7. C.S.P. Ojha, R. Berndtsson, P.N. Chandramouli, Fluid Mechanics & Machinery, Oxford University Press.
8. Gupta, Fluid Mechanics and Hydraulic Machines, Pearson Publication.
9. A.T. Sayers, Hydraulic and Compressible Flow Turbomachines.
10. R.K. Bansal, Fluid Mechanics and Hydraulic Machines.
11. G. FGopalakrishnan, A Treatise on Turbo Machines, Scitech Publication.
12. Karassic, Kulzsch, Fraser and Messina, Pump Handbook.
13. Cherkassky, Pumps, Fans and Compressors, MIR Publication, Moscow.

Practical

Machining & Machine Tools Lab
ME-691
Contacts: 3P
Credits: 2

At least 6 (six) of the following experiments/ assignments to be conducted.

		Hours (days)
1.	Measurement of cutting forces (Pz and Px or Py) in straight turning at different feeds and velocities	3 (1)
2.	Measurement of average cutting temperature in turning under different speed – feed combinations	3 (1)
3.	Measurement of surface roughness in turning under different conditions	3 (1)
4.	Study of chip formation (type, color & thickness) in turning mild steel and evaluation of role of variation of cutting velocity and feed on chip reduction coefficient /cutting ratio and shear angle	3 (1)
5.	Measurement of tool – wear and evaluation of tool life in turning mild steel by HSS or carbide tool	3 (1)
6.	Geometrical and kinematic test of a centre lathe or a drilling machine	3 (1)
7.	Producing a cast iron vee – block by machining	9 (3)
8.	Production of a straight toothed spur gear from a cast or forged disc	9 (3)

IC Engine Lab
ME-692
Contacts: 3P
Credits: 2

Any 6 (six) of the following experiments to be conducted.

1) Determination of calorific value of a fuel by Bomb calorimeter.
2) Flue gas analysis by ORSAT apparatus.
3) Study of valve timing diagram of Diesel Engine.
4) Performance Test of a muticylinder Petrol Engine by Morse method.
5) Performance Text of an I.C. Engine using electric (eddy current) dynamometer.
6) Use of catalylitic converters and its effect on flue gas of an I.C. Engine.
7) Study of MPFI (multipoint fuel injection system).

Design Practice-II
ME-693
Contacts: 3P
Credits: 2

Computer terminal exercises compatible to theory course on ME 603: Machine Design

1. At least **two assignments** on 2-D and 3-D modelling of mechanical components and systems using software packages like AUTOCAD, CATIA, PRO E or similar software
2. At least **one assignment** on design analysis of mechanical components using software packages like CATIA, PRO E or similar software.
3. At least **one assignment** on Design Practice using codes, e.g., Pressure vessel codes, Gear design codes etc.
4. At least **one assignment** on Selection of mechanical components from manufacturers' catalogue, e.g., chain drive, rolling element bearings etc.

Dynamics of Machines Lab
ME-694
Contacts: 3P
Credits: 2

At least 6 (six) experiments from the following topics to be conducted.

Experiments to be conducted on

1. Studying and designing different mechanisms for performing specific tasks in a machine tool, and for common engineering applications.
2. Studying vibratory systems of single and more than one degree of freedom in linear and rotory systems;
3. Static and dynamic balancing of rotating masses;
4. Balancing of reciprocating masses;
5. Experiments on working of governor, operation and analysis.
6. Experiments on working of gyroscope, operation and analysis.
7. Designing cam,
8. Studying operation of cams and its analysis.

Air Conditioning & Refrigeration Lab
ME-695A
Contacts: 3P
Credits: 2

At least 4 (four experiments) to be conducted of which No. 4 is compulsory.

1. Study of a Domestic Refrigerator.
2. Study of a room (window type) Air Conditioner.
3. Determination of C.O.P of a vapour compression refrigeration system.
4. Experiment in an Air Conditioning Test Unit; Determination of bypass factor and plotting of the cooling – dehumidification process on a psychometric chart.
5. Performance test of thermoelectric refrigeration system.

Mechatronics Lab
ME-695B
Contacts: 3P
Credits: 2

At least 6 (six) experiments of the following list of topics to be conducted.

Experiments on:

1. Open loop position control;
2. Closed loop position control using positional and velocity feedback;
3. Use of analog and digital servosystems,
4. Use of PID control;
5. Experiments on pneumatic drives and actuators;
6. Experiments on hydraulic drives and actuators;
7. Use of logic gates;
8. Programming on a 8085 Microprocessor training kit;
9. Programming on a PLC for simple control operations.

Fluid Power Control Lab
ME-695C
Contacts: 3P
Credits: 2

At least 6 (six) of the following experiments to be conducted.

1. Study of a Hydraulic Trainer system, making a circuit diagram of the system and labeling all the components with their basic specifications.
2. Same as in 1 above for a Pneumatic Trainer system.
3. Perform any four experiments from the following :
   - (i) Operation and study of the function of a pressure reducing valve in a hydraulic circuit.
   - (ii) Controlling the speed of a hydraulic cylinder by operating a flow control valve and measurement of piston velocity.
   - (iii) Design, prepare and operate a hydraulic / pneumatic circuit for automatic sequencing of two cylinders.
   - (iv) Design, prepare and operate a pneumatic circuit for lifting and then holding a load.
   - (v) Design, prepare and study of a hydraulic circuit for rapid advance, slow feed and then rapid return.
   - (vi) Prepare an AND logic circuit using pneumatic components
   - (vii) Prepare an OR logic circuit using pneumatic components.

Proposed

VII Semester
Theory

ME 701
Power Plant Engineering
Contact Hours: 4L
Credit: 4

Module-1
Power plant cycles, reheat, regenerative and binary vapor and co-generation cycles. 4
Module-2
Boilers: Definition, classification, fire tube and water tube boilers, mountings and accessories. Draft in boilers, performance of boiler - boilers efficiency, equivalent evaporation, Losses in boilers.
Coal and combustion: Properties of coal, ultimate analysis and proximate analysis, combination calculation.

6
Module-3
Fuel bed firing, PF firing and Fluidized bed boilers.
Introduction to boiling and circulation in boilers.
Power station boilers - Benson, Lamont. Supercritical boiler. 5
Module-4
Boilers accessories: Super heater, economizer and air-pre heater.
Handling of coal and ash. 5
Module-5
Steam turbine- i) parts and classification, ii) nozzles types, flow through nozzles and nozzle efficiency.
Impulse turbine - velocity diagram, work done and blade efficiency. 7
Module-6
Pressure compounding and velocity compounding of steam turbine. 4
Module-7
Impulse reaction turbine - Velocity diagram, degree of reaction and Parsons turbine. 4
Module-8
Governing in Steam turbine.
Condensers – Basic ideas. 5
Module-9
Power plant economics: load curve and various factors, cost of power generation.
Introduction to Hydel, Nuclear and Renewable power plants. 4
Total: 44

Recommended Books:

1. P.K. Nag, “Power plant Engineering,” Tata McGraw - Hill.
2. Arora and Domkundwar, “A course in Power plant Engineering” Dhanpat Rai & Sons.
3. M.M.EI- Wakil, “Power plant technology,” Tata McGraw - Hill.

ME702
Advanced Manufacturing Technology
Contact Hours: 4L
Credit: 4

Contacts : 4L **Contact week/ Semester: 12**

Sl.No.	Syllabus	Contact Hrs.
1.	**Introduction to and scope of the subject of Advanced Manufacturing Technology**	**1**
2.	**Manufacturing Systems and Automation :** Job shop, Flowlines, Transfer lines, Project shop, Continuous processes, Cellular manufacturing system, Flexible Manufacturing System: **Automation:** (i) degree of automation and their justified application in different levels of production (ii) benefits and draw backs of employing automation (iii) examples of conventional non-automatic, semi-automatic and automatic machine tools	**8**

Sl.No.	Syllabus	Contact Hrs.
	(iv) extent of automation in transfer machines **Integrated Manufacturing Production System:** Steps involved in implementation, forming the linked-cell factory.	
3.	**CNC machine tools and systems** (i) types of automation ; fixed (or hard), programmable and flexible (ii) need and advantages of flexible automation (iii) basic principles of NC system Components and their functions in NC machines (i) Control ; MCU, DPU and CLU (ii) feed drives ; special motors and screw-nut system (iii) advantages of CNC over NC machines Basic systems of NC and CNC machines (i) coordinate system (ii) control – open loop and closed loop (iii) dimensioning – absolute and incremental CNC machine tools ; (i) structure and working principle (ii) examples and use of CNC machines (iii) machining centre (MC) – characteristics and applications. Control of tool – work travel ; (i) point – to – point and contouring (ii) interpolation – linear and circular	**5**
	Part programming for NC, CNC and MC systems Manual part programming (i) definition and codes used (ii) sequential steps (iii) examples ; part programming for machining in CNC lathes, drilling machines and milling. Computer aided part programming (i) definition and advantages (ii) programming languages (iii) statements in APT (iv) examples of CA part programming in APT	**4**
4.	**An overview of Non Traditional Manufacturing -** Advantages over traditional, classification, characteristics of all processes: **Abrasive Jet Machining (AJM)** Working principle with help of layout, Applications, Effect of pressure, strand-off distance, grain size, abrasive flow rate on material removal rate (mrr) Mechanism of material removal. Advantages and limitations. **Water Jet Machining:** Introduction, Machining System, Basic principle, Process parameters, Applications, Advantages and Disadvantages. **Ultrasonic Machining (USM)** Schematic Diagram of USM- Working principle, Functions of each equipment used in the set up, Material removal process. Influence of Process parameters on (i) machining rate (ii) Surface finish and accuracy and repeatability, Applications. **Plasma Arc Machining** Basic principle, applications	**6**

Sl.No.	Syllabus	Contact Hrs.
5.	**Chemical Machining-** Introduction, Blanking, Chemical Machining to multiple depths, Design factors, advantages and disadvantages. **Electro-Chemical Machining-** Process principle, Equipment, Applications. **Electron Beam Machining** Set up, Basic Principle, Applications. **Electrical Discharge Machining (EDM)** Diesinking- Basic principle, Schematic diagram of EDM setup, Dielectric fluid, Electrode materials. System for maintaining the spark gap constant, Effect of cutting parameters- pulse-on-time, pulse off time, peak current setting, no load voltage, servo reference voltage, Applications. **Wire-cut EDM:** Schematic diagram, working principle Dielectric fluid, use. Advantages & Disadvantages of EDM, Applications.	**6**
6.	**Laser Beam Machining (LBM)** Characteristics of Laser light, Basic mechanism of Ruby laser, Energy level diagram of Ruby laser. Carbon Dioxide laser, Energy level diagram. Commercial lasers available for machining, welding Heat treating, cladding. **Hybrid Machining-** Introduction, Methodology for Hybrid Machining- thermal interaction, chemical and electrochemical interaction, mechanical interaction, Electromechanical Discharge Machining (ECDM/ECAM), Electrical Discharge Machining with Ultrasonic Assistance (EDMUS).	**6**
7.	**Rapid Prototyping-** Overview of Rapid Prototyping, Basic Process- CAD Model Creation, Conversion to STL format, Slice the STL File, Layer by layer construction, Clean and finish. **Principles, systems, relative advantages and applications of the common RP methods ;** (i) stereo lithography (SLG) (ii) selective laser sintering (SLS) (iii) fused deposition modelling (FDM) (iv) laminated objects manufacturing (LOM) (v) 3-D Inkjet Printing	**6**
	Total	**42**

Recommended Books

1. *Fundamentals of Modern Manufacturing* by Mikeel P. Grover– 3E Wiley
2. Automation, Production systems and CIM – M.P. Groover , Prentice Hall
3. *Non conventional machining* – P.K. Mishra, Narosa
4. *Manufacturing science* – Ghosh & Mullick, EWP
5. *Rapid prototyping* – A. Ghosh, EW Press
6. *Non traditional Manufacturing Processes* by Gary F. Benedict– Marcel Dekker
7. *Micromaching of Engineering* Material by Mc Geongh, J.A. – Marcel Dekker
8. *Advanced Machining Process, Nontraditional and Hybrid Machining Processes* by Hassan Abdel- Gawad El-Hofy – McGraw Hill, Mechanical Engineering Science

ME703A
Maintenance Engineering

Contact Hours: 3L
Credit: 3

Sl. No.	Syllabus	Contact Hrs.
1.	**Introduction:** Definitions of repair and maintenance; Importance of maintenance; Different maintenance systems- breakdown, preventive, planned; predictive maintenance through condition monitoring; Maintainability, failure pattern, availability of equipment / systems, design for maintainability.	**(5)**
	Total Productive Maintenance (TPM): definition, objective & methodology; Implementation of TPM; Lean maintenance; Overall equipment effectiveness (OEE)	**(3)**
2.	**Organizational structures for maintenance:** Objective; Maintenance functions and activities; Organizational requirements; Types of maintenance organizations, Manpower planning; Engineering stores & inventory management.	**(4)**
3.	**Economic Aspect of Maintenance:** Life cycle costing; Maintenance cost & its impact; Maintenance budget; Cost control; Maintenance audit- Procedure, tools, planning, reports.	**(4)**
4.	**Function and use of Maintenance Equipment, Instruments & Tools:** Facilities like NDT, painting, coating and cladding, Gas cutting and welding, crack detection, vibration monitor, balancing equipment, compressor, basic machine tools, lubricators and lubricants, chain pulley block, Tools like different types of wrenches, torque wrench, pipe wrench, plier, screw driver, dimension measuring instruments, feeler gauge, scraper, fitting shop tools, spirit level, hand grinder & drill, screw jack, etc.	**(6)**
5.	**Lubrication:** Purpose & importance; Type of lubricants, Properties of lubricants; Types of lubrication and their typical applications, lubrication devices, centralized lubrication system; Gasket, packing and seals;	**(4)**
6.	**Repair & Maintenance Procedures:** Repair of cracks, threads, worn shafts, keyways, bush bearing, damaged gear tooth. Assembly and dismantling of antifriction bearing; Maintenance of bearing, clutches, coupling, brakes, Alignment of shafts, belt and chain drives, gear drives, centrifugal pump, pipe and pipe fittings, electrical wiring, isolators and main switches, small induction motors; Steps for installation of a machine.	**(10)**

BOOKS

1. Mishra and Pathak, Maintenance Engineering and Management, PHI
2. Srivastava, Maintenance Engineering and Management, S. Chand & Company Ltd., New Delhi.
3. K. Venkataraman, Maintenance Engineering and Management, PHI

ME703B
Renewable Energy Systems
Contact Hours: 3L
Credit: 3

Topics — No. of Lectures

1. Principles of Renewable Energy:
   - i) The history of energy scene
   - ii) The energy future: energy and sustainable Development and role of renewable energy
   - iii) Scientific Principles of renewable energy — 04
2. Review of principles of thermodynamics, fluid dynamics and heat transfer — 01
3. Solar radiation:
   - i) Sun-Earth geometry
   - ii) Extraterrestrial Solar Radiation
   - iv) Measurement and estimation of solar radiation. — 04
4. Solar Water Heating:
   - i) Flat Plate Collectors: Heat Transfer analysis, Testing

ii) Evacuated Tube Collectors 05

5. Other Solar Thermal Applications:
   i) Air heaters
   ii) Water Desalination
   iii) Space Cooling
   iv) Solar Concentrators
   v) Solar ponds 03

6. Photovoltaic Generation:
   i) Photon absorption at Silicon p-n junction
   ii) Solar Cell
   iii) Application and Systems 04

7. Wind Power:
   i) Turbine types & terms
   ii) Mechanical & Electrical Power from Wind Turbines 03

8. Biomass & Biofuels:
   i) Use of Biomass
   ii) Classification & Use of Biofuels. 03

9. Wave Power & tidal Power: Basic Concepts 03

10. Ocean Thermal Energy Conversion 02

11. Geothermal Energy 02

12. Energy Storage 02

36

Books

1. Renewable Energy – G. Boyle, 2nd edition, OUP,2010.
2. Renewable Energy Resources- Twidell, J & Weir, T, 2nd edition, Taylor & Francis, 2006.
3. Non Conventional Energy Resources- B.H. Khan, T M H, 2010.
4. Non Conventional Energy Sources- G.D. Rai, Khanna Publishers.

P.S:In my opinion, Professional Electives IV and V should be separately grouped as:

ME703C
Tribology
Contact Hours: 3L
Credit: 3

Module	Syllabus	Contact hours
1	**Introduction:** History, Industrial Importance. **Engineering Surfaces:** Properties and Measurement: Measurement Methods, Surface Profilometry, Statistical Description of Roughness.	4
2	**Surface Contact:** Hertz contact theory, Greenwood-Williamson model, Elastic-plastic	4

	contact **Adhesion**: Basic Models, Factors influencing Adhesion.	
3	**Friction**: Measurement Methods, Origin of Friction, Friction Theories – adhesion and ploughing, Mechanisms, Friction of Metals, Non-metallic Materials.	6
4	**Wear:** Types: Adhesive, Abrasive, Corrosive, Fatigue, Minor Forms: Fretting, Erosion, Percussion, Delamination Theory, Wear Debris Analysis, Wear Testing Methods, Wear of Metals, Ceramics, Polymers.	6
5	**Surface Engineering**: Surface Treatments: Microstructural and Thermochemical Treatments, Surface Coatings: Hard Facing, Vapour Deposition Processes: PVD, CVD, PECVD etc.	4
6	**Lubrication:** Basic Equations for Fluid Film Lubrication. Hydrodynamic lubrication -Thrust and Journal bearings, Squeeze Film Bearings, Hydrostatic lubrication, Gas-Lubrication. Lubrication of rolling element bearings. Boundary lubrication – metal working lubrication, solid film lubrication. Hygiene of lubricants	10
7	**Nanotribology**: Measurement Tools: Surface Force Apparatus, Scanning Tunnelling Microscope, Atomic / Friction Force Microscope.	2
	Total	36

REFERENCES

7. P. Sahoo, Engineering Tribology, Prentice Hall-India, New Delhi, 2009.
8. B. Bhushan, Introduction to Tribology, Wiley, 2002.
9. G W Stachowiak and A W Batchelor, Engineering Tribology, Butterworth-Heinemann, 2005.
10. S.K. Basu, S.N. Sengupta, B.B. Ahuja, Fundamentals of Tribology, Prentice Hall-India, 2005.
11. B C Majumdar, Introduction to Tribology of Bearings, S Chand & Co, 2012.

ME704A
Quantity Production Method
Contact Hours: 3L
Credit: 3

Module Number	Lecture topics	Contact hours
Module-1	INTRODUCTION	4
1.1 1.2 1.3 1.4	Engineering Production ; aim and objectives history of progress, definition and requirements Levels of production ; piece, batch, lot, mass and quantity production Meahanisation and ; need, degree and types of automation Role of automation in industrial production	1 1 1 1
Module-2	Quantity production methods - Concept	16
2.1(a) (b) 2.2 2.3 2.4 2.5 2.6 2.7	Broad classification of engineering production methods Major sequential steps in industrial production ; preforming, semi finishing, heat treatment, finishing, assembly and inspection Quantity production (methods) of common items ; (i) shafts and spindles (1) (ii) automobile parts ; engine block, piston, connecting rods and crank shaft (1) (iii) metallic wires, rods, tubes, bars, plates and sheets (1) (iv) various types of gears and bearings (2) Methods of quantity production of cutting tools, tool inserts and tool holders Smallsize products ; pins, clips, needles, metallic caps, washers, utensils, chains springs, paste tubes and coins Large scale production of bolts and nuts Quantity production by spinning, bulging, magneto forming, hydro forming and explosive forming Production by powder metallurgical process.	1 5 4 1 2 3
Module-3	Planning and scheduling	6
3.1	Process planning and scheduling for quantity production using ; (i) semi-automatic and automatic lathes (2) (ii) transfer machines (1) (iii) CNC machining systems (including machining centres FMS) (2)	3

3.2	Design and use of jigs and fixtures for batch production in machine shops	3
Module-4	Productivity and quality enhancement in Quantity production	4
4.1 4.2 4.3	Group technology ; concept and application in large scale production Inspection and quality control in quantity production Computerisation and robotization in quantity production	1 1 2
Module-5	Non-conventional manufacturing of products in quantity	6
5.1 5.2 5.3	Quantity production by non-traditional processes ; Examples – EDM, ECM, AJM, USM, ChM and EBM Regenerative manufacturing ; rapid prototying and rapid tooling Quantity production of ceramic and polymer products.	2 2 2
	Total contact hours (approximately)	36

Books

1. Fundamentals of modern manufacturing – M. P. Groover, Pub. - Wiley
2. Manufacturing engineering and technology – S. Kalpakjin, Pub. -Wwsley
3. Processes and design for manufacturing – S. D. El Wakil, PWS Pub. Co.
4. Process and materials of manufacture – R. A. Lindberg , Pub. Prenlice Hall. ND
5. Materials and processes in manufacturing – Degarmo, Black and Kasher, Pub. Wiley & Sons
6. Tool design – C. Donaldson Pub. Tata Mc Graw Hill
7. Principles of machine tools – Sen and Bhattacharyya – Pub. New Central Agency Kolkata.
8. Non-conventional machining – P. K. Mishra, Pub. Narosa
9. Rapid prototyping – A. Ghosh, Pub. Eastwest press ND
10. Metal cutting tool production – Palay ; MIR Moscow
11. Metrology and ganging – Parson / Judge.

ME704B
Advanced Welding Technology
Contact Hours: 3L
Credit: 3

Module	Content	Hour
1	Review of welding processes, joint design	**3**
2	Process descriptions of and parametric influences on fusion welding; arc welding- SMAW, stud arc welding, GMAW, GTAW and FCAW, solid state welding processes- pressure welding, friction welding, diffusion welding; resistance welding processes.	**6**
3	Arc welding- different types of equipment, power sources, arc characteristics, electrode selection.	**5**
4	Critical and precision welding processes like: PAW, LBW, EBW, USW, friction stir welding, under-water welding. Welding of plastics, ceramics and composites.	**5** **2**
5	Welding metallurgy, HAZ, effects of different process parameters on the characteristics of weldment. Welding fixtures, welding automation and robotic applications	**6** **1**
6	Weldability of plain carbon steels, stainless steel, cast iron, aluminium and its alloys.	**4**
7	Welding defects- types, causes, inspection and remedial measures; testing of welded joints by visual inspection, dye-penetration (DP) test, ultrasonics and radiography. Safe Practices in Welding.	**3** **1**
	Total	**36**

Text and Reference Books:

5. O.P. Khanna, A Text Book of Welding Technology, Dhanpat Rai & Sons.
6. R.S. Parmar, Welding Engineering and Technology, Khanna Publishers.

7. M. Bhattacharyya, Weldment Design, The Association of Engineers, India Publication, Kolkata.
8. J.C. Lippold and D.J. Kotecki, Welding Metallurgy and Weldability of Stainless Steels, Wiley-India (P) Ltd., New Delhi.
9. Udin, Funk and Wulf, Welding for Engineers, John Wiley and Sons.
10. J.L. Morris, Welding Process and Procedures.
11. S.V. Nadkarni, Modern Arc Welding Technology, Oxford & IBH Publishing Co. Pvt. Ltd./ Advani-Oerlikon Ltd.

ME704C
Computational Methods in Engineering
Contact Hours: 3L
Credit: 3

Module	Syllabus	Contact hours
1	**Approximations:** Accuracy and precision, round off and truncation errors, error propagation.	4
2	**Algebraic equations:** Formulation and solution of linear algebraic equations, Gauss elimination, LU decomposition, iteration methods – convergence, Eigen values and eigenvectors.	4
3	**Interpolation methods**: Newton's divided difference, interpolation polynomials, Lagrange interpolation polynomials	6
4	**Differentiation and Integration:** High accuracy integration formula, extrapolation, derivatives of unequally spaced data, Gauss quadrature and integration.	6
5	**Transform techniques**: Continuous Fourier series, frequency and time domains, Laplace transform, Fourier integral and transform, Discrete Fourier Transform, fast Fourier Transform.	6
6	**Differential Equations:** Initial and boundary value problems, eigen value problems, solutions to elliptical and parabolic equations, partial differential equations.	6
7	**Regression methods**: Linear and non-linear regression, multiple linear regression, general linear test squares. **Statistical methods**: Statistical representation of data, modeling and analysis of data, ANOVA, test of hypotheses.	4
	Total	36

References:

1. S K Gupta, Numerical Methods for Engineers, New Age International, 2005.
2. S C Chapra and R P Canale, Numerical Methods for Engineers, McGraw Hill, 1989.
3. R J Schilling and S L Harris, Applied Numerical Methods for Engineering using Matlab and C, Brooks/Cole Pub., 2000.
4. W W Hines & Montgomery, Probability and Statistics in Engineering and Management Studies, John Wiley, 1990.

ME705A
Software Engineering
Contact Hours: 3L
Credit: 3

Module I
Overview of Software Engineering, System Development Life Cycle, Waterfall Model, Spiral Model [4L]
Module II
System Requirement Specification – DFD, Data Dictionary, ER Diagram, Use Case Diagram, Process Organization & Interactions [7L]
Module III
System Design – Problem Partitioning, Top-Down and Bottom-Up Design, Decision Tree, Decision Table and Structured English, Functional vs. Object- Oriented Approach, User Interfaces [7L]
Module IV
Coding & Documentation - Structured Programming, Information Hiding, Reuse, Coding Standards & Code Walkthrough, System Documentation [6L]
Module V
Testing – Types of Testing, Test Case Specification, Test Execution & Defect Logging, Validation & Verification Metrics, Monitoring & Control [6L]
Module VI
Software Project Management – Project Scheduling, Staffing, Software Configuration Management, Quality Assurance, Project Monitoring [6L]
Recommended Book:
1. R. G. Pressman – Software Engineering, TMH

1. Pankaj Jalote, " An Integrated Approach to Software Engineering", Narosa
2. Rajib Mall ," Fundamentals of Software Engineering " ,PHI Learning Private Limited
3. IEEE Standards on Software Engineering

ME705B
Industrial Instrumentation
Contact Hours: 3L
Credit: 3

Module No.	Syllabus	Contact Hrs.
1	**DISPLACEMENT** - LVDT, capacitive type transducers- Theory, applications. **ACCELEROMETER AND VIBROMETER** – seismic instrument for acceleration measurement, velocity measurement, piezoelectric accelerometer, strain gauge accelerometer- theory and applications.	4
2	**PRESSURE** Absolute, gauge and vacuum pressures. **Elastic transducers:** Elastic diaphragm, Corrugated diaphragm, capsule type - relative merits and demerits, pressure ranges. Bourdon type pressure gauge- Theory, construction, installation, Pressure range, materials **Electrical Pressure gauges:** Strain gauges, Strain gauge half bridge and full bridge configurations, load cells **Vacuum gauges:** Mcleod gauge, thermal conductivity gauge, Calibration of pressure gauges- dead weight tester.	7
3	**TEMPERATURE** **Non- Electrical gauges:** Liquid in glass thermometer, pressure thermometer. **Electrical gauges**- resistance temperature detector- 2, 3 and 4-wire configurations thermocouples and thermopiles, CJC, Compensating wires, thermistor- theory, applications, relative merits and demerits, operating range. **Non contact type temperature gauges** - total radiation pyrometer, optical pyrometer, temperature measuring problem in flowing fluid. Thermo well.	6
4	**FLOW** **Variable head type flow meters**: orifice plate, Venturi tube, Flow nozzle-Theory, construction, installation, tapping, selection methods. **Variable Area flow meter**: Theory ,construction and installation **Positive displacement type flow meters**: Nutating disc, reciprocating piston, oval gear and helix type-Theory, construction and installation **Open channel flow measurements**: Different shapes of weirs and corresponding flow relations. **Electrical type flow meters:** Theory, installation details of electromagnetic flow meter, ultrasonic flow meter **Guide lines for selection of flow meters , Calibration of flow meters**	8
5	**LEVEL** **Non-Electrical gauges:** Sight glass type, Float type, displacer type, Air purge system-Theory, arrangements, relative merits and demerits **Electrical level gauge:** Resistive and capacitive types- Theory, arrangement, limitations **Nuclear radiation type, ultrasonic type** **Differential pressure type level measurement:** open and closed tanks **Boiler drum level measurement.**	6
6	**DATA Acquisition, Transmission and Recording:** Cable transmission of analog voltage and current signals; cable transmission of digital data; Analog voltmeters and potentiometers; digital voltmeters and multimeters; Electromechanical XT and XY recorders; Analog Cathode-ray oscilloscope.	5
	Total:	**36**

Text and Reference Books

1. R K Jain, "Mechanical and Industrial Measurements", Khanna Publishers Co Ltd., New Delhi.
2. S.K.Singh, "Industrial instrumentation", TMH
3. RK Rajput, "Mechanical Measurements and Instrumentation", SK Kataria and Sons, New Delhi.
4. Donald P. Eckman, " Industrial Instrumentation", Wiley
5. E O Doeblin, Measurement Systems- Application and Design, McGraw Hill
6. T G Beckwith and N L Buck, "Mechanical Measurements", Addition Wesley Publishing Company Limited.
7. J P Holman, "Experimental Methods for Engineers", McGraw Hill
8. Alan S Morris, "Measurement and Instrumentation Principles", Butterworth.

9. Rangan, Mani and Sharma, "Instrumentation", Tata McGraw Hill Publishers, New Delhi.

ME705C
Operations Research
Contact Hours: 3L
Credit: 3

Sl. No.	Syllabus	Contact Hrs.
1.	**Introduction:** Brief history of development of OR; Introduction to different OR problems/ techniques: Decision theory, Linear programming, Transportation and Assignment problems, Network analysis, Sequencing, Project scheduling, Integer programming, Non-linear programming, Inventory control, Queuing or Waiting line problems, Metaheuristics.	**(2)**
2.	**Decision Theory:** Structure of the problem (decision table); Decision making under uncertainty with optimistic, pessimistic and average outcome criteria; Decision making under risk with expected value and expected loss criteria; Sequential decision using decision trees.	**(4)**
3.	**Linear Programming (LP);** Nature of LP problems through examples; Formulation of LP Problems; Graphical solutions of two decision variable problems; Properties of a solution to LP problems: convex solution space and extreme point solution; General form of LP model; Simplex method and its meaning; Steps of simplex method in tabular form; Solving LP problems by Simplex Method; Sensitivity analysis.	**(7)**
4.	**Transportation & Assignment Problems:** Nature of a transportation or distribution problem; Tabular representation of a transportation problem; North-West Corner initial solution; Stepping stone method; Concept of dummy source or destination; Vogel's approximation method. Nature of an Assignment problem; Tabular representation; Hungarian method for solving assignment problems.	**(4+1)**
5.	**Network Analysis:** Network models and terminologies like arcs, nodes, paths, tree, spanning tree; shortest path/route problem; The minimum spanning tree problem; The maximal flow problem.	**(4)**
6.	**Waiting line Problems:** Structure of a waiting line System: Single-channel waiting line, process of arrivals, distribution of service times, queue discipline, steady stage operation; Single channel model with Poisson arrivals and exponential service time; Multiple channel model with Poisson arrival and exponential service times; Single channel model with Poisson arrivals and arbitrary service time (M/G/1); Economic analysis of waiting lines.	**(6)**
7.	**Non-Linear Programming:** Graphical illustration of a non-linear programming problem; Unconstrained optimization by (i) direct search method, (ii) steepest decent method; Constrained optimization by lagrange multipliers; Integer linear programming by branch & bound technique; Dynamic programming problems and their characteristics; Bellman's principle of optimality; solving (i) Stagecoach problem, (ii) Knapsack problem.	**(8)**

BOOKS
1. Kanti Swarup, P.K. Gupta and Man Mohan, Operations Research, Sultan Chand & Sons, New Delhi.
2. I.A. Taha, Operations Research: An Introduction, Pearson Publication
3. C.K. Musatfi, Operations Research, New Age International Publishers
4. S.S. Rao, Engineering Optimization, New Age International Publishers
5. R. Panneerselvam, Operations Research, Prentice Hall of India
6. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, The McGraw Hill Companies.

ME705D
Biomechanics & Biomaterials
Contact Hours: 3L
Credit: 3

Module	Syllabus	Contact hours
1	**Musculoskeletal Anatomy**: Basic Statics and Joint Mechanics (elbow, shoulder, spine, hip,	6

	knee, ankle)	
2	**Basic Dynamics to Human Motion**: Review of linear and angular kinematics; Kinetic equations of motion; Work & energy methods; Momentum methods; Examples in biomechanics; Modern kinematic measurement techniques; Applications of human motion analysis Structure, Function, and Adaptation of Major Tissues and Organs	6
3	**Fundamental Strength of Materials in Biological Tissues**: Introduction to Viscoelasticity. **Fundamentals of biomaterials science**. Concept of biocompatibility. Classes of biomaterials used in medicine, basic properties, medical requirements and clinical significance. Disinfection and sterilization of biomaterials.	6
4	**Physico-chemical properties of biomaterials**: mechanical (elasticity, yield stress, ductility, toughness, strength, fatigue, hardness, wear resistance), tribological (friction, wear, lubricity), morphology and texture, physical (electrical, optical, magnetic, thermal), chemical and biological properties.	6
5	**Elements in contact with the surface of a biomaterial**: blood composition, plasma proteins, cells, tissues. **Phenomena at the biointerfaces**. Molecular and cellular processes with living environment, blood-materials interaction, short and long term reactions to the body.	6
6	**Testing of biomaterials**: in vitro, in vivo preclinical and in vivo clinical tests. Technologies of biomaterials processing, as implants and medical devices; improvement of materials biocompatibility by plasma processing.	6
	Total	36

References

1. Fundamentals of Biomechanics: D V Knudson, Springer.
2. Fundamentals of Biomechanics: Equilibrium, Motion, and Deformation, by Ozkaya and Nordin, Springer.
3. Biomechanics: Mechanical Properties of Living Tissues, by Fung, Springer
4. Basic Biomechanics of the Musculoskeletal System, by Nordin & Frankel, Barnes & Noble.
5. Biomaterials Science, An Intoduction to Materials in medicine, Eds. B. D. Ratner and A. S. Hoffman, Academic Press, New York.

Practical

ME791

Advanced Manufacturing Technology Laboratory

Contact Hours: 3P
Credit: 2

1) Study of Abrasive Jet Machining
2) Study of Ultrasonic Machining
3) Parametric Study of Electro-Discharge Machining
4) Study of Electro-Chemical Machining
5**) Study of geometry of robot manipulator, actuators and grippers**
6) Programming on CNC Turning
7) Programming on CNC Milling Machine
8) Robot Programming.

(At least six experiments are to be carried out in this laboratory)

ME781

Project (Part I)

Students in small groups will perform either an Industrial case study, or Preparation of a feasibility report, or Experimental investigation, or Computational/ Theoretical work, or Design and development of equipment/system.

An industrial case study/ project, if undertaken by the student, is to be supervised jointly by industry personnel and a teacher. The task is to complete over a period of two semesters, and the progress of the work will be evaluated through presentation of the same in front of a panel of examiners followed by a viva voce examination.

ME782
Viva Voce on Vacational Training

ME783
Group Discussion

VIII Semester
Theory

ME801(HU)
Economics for Engineers
Contact Hours: 3L
Credit: 3

Module

1. Engineering decision making: Selection of equipment, Replacement and maintenance, New product – make or buy, Cost reduction strategies, Improvement in service and quality. 01
2. Definition and Scope of Engineering Economics: Concept of cost and revenue, Break event analysis, Law of demand and supply. 04
3. Replacement and Maintenance Analysis: Type of maintenance, Economic life of an asset, Replacement - equipment retirement, assegmentation and replacement of item that fail suddenly and that fail over a period of time. 04
4. Depreciation Method: What is depreciation, Straight line method, declining balance method, Sum of the yea rs digits method, Sinking fund method, Annuity method. 05
5. Cash Flow Analysis: Present worth method, Future worth method, Increasing analysis payback period, Rate of return method. Life cycle analysis 05
6. Financial Accounting and taxes: Balance sheet and income statement, Financial ratios, Income tax considerations. 05
7. Inflation: Concepts and reasons of inflation, to use inflation in cost flow methods. 03
8. Uncertainty, dealing with Risk: Probability analysis, decision trees, Monte Carlo simulations. 05
9. Value Engineering Analysis: Function and aim of Value engineering, Value analysis vs Value engineering procedures. 02
10. Capital budgeting, types of capital 02

Total: 36

Books Recommended:

1. R. Pannerselvom, Engineering Economics, PWH
2. Newman, Eschenbach & Lavelle, Engineering Economic Analysis
3. Provin Kumar, Fundamentals of Engineering Economics, John Wiley.
4. S.K. Poddar, Business Studies: Financial Management (Including Accounting) and Management Accountancy for Non-Finance Professionals, The Association of Engineers, India Publication.
5. White, Case & Pratt: Principles of Engineering Economic Analysis, Wiley India.
6. Riggs,Bedworth & Randhawa-Engineering Economics,4th ed,TMH.

ME802A
CAD/CAM
Contact Hours: 3L
Credit: 3

Module	Content	Hour
1	Fundamentals of CAD- Design process, benefits of computer aided design, graphics standards	**3**
2	Geometric modeling- wire-frame, surface and solid modeling Transformation- translation and rotation exercise problems and programming Stress analysis- basics of FEM, formation of stiffness matrix for two elements.	**6** **8**
3	Introduction to computer aided manufacturing (CAM) systems, basic building blocks of computer integrated manufacturing (CIM).	**4**
4	Toolings of CNC machines, tool and work handling systems involving robot, AGV, RTV, AS/RS, ATC, APC	**3**
5	Robotics; types, anatomy, drives and applications.	**3**
6	Computer aided production planning and control, Manufacturing from product design- CAD-CAM interface, concept of group technology (GT), CAPP	**6**
7	Control systems, Process monitoring, Adaptive control systems, etc.,	**2**
8	Automatic inspection systems, use of CMM, Reverse Engineering	**1**
	Total	**36**

References:

1. P.N. Rao, N.K. Tewari and T.K. Kundra, Computer Aided Manufacturing, Tata McGraw-Hill Publication.
2. M.P. Groover and E.W. Zimmers Jr., CAD/CAM, Prentice Hall of India
3. P. Radhakrishnan, S. Subramanyan and V. Raju, CAD/CAM/CIM, New Age International Publishers.
4. P.N. Rao, CAD/CAM, Tata McGraw Hill Publication.
5. M.P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, Prentice Hall of India.
6. I. Zeid, CAD/CAM - Theory and Practice, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
7. S.R. Deb, Robotics Technology and Flexible Automation, Tata McGraw-Hill Publication.
8. S.K. Saha, Introduction to Robotics, The McGraw-Hill Publication
9. P.B. Mahapatra, Computer-Aided Production Management, Prentice Hall of India.

ME802B
Industrial Robotics
Contact Hours: 3L
Credit: 3

1. Introduction: 4

Brief history of robotics; definition of robot; Main components of robot: manipulator, sensors, controller, power conversion unit; Robot geometry: types of joints, workspace, number of degrees of freedom; Common configurations used in arms: rectangular, cylindrical, spherical, joined; Classification of robot according to coordinate system: cartesian, cylindrical, polar, articulated or jointed; Classification of robots according to control method: non-servo, servo; Robot specifications: payload, accuracy, repeatability resolution, maximum tip speed, reach stroke:

2. Robot End Effector 4

End effector: definition, gripper, tools; Gripper : main parts, source of power; Types of grippers: mechanical grippers, vacuum cups, magnetic grippers, adhesive grippers, Hooks, scoops, ladles, universal gripper; Robot Tools: Spot welding gun, pneumatic impact wrench, pneumatic nut runner, inert gas welding torch, heating torch, grinder, spray painting gun.

3. Robot Actuators: 4

Definition; Characteristics: power to weight ratio, stiffness, compliance, reduction gears; Conventional actuators: hydraulic actuator, pneumatic actuator, electric motor, direct drive motor, stepper motor, servo motor; Special actuators: magnetostrictive, shape memory alloy, elastomer.

4. Robot Sensors: 9

Definition; of Sensor and transducer; Calibration; Basic categories of measuring devices: analog, discrete; Main types of sensors: position, velocity, acceleration, force and pressure, torque, slip and tactile, proximity.
Definition of digital image, generation of digital image; Robot Vision System: definition, use, functions, components, classification; vision cameras; Techniques of image processing and analysis: Image data reduction, segmentation, feature extraction, object recognition; Application of robot vision system.

5. Robot Kinematics: 7

Definition of Robot kinematics, Tool frame and base frame. Word –coordinate system, Direct kinematics, Inverse kinematics, Describing position and orientation of an object in space, Homogenous transformation, Translational transformations, Rotational transformations, Denavit- Hartenberg representation.

6. Robot Programming 4

Definition of robot programming; Different methods of robot programming: teach-pendant programming, key board programming; Programming languages: VAL II, AML/2, ARM BASIC

7. Industrial Applications of Robots 4

Welding, Spray painting, Grinding;Material Transfer: machine loading and unloading, Processing operation; Assembly operation; Inspection.
Special applications: underwater prospecting and repairs, Mining, Space Exploration, Surgery.

Total: 36

TEXT AND REFERENCE BOOKS:

1. Klafter, Richard D. Chmielewski, Thomas A. and Negin, Michael (2001) - Robotic Engineering:An Integrated Approach, Prentice-Hall of India Pvt. Limited.

2. Mikell P. Groover, Mitchell.Weiss, Roger N. Nagel, Nicholas G. Odrey, Industrial Robotics: Technology, Programming and Applications, McGraw-Hill International Edition

3. S.R. Deb, Robotics Technology and Flexible Automation, Tata McGraw-Hill Publication.
4. S.K. Saha, Introduction to Robotics, The McGraw-Hill Publication
5. Niku, Saeed B., Introduction to Robotics Analysis, Systems, Applications, Prentice Hall of India Private Limited, New Delhi

6. Koren, Yoram, Robotics for Engineers, McGraw-Hill Book Company, Singapore
7. Hegde, Ganesh S., A Textbook on Industrial Robotics, Laxmi Publications (P) Ltd.

ME802C

Energy Conservation & Management

Contact Hours: 3L
Credit: 3

Topics	No. of Lectures
1. The Energy Resources; Finite & Renewable	03
2. The Need for Energy Conservation- estimation of	

	Finite fuel resource; Hubbert's model for oil reserve	03
3.	Total Energy Concept- CHP Cycles & their applications	06
4.	Waste Heat Recovery; Waste Heat Exchangers; Commercial Waste Heat Recovery Devices- Recuperators, Regenerative Heat Exchangers, Heat Pipes	08
5.	Industrial Energy Conservation- Industrial Insulations; Case Studies for HVAC, Air Compressor, Mechanical Handling & Other Systems	08
6.	Energy Audit; Basic Steps; Graphical representation; Case Studies	04
7.	The Economics of Energy Saving Schemes; Costs; investment analysis	04
		36

Books

1. Energy Management- Murphy WR, G Mckay- Butterworth Heinmann, 2007
2. Energy Mangement, Audit & Conservation-De Barun, , Vrinda Publications, Delhi, 2007
3. Eastop & Croft- Energy Efficiency, Longman, 1990
4. Turner- Energy management Handbook, 2nd Ed., Fairmont Press, 1993

ME802D **Contact week/ Semester: 12**
Quality & Reliability Engineering
Contact Hours: 3L
Credit: 3

Sl.No.	Syllabus	Contact Hrs.
1.	**Management of Product Quality** Evolution of Quality Control; Changing Quality Concepts; Modern Concept of Total Quality Management; Contribution of Quality masters (Deming, Juran, Crosby, Ishikawa, Taguchi);	**3**
2.	**Creating Quality by Design** Assessment of Customer's needs; Formulation of Design Specifications; Standardization; Costs of Quality; Quality Circles; 5-S concept;	**4**
3.	**Total Quality Management** Concept of Total Quality, Difference between "Quality" Management and "Total Quality" Management, total quality maintenance, total quality in service sector; Role of Customer and People in Total Quality Management; Steps for Quality Improvement, Kaizen; Organizing for effective Quality Management;	**4**
4.	**Process Control** Control Charts; Statistical Quality Control Tools;	**4**

Sl.No.	Syllabus	Contact Hrs.
	Statistical Process Control and Process Capability, Zero defect programme; Six – Sigma approach;	
5.	**Quality Management Systems** ISO 9000 Series of Standard; ISO 14000 Series of Standards;	**4**
6.	**Strategic tools and Techniques for TQM** Need for Tools and Techniques in TQM; Commonly used Tools for TQM; Approaches and Deployment of Tools for Quality Planning – Quality Function Deployment (QFD), concurrent engineering; Tools for continuous Improvement – Deming's Plan – Do – Check – Act (PDCA) cycle, Poka – Yoke (Mistake – Proofing), Taguchi's Quality Loss Function.	**5**
7.	**Reliability** Concept and definition of reliability; Reliability Parameters: Reliability as a function of time, failure rate as a function of time, constant failure rate, mean time to failure (MTTF), MTTF as a function of failure rate, mean time between failure (MTBF), mean down time (MDT), maintainability & availability, increasing failure rate, bath-tub curve;	**7**
	Brief discussion on hazard models: constant hazard model, linearly increasing hazard model, nonlinear hazard model and weilbull distribution, Advantages of weibull distribution; System reliability models: series system, parallel system, series-parallel system.	
8.	**Risk Assessment & Reliability in Design** Causes of failures, Failure modes & Effects Analysis (FMEA), faulty tree analysis (FTA); Tribological failure and monitoring techniques; Design based on reliability, redundancy in design.	**5**
	Total	**36**

Recommended Books

1. H. Lal, Total Quality Management – A Practical Approach — New Age International (P) Ltd. Publishers
2. S. K. Mondal –Total Quality Management Principles and Practice –Vikas Publishing House Pvt. Ltd.
3. A. V. Feigenbum– Total Quality Control, Mcgraw-Hill Book Company
4. Juran's Quality Control Handbook –McGraw Hill Book Company
5. Amitava Mitra, Fundamentals of quality Control and Improvement — PHI
6. Grant and Leavenworth-Statistical Quality Control, 7th Edition, Tata Mcgraw Hill
7. E. Balaguruswamy , Reliability Engineering – TMH
8. Bhadury and Basu- Terotechnology: Reliability Engineering and Maintenance Management, Asian Books Pvt. Ltd.
9. Paul Kales- Reliability of Technology, Engineering and Management- PHI

ME803A
Safety and Occupational Health
Contact Hours: 3L
Credit: 3

1. Development of industrial safety **02**

Developments in Occupational Health, Occupational Safety and Health in India

2. Accidents and their prevention **06**

Theory of accident, Anatomy of an accident, How Accidents are Caused? , , Cost of Accidents, Principles of Accident Prevention, Techniques of Accident Prevention, Safe Work Environment, Housekeeping, Job Safety Analysis, Investigation of Accidents, Ergonomics, Personal Protective Equipment, Promotion of Health and Safety, Basic Safety Programming

3. Fire hazard **06**

Types of fire, Fire Hazards, Fire Explosion, fire prevention, Means of Escape in Case of Fire Inspection Safety Supervision Safety, Responsibility Safety Inspection, Fire prevention authorities, Rules Safety Training Safety Appraisal Safety Communication Safety Audit

4. Occupational health and safety **06**

Occupational Health, Occupational Health Services in Places of Employment, Occupational Physician, Occupational Health in Developing Countries, Occupational Safety, Occupational Safety in Developing Countries, Promoting Occupational Health and Safety, Work Related Diseases, Occupational Health Hazards Recognition of Hazards, Industrial Hygiene, Occupational Diseases, basics of OHSAS 18001

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5. Health and safety at workplaces **06**

Health and Safety hazards, Occupational Health Requirements, Occupational Safety Requirements, Occupational Welfare Requirements, Abstracts and Notices, Obligations of a Worker, Obligations of Occupier, Personal protective equipment , Causes of Accidents, Prevention of Accidents, Safety Legislation, Safety Guidelines, emergency actions, related acts ***(related to chemical processes, mines, workshop practices, construction work, electrical installations)***

6. Health and safety management **04**

Basics of Safety management, Role of safety supervisor, planning for safety, Safety Policies, Safety Promotion, Safety Committee, safety education & training, Health and Safety Process, Measuring Safety, Risk Management and Loss Control,

7. Accident compensation **06**

Brief introduction to different acts - The Dangerous Machines (Regulations) Act, 1983, The Employers' Liability Act, 1938 The (Indian), Fatal Accidents Act, 1855 The Public Liability Insurance Act, 1991, The Workmen's Compensation Act, 1923, The Employees' State Insurance Act, 1948, Role of National Safety Council, International labour office

References

1. **Safety management Systems**, A. Waring, (Chapman & Hall,1996)
2. **Environmental Health & Safety Management – A Guide to Compliance**, N.P.Cheremisinoff, M.L.Graffia, (Noyes Publin. 2003)
3. **Safety at Work**, J.Ridley & J.Channing (5th. Edn.), (Butterworth & Heinemann, 2001)
4. **Occupational Health & Hygiene**, J.Stranks, (Pitman Publn., 1995)
5. **Safety management: Strategy & Practice**, R.Pybuss, (Butterworth & Heinemann, 1997)
6. **Essentials of Safety management**, H.L.Kalia, A.Singh, S.Ravishankar & S.V.Kamat, (Himalaya Publishing House, 2002)
7. **Industrial Health & Safety Management**, A.M.Sarma, (Himalaya Publishing House, 2002)
8. **Encyclopaedia of Occupational Health & Safety (4th Ed.),** Vol –I-IV, Ed. J.M.Stellman – International Labour Office, Geneva.
9. **Safety Management System** – Alan Waring, Chapman & Hill, London
10. **Practical Health & Safety Management for small business**- Jacqneline Jaynes, 2000, Butterworth Heinemann,
11. **Industrial Safety and Human Behaviour,** H.L.Kalia, AITBS Publishes, India.

ME803B
Automation and Control
Contact Hours: 3L
Credit: 3

Module	Content	Hour
1	**Introduction to control system:** Concept of feedback and Automatic control, Effects of feedback, Objectives of control system, Definition of linear and nonlinear systems, Elementary concepts of sensitivity and robustness. Types of control systems, Servomechanisms and regulators, examples of feedback control systems. Transfer function concept. Pole and Zeroes of a transfer function. Properties of Transfer function. **Mathematical modeling of dynamic systems:** Translational systems, Rotational systems, Mechanical coupling, Liquid level systems, Electrical analogy of Spring–Mass-Dashpot system. Block diagram representation of control systems. Block diagram algebra. Signal flow graph. Mason's gain formula. **Control system components:** Potentiometer, Synchros, Resolvers, Position encoders.	08
2	**Time domain analysis:** Time domain analysis of a standard second order closed loop system. Concept of undamped natural frequency, damping, overshoot, rise time and settling time. Dependence of time domain performance parameters on natural frequency and damping ratio. Step and Impulse response of first and second order systems. Effects of Pole and Zeros on transient response. Stability by pole location. Routh-Hurwitz criteria and applications. **Error Analysis:** Steady state errors in control systems due to step, ramp and parabolic inputs. Concepts of system types and error constants.	08
	State variable Analysis:	

3	State variable model of Linear Time-invariant system, properties of the State transition matrix, State transition equation, Definition of transfer function & Characteristic equation, definition of controllability and observability.	08
4	**Stability Analysis using root locus:** Importance of Root locus techniques, construction of Root Loci for simple systems. Effects of gain on the movement of Pole and Zeros. **Frequency domain analysis of linear system:** Bode plots, Polar plots, Nichols chart, Concept of resonance frequency of peak magnification. Nyquist criteria, measure of relative stability, phase and gain margin. Determination of margins in Bode plot. Nichols chart. M-circle and M-Contours in Nichols chart.	12
5	**Control System performance measure:** Improvement of system performance through compensation. Lead, Lag and Lead- lag compensation, PI, PD and PID control.	4

**** Numerical problems to be solved in the tutorial classes.**

Text and Reference Books:

1. K. Ogata, Modern Control Engineering, 4th Edition, Pearson Education.
2. I. J. Nagrath and M. Gopal, Control System Engineering, New Age International Publication.
3. D. Roy Choudhury, Control System Engineering, PHI
4. B.C. Kuo and F. Golnaraghi, Automatic Control Systems, 8th Edition, PHI
5. Bandyopadhyaya, Control Engineering Theory & Practice, PHI
6. K.R. Varmah, Control Systems, Mc Graw hill
7. Norman Nise, Control System Engineering, 5th Edition, John Wiley & Sons
8. R.C. Dorf and R.H. Bishop, Modern Control System, 11th Edition, Pearson Education.
9. C. G. Graham, F. Graebe, F. Stefan, S.E. Mario, Control System Design, PHI
10. Macia and Thaler, Modeling & Control of Dynamic System, Thompson
11. C.T. Kilian, Modern Control Technology Components & Systems, 3rd edition, Cengage Learning.
12. Y. Singh and S. Janardhanan, Modern Control Engineering, Cengage Learning
13. R. Anandanatarajan and R. Ramesh Babu, Control System Engineering, SCITECH
14. A. William and Wolovich, Automatic Control system, Oxford

ME803C

Water Resource Engineering

Contact Hours: 3L

Credit: 3

Module 1	**Fluid Mechanics**	
	Review of fluid statics	**1**
	Review of fluid dynamics; dimensional analysis	**3**
Module 2	**Closed Conduit Flow**	
	Closed conduit flow	**2**
	Design of water distribution systems, pipe network analysis: Hardy Cross Method	**3**
	Design of Network Reservoir pipeline	**4**
Module 3	**Open Channel Flow**	
	Continuity, momentum equations	**1**
	Chezy, Mannings and energy equations	**6**
	Water surface profiles	**2**
Module 4	**Surface Water Hydrology**	
	Rainfall depth, duration, distribution, determination of average rainfall depth by Arithmatic Mean Method, Thiessen Polygon Method and Isohyetal Method	**4**
	Rainfall/ runoff equations	**2**

	Rainfall/ runoff models, unit hydrograph, hydrologic routing models	**4**
Module 5	**Groundwater Hydrology** Porosity and water content, Equations of ground water flow (unconfined aquifers/ confined aquifers/ unsaturated flow), Estimation of aquifer parameters using graphical and analytical approach	**4**
	Total	**36**

Text and Reference Books:

1. S.K. Garg, Hydrology and Water Resources Engineering, Khanna Pub.
2. R.A. Wurbs and W.P. James, Water Resources Engineering, PHI Learning Pvt. Ltd., New Delhi.
3. K. Subramanya, Engineering Hydrology, Tata McGraw-Hill.
4. C.S.P. Ojha, R. Berndtsson and P. Bhunya, Engineering Hydrology, Oxford University Press.
5. M. J. Deodhar, Elementary Engineering Hydrology, Pearson Education.
6. K. Subramanya, Flow in Open Channels,Tata McGraw-Hill.
7. R. Srivastava, Flow through Open Channels, Oxford University Press.
8. Ven Te Chow, Open-Channel Hydraulics, McGraw-Hill.

ME803D
Automobile Engineering
Contact Hours: 3L
Credit: 3

MODULE	SYLLABUS	CONTACT HRS.
1	**Introduction:** History & Development of Automobile. various sub system of Automobile.	01
2	**Prime Mover:** Engine for Two –Wheeler & Three- Wheeler vehicles, Engine for passenger cars, commercial and other vehicle, Fuel system for carburetted engine, MPFI engine and Diesel engine, Lubrication and cooling system.	05
3	**Auto Electrical:** Electric Motor as prime mover, Battery, generator, Ignition system, Starting system, lighting & signalling	06
4	**Steering System:** Devis steering & Ackerman steering system. Rack & pinion, cam & lever, worm & sector system.	03
5	**Transmission System:** Flywheel & clutch. Gearbox sliding and constant mesh type, Automoatic Transmission, Universal joint, Propeller shaft.	06
6	**Differential & Axle:** Construction & function of differential, Different types of front & rear axles.	03
7	**Suspension System:** Conventional and independent suspension system, application.	03
8	**Brake System:** Disc & drum brake, Hydraulic brake, Parking brake. Stopping distance.	03
9	**Power Requirement:** Various resistances such as air resistance, gradient resistance, rolling resistance. Tractive effort. Torque- Speed curve. Horse power calculation.	04
10	Maintenance of Vehicle.	02
	TOTAL	**36**

Reference Books:

1. Motor Vehicle by Newton, Steed and Garrette 2nd ed, Butter worth.
2. Automobile Mechanics by N.K.Giri, 7th ed, Khanna Publishers.
3. Automobile Engineering by Amitosh De, Revised edition 2010, Galgotia Publication Pvt. Ltd.
4. Automobile Mechanics by Heitner Joseph, East West Press.

Practical

ME881
Design of a Mechanical System
In this sessional course work the students have to make design calculations and prepare component & assembly drawings/sketches (preferably in CAD) on a mechanical system assigned to a group of 4 to 5 students. Mechanical systems will include plants, equipment,instruments, drives, mechanisms, hydraulic/pneumatic/lubrication systems etc. The teachers will allocate one suitable mechanical system appropriate for a 8th. semester Mechanical Engineering student to each group of students.The students have to carryout the design work in consultation with the respective teacher/s and submit the design

work in bound volumes individually and face a viva voce examination as proof of their individual understanding of the design work.

ME882
Project:Part-II
Students in small groups will perform either an Industrial case study, or Preparation of a feasibility report, or Experimental investigation, or Computational/ Theoretical work, or Design and development of equipment/system.

An industrial case study/ project, if undertaken by the student, is to be supervised jointly by industry personnel and a teacher. The task is to complete over a period of two semesters, and the final work will be submitted in the form of a printed hardcopy and will be evaluated through presentation of the same in front of a panel of examiners followed by a viva voce examination.

ME883
Comprehensive Viva