Syllabus for B.Tech(Production Engineering)

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

Recommended Structure for Forthcoming Semester of B.Tech Courses on PE starting from 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(Production Engineering)

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

Third Year– Fifth Semester

A. THEORY							
Sl. No.	**Field**	**Subjects**	**Contact Hours / Week**				**Cr. 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.	**PE 501**	*** Professional Elective-I**	3	0	0	3	3
Total Theory			19	0	0	19	19
B. PRACTICAL							
Sl. No.	**Field**	**Subjects**	**Contact Hours / Week**				**Cr. Points**
			L	**T**	**P**	**Total**	
7.	**PE 581 (Sessional)**	Seminar-I	0	0	3	3	1
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.	**PE 591A/B**	Professional Elective Lab-I **	0	0	3	3	2
		Total Practical	0	0	14	14	8
		Total Semester	19	0	14	33	27

***List of Professional Elective 1:**	**PE 501A-Ergonomics and Work Design** **PE 501B- Computer Graphics and Solid Modeling**
****List of Professional Elective Lab I:**	**PE 591A-Ergonomics and Work Design Laboratory** **PE 591B- Computer Graphics Laboratory**

Third Year – Sixth Semester

A. THEORY							
Sl. No.	**Field**	**Subjects**	**Contact Hours / Week**				**Cr. Points**
			L	**T**	**P**	**Total**	
1.	**HU611**	Production & Operations Management	2	0	0	2	2
2.	**ME 601**	IC Engines and Gas Turbines	3	0	0	3	3
3.	**PE 601**	Metal Cutting Principles and Machining Technology	3	0	0	3	3
4.	**ME 603**	Machine Design	3	0	0	3	3
5.	**PE 602**	**@ Professional Elective-II**	**3**	**0**	**0**	**3**	**3**
6.	**PE 603**	**@@ Professional Elective-III**	**3**	**0**	**0**	**3**	**3**
Total Theory			17	0	0	17	17
B. PRACTICAL							
Sl. No.	**Field**	**Subjects**	**Contact Hours / Week**				**Cr. Points**
			L	**T**	**P**	**Total**	
7.	**PE 681 (Sessional)**	**Seminar II**	0	0	3	3	**2**
8.	**PE 691**	Machining Technology & Machine tools Systems Lab	0	0	3	3	2
9.	**ME 692**	IC Engine Lab	0	0	3	3	2
10.	**ME 693**	Design Practice-II	0	0	3	3	2
Total Practical			0	0	12	12	8
Total Semester			17	0	12	29	25

@ List of Prof. Elective-II:
1. PE 602A- Machine Tools systems
2. PE 602B- Fluid Power Control

@@List of Prof. Elective-III:
1. PE 603A-Materials Handling
2. PE 603B- Production Planning and Control

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

Syllabus for B.Tech(Production Engineering)

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

Fourth Year– Seventh Semester

A. THEORY							
Sl. No.	Field	Subjects	Contact Hours / Week				Cr. Points
			L	T	P	Total	
1	PE 701	Automation, CNC Machines and Robotics	4	0	0	4	4
2	PE 702	Advanced Manufacturing Processes	4	0	0	4	4
3	PE 703	^Professional Elective-IV	3	0	0	3	3
4	PE 704 / ME 704	^^Professional Elective-V	3	0	0	3	3
5	PE 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	
1	PE 791	CAD-CAM Laboratory	0	0	3	3	2
2	PE 781	Viva-voce on Vacational Training	0	0	0	0	2
3	PE 782	Project: Part I	0	0	3	3	2
4	HU 781	Soft Skill Development and Group Discussion	0	0	2	2	2
		Total Practical	0	0	8	8	8
		Total Semester	17	0	8	25	25

^List of Prof. Elective-IV		^^List of Prof. Elective-V		^^^ List of Free Elective-I	
PE 703A	Operations Research	PE 704A	Non Destructive Testing	PE 705A	Automotive Engineering
PE 703B	Computational Techniques in Engineering	PE 704B	Finite Element Methods and Applications	PE 705B	Refrigeration and Air Conditioning
PE 703C	Decision Support Systems and MCDM	PE 704C	Advanced Robotics	PE 705C	Sensors and Data Acquisition
		ME 704 B	Advanced Welding Technology		

Proposed

Fourth Year– Eighth Semester

A. THEORY							
Sl. No.	Field	Subjects	Contact Hours / Week				Cr. Points
			L	T	P	Total	
1	PE 801	Engineering Economy and Financial Management	3	0	0	3	3
2	PE 802	$Professional Elective-VI	3	0	0	3	3
3	PE 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	
1	PE 891	Industrial Engineering Laboratory	0	0	3	3	2
2	PE 881	Project: Part II	0	0	12	12	8
3	PE 882	Comprehensive Viva-voce	0	0	0	0	2
		Total Practical	0	0	15	15	12
		Total Semester	9	0	15	24	21

$List of Prof. Elective-VI		#List of Free Elective-II	
PE 802A	Reliability Engineering and Plant Maintenance.	PE 803A	Supply Chain Management
PE 802B	Computer Integrated Manufacturing	PE 803B	Entrepreneurship Development
PE 802C	Tribology and Terotechnology	PE 803C	Total Quality Management

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 (2^{nd} 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=ε0E+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 302 : 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

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, 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;	6
7.	**Mechanical Properties of Materials:** Elastic properties of materials—tensile and compressive stress and strain, stress-strain behaviour, modulus of elasticity (Young's	6

Sl.No.	Syllabus	Contact Hrs.
	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.	
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≤P(A)≤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 $P_o y''+P_1 y'+P_2 y=0$ 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.	02
	2. Kinematics of fluid flow: fluid flow and classifications. Continuity equation in 1D & 3D. Potential flow & Stream function; types of flow lines.	03
2	**3.** Dynamics of fluid: equations of motion; Euler's equation; Bernoulli's equation; Applications of Bernoulli's equation.	04
	4. Momentum Analysis of flow systems; the linear momentum equation for steady flow, differential approach.	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.	02
	8. Flow of fluid around submerged bodies; basic concepts of drag and lift.	02
	9. Boundary layer – definition; Boundary layer separation – basic concept.	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.

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(10th 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 **Contracts: 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 Readings: Text & References:
1. Robbins & Caulter – Management (Prentice Hall of India, 8th Edition)
2. John R.Schermerhorn– Introduction to Management (WILEY-INDIA EDITION,10th Edition)
3. Koontz – Principles of Management (Tata McGrew Hill, 1st Edition 2008)
4. New Era of Management, 10th Edition by Richard L. Daft published by Cengage Learning
5. Stoner, Freeman, Gilbert. Jr. – Management (Prentice Hall of India, 6th Edition)
6. Koontz, weihrich – Essentials of Management (TMH, 5th Edition)
7. D.Chandra Bose– Principles of Management and Administration (PHI)
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. Management of Principles and Practices by Joseph M Putty
11. Principles of Management" - 10 e/d by Richard. L.Daft; Cengage Learning
12.Management Principles and Practices by Joseph M Putti Publisher- Macmillan

Dynamics of Machines

ME-501 **Contracts: 3L**
Credits- 3 **Contact weeks/Semester: 12**

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 prrcrssional motion; Effect of gyroscopic couple on aeroplane and ship; Stability of two wheel and four wheel vehicles taking turn.	2

Note to the teachers:
1. Stress should be given on the concepts of different topics.
2. All deductions should be worked out and explained.
3. Sufficient number of problems from each topic should be worked out during the class and as home assignment.

Note for paper setter:
At least two questions to be set from vibration group (module 1 to 3) and at least one from other modules.

Recommended Books:
1. Theory of vibration with Applications by W.T. Thomson, Mc.Graw Hill.
2. Theory of Machines and Mechanisms by Uicker, Pennock & Shigley, 3rd Ed., Oxford University Press.
3. Theory of Mechanisms and Machines by Ghosh & Mallik, AEWP.
4. Mechanism and Machine Theory by Rao & Dukkipati, 2nd Ed., New Age Int. Pub.
5. The Theory of Machines through solved problemsby J.S. Rao, New Age Int. Pub.
6. Theory of Machines by S.S. Rattan, TMH.

Heat Transfer

ME-502 **Contacts: 4L**
Credits- 4 **Contact weeks / semester: 12 (minimum)**

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

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

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 significantce 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. Introduction to Heat Transfer – S. K. Som, PHI.
2. Yunus A. Cengel, "Heat and Mass Transfer", The McGraw- Hill Companies.

3. Fundamentals of Heat & Mass Transfer – Sarif K. Das, Narosa.
4. Incropera, DeWitt, Bergmam, & Lavine, "Fundamentals of Heat and Mass Transfer", Wiley India Edn.
5. Engineering Heat Transfer – N.V. Suryanarayana, Penram International.
6. Principles of Heat Transfer-Kreith; Cengage learning.
7. Heat & Mass Transfer – P. K. Nag, TMH.
8. P.S. Ghoshdastidar, "Heat Transfer", Oxford University Press.
9. Fundamentals of Heat & Mass Transfer – M. Thirumaleshwar, Pearson.
10. Single OP: Heat & Mass Transfer-Macmillan India'2008.
11. Heat Transfer-J P Holman and Souvik Bhattacharyya, 10th ed,TMH

Design of Machine Elements

ME-503 **Contacts: 4L**
Credits: 4 **Contact week / semester: 12 (minimum)**

Module No.	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.	6
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

Note for Teachers:
1. Stress should be given in explaining different concepts.
2. Use and application of different machine elements should be highlighted.
3. Numerical problems should be worked out in class as well as through home assignment.

Note to Examination Paper Setter:
1. At least one question should be set from each module.
2. Approx 50% marks should be allotted to numerical problems.

Books Recommended:
1. Design of Machine Elements by V. B. Bhandari, TMH
2. Mechanical Engineering Design by Shigley and Mischke,TMH
3. Theory and Problems of Machine Design by Hall, Holowenko and Laughlin, TMH
4. Machine Design by T.H. Wentzell, Cenage Learning.
5. Design of Machine Elements by M. F. Spotts, Prentice Hall
6. Machine Design by P. Kannaiah, Scitech Publications.

Metrology & Measurement

ME-504 **Contacts: 3L**
Credits- 3 **Contact week/Semester: 12**

Module	Syllabus	Contact

No.		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 (Rmax), centre line average (CLA, Ra), 4average depth (Rm), 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
	TOTAL:	36

Note for Teachers:
1. Different concepts involved should be explained.
2. Operating principle of different instruments should be explained, and whenever possible the working of the instruments/equipment should be demonstrated in class and/or corresponding lab (ME 594).

Note for Examination Paper Setter:
At least one question should be set from each module.

Books Recommended:
1. Measurement systems – Application and Design by E.O. Doebelin and D.N. Manik, 5th ed., Tata McGraw Hill.
2. Principles of Engineering Metrology by R. Rajendra, Jaico Pub. House.
3. Mechanical Measurements by Beckwith, Lienhard and Marangoni, 6th ed. Pearson.
4. Metrology & Measurement.

List of Professional Electives-I

Ergonomics and Work Design
PE 501-A **Contacts: 3L**
Credits- 3 **Contact week/Semester: 12**

Module	Syllabus	Contact Hours
1	Defining Human Factors in a Production System; Characteristic features of man-machine system; Human performance and performance reliability.	**5**
2	Human Sensori-motor systems, stimulus dimensions, human information processing, noise and theory of signal detection (TSD); Quantitative and qualitative visual displays; Human factors associated wish speech communication	**6**
3	Continuous control systems; Types of control functions tools and related control devices; Design of work place and work components; Applied anthropometry, activity analysis.	**9**
4	Human performance under heat, cold, illumination, vibration, noise, pollution, static and dynamic conditions.	**4**

5	Introduction to biomechanics and bio-engineering aspects of human motor activity; Performance of body members in making different types of movements; Energy expenditure in physical activities; Spatial movements and conceptual relationships of stimuli and responses.	**8**
6	Application of results from human factors data and analysis in work study, work design, method study and work measurement techniques.	**4**
	Total	*36*

Books Recommended:

1. Human factors Engineering by M. S. Sanders and McCormick, TMH.
2. Ergonomics at work by Murrell.
3. Introduction to work study. ILO, Geneva, Oxford & IBH Pub Co. Pvt. Ltd.
4. Handbook of Human Factors and Ergonimics by G. Salvendy, John Wiley & Sons
5. Ergonomics – How to design for ease and efficiency by KHE Kroemer, Prentice Hall Englewood Cliffs.

PE 501B : ***Computer Graphics and solid modeling***
Contacts : **3L**
Credits ***:*** ***3***

Module	Syllabus	Contact Hours
1	**Introduction to the Subject objective and area of application of the Subject; Graphics Input and Output Devices**	**1**
2	**Graphics standards:** ACM, ANSI, ISO, DIN, GKS, PHIGS, IGES, NAPLPS;	**1**
3	**Viewing and clipping:** WCS (working Coordinate System), SCS (Screen Coordinate System), MCS (Model Coordinate System), Screen layout, View (front, top, right, isometric, auxiliary), Graphics Entities; Windows to viewport transformation, Cohen Sutherland algorithm for Line clipping; Liang- Barskey's algorithm for line clipping and polygon clipping	**4**
4	**Types and Mathematical Representation of Curves: Parametric Representation of Analytic Curve:** Scan Conversion; scan conversion of point, line (DDA algorithm); Bresenham's algorithm. for scan conversion of Line and circle; Midpoint circle algorithm, scan conversion of ellipse, **Parametric Representation of Synthetic Curve: concept,** mathematics of Hermite Cubic Spline; Mathematics of Bezier curve; Mathematics of β-Spline curve.	**6**
5	**Types and Mathematical representation of surfaces: Parametric Representation of Analytic Surface (Plane Surface, Ruled Surface, Surface of Revolution), Concept of twist vector, Hermite bi-cubic Surface, Bezier Surface, Concept of free form Surface/Sculptured Surface**	**4**
6	**Types and Mathematical Representation of Solids: and Solid Modeling Based Applications:** Concept of topology and geometry, Constructive Solid Geometry, Half Spaces; Boundary Representations (B-rep); Euler's equation for open and closed polyhedron, Sweep Representation and Boolean operations; Concept of graph, digraph, tree, binary tree, inverted binary tree,	**6**
7	**Two and Three-dimensional Transformations of geometrical models-** Translation, Scaling, Reflection, shearing and Rotation.	**4**
8	**Homogeneous Representation and Mapping:** Transnational, Rotational, and General Mapping.	**2**
9	**Projection of Geometrical Models:** Orthographic Projection; Perspective Projection and Engineering Applications.	**4**
10	**Visualization, Hidden line and Hidden Surface and Solid Removal:** Depth Comparison, Z-Buffer Algorithm.	**2**
11	**Visibility of objects;** Shading and Color Models.	**1**
12	**Data base for CAD geometries.**	**1**
	Total	**36**

Books Recommended:

1. **Schaum's outlines Computer graphics: Roy. A. Plastock and Xiang.**
2. **CAD / CAM theory and Practice: Ibrahim Zeid. MGH**

SEMESTER - V
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-I
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 meter 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).

Ergonomics and Work Design Laboratory
PE-591-A
Contacts: 3P
Credits: 1

[Experiment No. 8 is mandatory and six more experiments to be conducted from the following]

1) Study of Bones and Joints through musco-skeletal system of a subject postured on an ergonomic chair.
2) Anthropometric Attributes and approaches through anthropometric caliper, rod scale, pelvimeter along with assessment of BMI (Body Mass Index).

3) Determination of total cardiac cost of a subject while running on a treadmill by monitoring the Blood Pressure and Glucose Level.
4) Determination of total cardiac cost of a subject while riding on a By-cycle Ergometer by monitoring the Blood Pressure and Glucose Level.
5) Vibration analysis a wood planer and assessment of comfort.
6) Assessment of Reaction forces during load lifting activity through force platform.
7) Ascertainment of joint angles during activity through Goniometer.
8) CAD Assisted Ergonomic Design of Mechanical System through Software like CATIA ERGO etc.

Computer Graphics Laboratory
PE-591-B
Contacts: 3P
Credits: 1

1. Turbo C programming for scan conversion of lines by DDA Method.
2. Turbo C programming for scan conversion of lines by Bresenham's line algorithm.
3. Turbo C programming for scan conversion of lines by Bresenham's Circle algorithm.
4. Turbo C programming for scan conversion of lines by mid point algorithm.
5. Programming for Geometrical transformations like: translation, rotation, mirroring, scaling, shearing.
6. Turbo C programming for Viewing and clipping.
7. Programming for realization of Boolean operations.

Sessional

Seminar-I
PE 581
Contacts: 3P
Credits: 1

[Topics to be chosen pertinent to the trends and advancements in the field of Production Engineering. In addition the students should get acquainted with the presentation Skill.]

SEMESTER - VI
Theory
Production & Operations Management

HU-611 **Contracts: 2L**
Credits- 2 **Contact weeks/semester: 12 (min)**

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. Modern Production/Operations Management, 8th ed.by Buffa and Sarin, John Wiley & Sons.
2. Production and Operations Management by R. Panneerselvam, PHI.
3. Operations Management by Russell & Taylor, 4th ed.' PHI.
4. Production and Operations Management by Adam and Ebert, PHI.

IC Engines & Gas Turbine

ME-601 **Contracts: 3L**

Credits- 3

Module	Syllabus	Contact Hours
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.	[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.	[4]

Module-12	Pollution control of emissions of I.C. engines.	[2]
Module- 13	Introduction to Gas Turbine Cycles & Performance.	[2]
	Total	*40*

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.

Metal Cutting Principles and Machining Technology

PE-601 **Contracts: 3L**
Credits- 3

Module	Syllabus	Contact hours
1	**Principal of metal cutting:** Introduction to metal cutting (MWFT system). Concept of MRR. Role of cutting tool and cutting parameters.	1
2	**Tool Geometry**: Basic shape of cutting tool, Tool-in-hand nomenclature, Tool point reference system, Feed system mathematics, (Stereometry) in setting system. ASA, ORS, NRS, MRS system of nomenclature, Inter-relationship between different systems.	2
3	**Tool materials**: Requirements/ properties. Carbon tool steels, HSS, Cast alloy steel, cemented carbides, ceramics, CBN, UCON, Stellite.	2
4	**Mechanics of chip formation:** Overview of chip formation, classification of chips, Built up edge (BUE). Orthogonal cutting, oblique cutting, concept of shear plane, shear angle and chip reduction co-efficient.	3
5	**Cutting forces:** Merchant's circle diagram. Force system during turning, Facing, Frictional force, Velocity relationship, Force measurements (Dynamometry)	2
6	**Temperature in metal cutting:** Shear plane temperature, Average tool-chip interference temperature. Cutting fluid, cryogenic cooling.	1
7	**Wear in cutting tools**: Causes of wear machinability and tool life, Taylor's tool life equation, Economic tool life. Effect of various parameters on tool life.	1
8	**Surface roughness:** Factors affecting surface quality, Effect of nose radius, Effect of angles, Effect of cutting parameters on surface roughness.	2
9	Generalized analysis for **optimization of cutting parameters**, Optimum cutting speed for maximum production.	1
10	**M/c tool – Definition and classification.** **Generation and machining principles.**	2
11	**Setting and operations on machines (including major units and specifications)** **Lathe, Milling, Shaping, Slotting, Planing, Drilling, Boring, Broaching, Grinding (cylindrical, surface, centreless), Thread rolling, Gear cutting**	12
12	Jigs and Fixtures- location and clamping	2
13	**Concepts of job batch and mass production. Machining on capstan and turret lathes. Single and multi spindle automats**	3
14	**μ -Finishing operations- Honing, Lapping, Superfinishing.**	2
	Total	36

Books recommended

1. Metal cutting theory and practice – A. Bhattacharyya, Pub- New Central Book Agency (P) Ltd. Kolkata.
2. Machining and machine tools – A.B. Chattopadhyay, Pub- Wiley India (P) Ltd. New Delhi.
3. Principle of machine tools – Sen and Bhattacharyya, Pub.-New Central Book Agency (P) Ltd, Kolkata.
4. Automation, Production Systems and CIM–M.P.Groover, Pub- Prentice-Hall of India (P) Ltd.New Delhi.
5. Metal cutting theory and practice – Stephenson & Agapion, Pub- Taylor and Francis – (group) – NY.

Machine Design

ME-603 **Contracts: 3L**
Credits- 3 **Contact week / semester: 12 (min)**

Module	Syllabus	Contact Hours

Module-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]
Module-2	**Brakes :** Function, types; Single or double block / show 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]
Module-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]
Module-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]
Module-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]
Module-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]
Module-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]
Module-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*

Note for Teachers:

1. Stress should be given in explaining different concepts.
2. Use and application of different machine elements should be highlighted.
3. Numerical problems should be worked out in class as well as through home assignment.

Note to Examination Paper Setter:

1. at least one question should be set from each module.
2. approx 50% marks should be allotted to numerical problems.

Books Recommended:

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

List of Professional Elective-II

PE 602A : Machine Tools Systems
Contacts : 3L
Credits : 3

Module	Syllabus	Contact hours
1.	**Principle of generation of various surfaces in Machine Tools:** Metal cutting :Machine tools: The definitions; Different machining operations performed in machining tools; Types of machines tools; Types of surfaces, profiles and paths produced by machine tools; Generation principles; Combination of specific formative principles to produce direct paths and or desired surfaces;	3
2.	**Conformable kinematics synthesis for tracing, forming, enveloping and generation:** Tracing method; Forming method; Enveloping method; Generating method;	2

3.	**Kinematics structure of geared and stepless drives for machines:** Fundamental of kinematic structure of machine tool: Structure E-11, Structure E-11, Structure E-22, Structure E-33, Structure C-12, Structure C-14, Structure K-23, Structure K-25,	3
4	**Designing discrete step drives for machine tools speeds:** Basic principle; Steped and stepless output; Requirements for layout of a stepped drive; Selection of range of spindle speeds; Setting upper speed limit of a centre lathe; Setting lower speed limit of a centre lathe; Setting upper and lower speed limit of a milling machine; Typical layout of intermediate spindle speeds; Construction of speed diagram; construction of speed diagram; Layout of speeds in arithmetic progression; Layout of speeds in geometric progression ; Logarithmic progression; Kinematic advantages of a G.P. series; Speed structure analysis; Representation of speeds;	8
5.	**Designing discrete step drives for machine tools feeds**: Purpose of feed motion. Feed in reciprocating machines; Feed in drilling machines; Feed in milling machine; Feed in lathe; Designing feed gear train for cutting Whitworth threads;	2
6.	**Stepless drives:** Mechanical stepless drives**:** Hydraulic stepless drives; Electrical drives;	2
7.	**Design principles of machine tool gear boxes:** Types of structures; feasibility of structural forms; Ray diagrams; Decision for the best ray diagram of a gear box. Determining the number of teeth in a gear. Examples.	5
8	**Hydraulic drives and control:** Advantage of hydraulic drive; Hydraulic pumps; Vane pump; Hydraulic circuits: Fundamentals; Various types of valves for hydraulic systems; Hydraulic servo controls;	2
9.	**Electrical drives and control:** Analysis of dynamic load; selection of motor rating; speed change in electrical motors; Starting and stopping of motors; electrical reversing;	2
10.	**Machine tool structures: principle of design:** Introduction; Basic principle for design of strength; Basic principles of design for rigidity; optimum design criterion	2
11.	**Special tools and attachments:** Work-holding attachment; Analysis of collet action; Design of collet section; Bar feeding mechanisms for turret and capstan; Technology of turret and capstan work; Tooling layout in turret work; Swiss type Automatic machine; Cam design;	3
12	**Selection and acceptance testing of machine tools:** Object and procedure for acceptance test; Instrument required for acceptance test; Sequence of acceptance test;	2
	Total	36

PE 602B : Fluid Power Control
Contacts : 3L
Credits : 3

Module	Syllabus	Contact hours
1A	What is 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,	**4**

	unloading 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;	**6**
7	Use of electrical devices for controlling fluid circuits; function of electrical devices like pushbutton 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**
	Total	**36**

Note for Teachers:

1. Different concepts involved should be explained with care.
2. A few industrial applications of hydraulic and / or pneumatic system should be shown and explained through factory visit / video shows.
3. Numerical problems should be worked out, wherever possible.

Note to Examination Paper setter:

At least one question should be set from each module.

Books recommended:

1. Introduction to Hydraulics and Pneumatics, 2nd. ed. by Ilango and Soundararajan, PHI.
2. Fluid Power with Applications by A. Esposito, 6th Ed, Pearson Prentice Hall.
3. Pneumatic Systems: Principles and Maintenance by S.R. Majumdar, Tata McGraw Hill.
4. Fluid Power and Control Systems by E. C. Fitch, Jr, Mc Graw Hill Book Co.
5. Industrial Hydraulics by Banks and Banks, Prentice Hall.

List of Professional Elective-III

PE 603A : ***Material Handling***
Contacts : **3L**
Credits ***:*** ***3***

Module	**Syllabus**	Contact Hours
Module-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**
Module-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**
Module-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**
Module-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**

Module-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**
Module-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**
Module-6A	**Robotic handling :** Materials handling at workplace; Major components of a robot; Applications of robotic handling.	**2**
Module-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
	Total	*36*

Note for Teachers:
1. Constructional features, working principle and specific applications of each of the MH equipment should be explained.
2. Working of some of the MH equipment should be shown to students through factory visits/video shows.

Note to Examination Paper Setter:
At least one question should be set from each module.

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

PE 603B : ***Production Planning and Control***
Contacts : **3L**
Credits ***:*** ***3***

Module	**Syllabus**	Contact Hours
Module-1	Demand forecasting: Long and short term demand forecasting methods	**4**
Module-2	Regression analysis and Smoothing methods. Estimation of trend, cycle, seasonality components. Analysis of forecast error and computer control of forecasting systems.	**4**
Module-3	Plant location, capacity scheduling, Warehouse location and capacity scheduling; Multiple Plant Production Facility Design.	**4**
Module-4	Aggregate Planning and Master Production Planning and Scheduling;	**4**
Module-5	Operations scheduling and Control: Basic Sequencing and scheduling techniques, Despatching rules; Chasing and updating of Production Schedules.	**6**
Module-6	Design of Production Planning and Control Systems: System Design for continuous and intermittent Production Systems; Integration of Master Production,	**5**
Module-7	Material Requirement and Shop Scheduling Systems. MRPI & MRP II,	**5**
Module-8	Diagonistic Analysis of Production Planning and Control Systems: Techniques of analysis and evaluation of system performance.	4
	Total	*36*

Books Recommended:
1. Production Systems Planning Analysis & Control by James L. Riggs, John Wiley & Sons
2. Modern Production / Operations Management by Elwood S. Buffa, Rakesh K. Sarin, John Wiley & Sons
3. Production / Operations Management : Concept, Structure & Analysis by Tersine R.J., North Holland.

SEMESTER - VI
Practical

Machining Technology & Machine tools Systems Lab
PE-691
Contacts: 3P
Credits: 2
Contact week / Semester -12

1. Study of chip formation (type, color & thickness) in turning mild steel and evaluation of Shear Plane angle (β), Chip reduction co-efficient (ζ), Metal Removal Rate (MRR) and Total machining time ($T_{m/c}$) in turning.
2. Measurement of cutting forces (P_z and P_x or P_y) in straight turning at different feeds and velocities.
3. Measurement of average cutting temperature in turning under different speed – feed combinations
4. Measurement of surface roughness in turning under different conditions.
5. Measurement of tool – wear and evaluation of tool life in turning mild steel by HSS or carbide tool.
6. Manufacturing of an intricate object involving operations in lathe, milling, shaping, drilling, grinding etc. including estimation of machining time for lathe, milling, shaping, drilling, grinding etc.
7. To ascertain the Apron Mechanism and Determination of Apron Constant.
8. Study of the kinematic structure of centre lathe encompassing the ray diagram, saw diagram and to ascertain the productivity loss. Design of gearbox under specified power, step and stage.
9. Study of kinematic structure milling (including indexing)/drilling/shaping/hobbling machine and gear shaping machines.
10. Designing of cams relevant to manufacturing of a bolt type object produced through automatic screw cutting machine.

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 muti-cylinder Petrol Engine by Morse method.
5) Performance Text of an I.C. Engine using electric (eddy current) dynamometer.
6) Use of catalytic 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
Contact week / semester: 12 (min)

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

1. At least **two assignments** on 2-D and 3-D modeling 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.

Sessional

Seminar-II
PE 681
Contacts: 3P
Credits: 2

[Topics to be chosen pertinent to the trends and advancements in the field of Production Engineering. In addition the students should get acquainted with the presentation Skill.]

Details of Syllabus of 7th Semester

PE 701
Automation, CNC Machines and Robotics
Contact Hours: 4L
Credit: 4

Module No.	Description of Topic	Lectures Hours
1	**Introduction:** Concept of Mechanization and Automation; Need philosophy; basic elements; classification of automated manufacturing systems [hard, programmable and flexible automation]; strategies for automation in production systems; on line condition monitoring of automated systems, Level of automation.	3
2	**Parts handling automation:** Basic concepts of chute, magazine, hopper, separator, feeders, ejectors, orienters and transfer machines.	6
3	**Machine tool automation:** Single and multi spindle automats, Swiss type automats and design of automat for a specific product.	4
4	**Basic principles of NC system:** Components and their functions in NC machines; MCU, DPU and CLU; drives; special motors and screw-nut system; advantages of CNC over NC machines; Basic systems of NC and CNC machines: coordinate system, open loop and closed loop control; absolute and incremental mode.	3
5	**CNC machine tools:** structure and working principle; examples and use of CNC machines; machining centre (MC) – characteristics and applications; Control of tool–work travel; PTP and Continuous; interpolation – linear and circular.	3
6	**Part programming for NC, CNC and MC systems:** Manual part programming: different controllers and codes used; sequential steps of part programming; examples: part programming for machining in CNC lathes [step turning, taper turning, grooving, thread cutting, drilling, boring, facing, contouring etc] and milling [pocketing, island pocketing, grooving, peck drilling].	9
7	**Computer aided part programming:** definition and advantages; programming languages; statements in APT; examples of CA part programming in APT.	3
8	**Introduction to Robotics:** Synthesis of elements with movability constraints; Elements of robot anatomy; Hydraulic, pneumatic and electrical manipulators;	4
9	End-effectors and their design issues and aspects.	3
10	**Robot Kinematics:** forward and backward kinematics; D-H parameter, mapping of the end effector.	4
11.	Robot Sensors and controllers, Path and Trajectory Planning; Robot Programming Languages.	3
12.	Applications of industrial robots; Economics of robotics.	3
	Total	**48**

References:
1. Fundamentals of Industrial Automation by V Tergan, I Andreev and B. Liberman, MIR Publisher.
2. Automation, Production Systems and Computer Integrated Manufacturing by M. P. Groover, Pearson Education.
3. Introduction to Robotics by J. J. Craig, Addison-Wesley.
4. Computer Control of Manufacturing Systems by Y. Koren, Tata Mc Graw Hill.
5. CNC Machines by N. K. Tewari, Kundra and P. N. Rao.
6. Robotics Technology and Flexible Automation by S. R. Deb, TMH.

PE 702
Advanced Manufacturing Processes
Contact Hours: 4L

Credit: 4

Module No.	Description of Topic	Lectures Hours
1	Integrated automation, computers and managerial challenges; modern cutting tools, ISO nomenclature and tool management, CAPP, high speed machining, precision machining.	**10**
2	Introduction to new methods of production; Need and capability analysis of various processes; Classification and selection of non-traditional machining technologies. Abrasive processes of machining including Abrasive Jet machining (AJM), Water Jet Mechining (WJM) and ultrasonic machining (USM). Chemical machining (CHM), Electrochemical machining (ECM): Electrochemical deburring and honing: Electrochemical Grinding (ECG); Electrochemical Discharge Machining (ECDM); Electrochemical Arc Machining (ECAM). Electrical discharge machining (EDM); wire EDM, Electron beam machining (EBM); Plasma arc machining (PAM); Laser beam machining (LBM); Ion beam machining (IBM), Etching. Selecting the most suitable process for a product; Economic analysis of non-traditional machining processes.	**14**
3	Integration of CAD-CAM, Graphics standards, CAD and CAE, Computer networking, GT concept, FMS, CIM, Computer aided Quality Control, CMM, Application of AI in CAD/CAM/CIM.	**12**
4	Role of Rapid Prototyping; General features and classifications of Generative Manufacturing Processes. Stereo Lithography with photo-polymerization, liquid thermal polymerization, solid foil polymerization, selective laser sintering, selective powder binding, ballistic particle manufacturing, fused deposition modeling, shape melting, laminated object manufacturing, solid round curing, repetitive masking and deposition.	**12**
	Total	**48**

References:

1. Non-Conventional Machining by P.K.Mishra, Narosa Publishers.
2. Manufacturing Science by A. Ghosh, East-West Publications.
3. Non-Traditional Manufacturing by Benidict.
4. Non-Traditional Machining by Dr. A. Bhattacharya, The Institution of Engineers (Calcutta)
5. Automation, Production System & Computer Integrated Manufacturing by M.P. Groover, Pearson Education

Professional Elective-IV [PE 703]
PE 703-A
Operations Research
Contact Hours: 3L
Credit: 3

Module No.	Description of Topic	Lectures Hours
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.	**02**
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.	**04**
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.	**07**
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; Vogels approximation method. Nature of an Assignment problem; Tabular representation; Hungarian method for solving assignment problems.	**05**
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.	**04**
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	**06**

	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.	
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.	**08**
	Total	**36**

References:
1. Kanti Swarup, P.K. Gupta and Man Mohan, Operations Research, Sultan Chand & Sons, New Delhi.
2. H.A. Taha, Operations Research: An Introduction, Pearson Publication
3. C.K. Musatfi, Operations Research, 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.
7. Operations Research - An Introduction by H. A. Taha, Prentice Hall of India.
8. Operations Research by J. K. Sharma, Macmillan.
9. A Text Book of Operations Research: By Jana & Roy, Chhaya Prakashani.

PE 703-B
Computational Techniques in Engineering
Contact Hours: 3L
Credit: 3

Module No.	Description of Topic	Lectures Hours
1	**Approximations:** Accuracy and precision, round off and truncation errors, error propagation.	**04**
2	**Algebraic equations:** Formulation and solution of linear algebraic equations, Gauss elimination, LU decomposition, iteration methods – convergence, Eigen values and eigenvectors.	**04**
3	**Interpolation methods:** Newton's divided difference, interpolation polynomials, Lagrange interpolation polynomials.	**06**
4	**Differentiation and Integration:** High accuracy integration formula, extrapolation, derivatives of unequally spaced data, Gauss quadrature and integration.	**06**
5	**Transform techniques:** Continuous Fourier series, frequency and time domains, Laplace transform, Fourier integral and transform, Discrete Fourier Transform, fast Fourier Transform.	**06**
6	**Differential Equations:** Initial and boundary value problems, eigen value problems, solutions to elliptical and parabolic equations, partial differential equations.	**06**
7	**Regression methods:** Linear and non-linear regression, multiple linear regressions, general linear test squares.	**02**
8	**Statistical methods:** Statistical representation of data, modeling and analysis of data, ANOVA, test of hypotheses.	**02**
	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.

PE 703-C
Decision Support Systems and MCDM
Contact: 3L
Credit: 3

Module No.	Description of Topic	Lectures Hours
1	**Introduction:** Brief History; Conceptual Perspective; Decision Supports vs. Transaction Processing; Subsystems; DSS Framework.	**3**
2	**Business Decision Process:** Managerial Decision; Decision Making Context; And Process; Measure of Good Decision and Redesigning.	**3**
3	**Data Based Management Systems:** Information Characteristics and Gathering; Data Based Model; CODD's 12 Rules for Relational Database; Architecture and Normalization; Data Mining and Creating Knowledge; Examples.	**4**
4	**Dialogue Management Systems:** Group Decision Support Situation; Factors Considered	**4**

	for Designing User Interface; Communication Driven DSS; Contingency Theory; GDSS Benefit; Virtual Organization.	
5	**Model Driven DSS:** Accounting Model; Financial Model, Forecasting Model; Networking and Optimization Model; Simulation Model, Examples.	**4**
6	**Web Based DSS:** Designing Web Base DSS; Managing Inter-Organizational DSS, Advantages and Disadvantages of Web Based DSS; Example of Web Based DSS.	**3**
7	**Artificial Intelligence and Expert System in DSS:** Introduction; Knowledge Representation; Incorporation of Artificial Intelligence in Decision Support System.	**3**
8	**Evaluation of DSS:** Evaluation rules and Techniques; Criteria and Risk Factors; International Issues; Ethical and Privacy Issues.	**3**
9	**Multi-Criteria Decision Making:** Introduction; History; Scope of Implementation; MCDM Techniques – AHP, TOPSIS, VIKOR, PROMETHEE, COPRAS, DBA, MOORA, Grey Theory; Sensitivity Analysis.	**9**
	Total	**36**

References:

1. Decision Support System-Concepts and Resources for Managers by Daniel J. Power, Greenwood Publishing group, ISBN: 1-56720-497-X.
2. Decision Support System- V. S. Janakiraman and K, Sarukeshi, Prentice Hall of India.

Professional Elective-V [PE 704/ME 704]
PE 704-A
Non Destructive Testing
Contact Hours: 3L
Credit: 3

Module No.	Description of Topic	Lectures Hours
1	**Liquid Penetrant and Magnetic Particle Inspection:** Liquid Penetrant systems, processing cycles, inspection of surface defects, Generation of Magnetic fields, Magnetic particle inspection equipments, Demagnetization, Applications and limitations.	**07**
2	**Radiography:** Production of X-rays, Characteristic rays and white ray, Tube current and Voltage, Sources of X-rays, Half life period, Penetrating power, Absorption of X and Y rays, Radiation contrast and film contrast, exposure charts, pentameters and sensitivity, Safety.	**07**
3	**Eddy Current Inspection:** Eddy current production, Impedance concepts, Inspection of magnetic materials, Inspection of non magnetic materials, influences of various parameters, Advantages and limitations.	**07**
4	**Ultrasonic Testing:** Production of ultrasonic waves, Different types of waves, normal beam inspection, Angle beam inspection, thickness measurements, Applications.	**07**
5	**Recent Techniques:** Non destructive inspection, Instrumentation for non destructive testing, Principles of holography, Principle of acoustic emission, Applications of holographic techniques, advantages and limitations, Other techniques.	**08**
		36

References:

1. Barry Hull and Vernon John, “Non Destructive Testing”, MacMillan, 1988.
2. American Society of Metals, Metals Hand Book, 9th Edition, Volume 11 (1980).
3. Birchan, D, “Non Destructive Testing”, Oxford University Press, 1977.
4. Proceedings of the 10th International Acoustic Emission Symposium, Japanese Society for Non Destructive Inspection, Sendai, 1990.
5. Holler, P., “New Procedures in Non Destructive Testing” Springer Verlag, 1983.

PE 704-B
Finite Element Methods and Applications
Contact Hours: 3L
Credit: 3

Module No.	Description of Topic	Lectures 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.	**08**
2	**One dimensional problems:** Finite element modeling– Coordinates and shape functions, Potential energy approach– Element matrices and vectors, Assembly for global equations,	**08**

	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.	
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	**04**
4	**Two dimensional problems– vector variable problems:** Vector Variable problems, Elasticity equations–Plane Stress, Plane Strain and Axisymmetric problems, Formulation, element matrices, Assembly, boundary conditions and solutions Examples	**08**
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.	**06**
6	**Computer implementation**: Pre-processor, Processor, Post-processor. Discussion about finite element packages.	**02**
	Total	**36**

Reference:

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.

PE 704-C
Advanced Robotics
Contact: 3L
Credit: 3

Module No.	Description of Topic	Lectures Hours
1	**Introduction:** 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.	**4**
2	**Robot End Effector:** 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.	**4**
3	**Robot Actuators:** 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**
4	**Robot Sensors**: 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.	**9**

5	**Robot Kinematics:** 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.	**7**
6	**Robot Programming:** Definition of robot programming; Different methods of robot programming: teach-pendant programming, key board programming; Programming languages: VAL II, AML/2, ARM BASIC.	**4**
7	**Industrial Applications of Robots:** 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.	**4**
	Total	**36**

References:

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.

ME 704-B
Advanced Welding Technology
Contact: 3L
Credit: 3

Module No.	Description of Topic	Lectures Hours
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**

Reference Books:

1. O.P. Khanna, a Text Book of Welding Technology, Dhanpat Rai & Sons.
2. R.S. Parmar, Welding Engineering and Technology, Khanna Publishers.
3. M. Bhattacharyya, Weldment Design, the Association of Engineers, India Publication, Kolkata.

4. J.C. Lippold and D.J. Kotecki, Welding Metallurgy and Weldability of Stainless Steels, Wiley-India (P) Ltd., New Delhi.
5. Udin, Funk and Wulf, Welding for Engineers, John Wiley and Sons.
6. J.L. Morris, Welding Process and Procedures.
7. S.V. Nadkarni, Modern Arc Welding Technology, Oxford & IBH Publishing Co. Pvt. Ltd./ Advani-Oerlikon Ltd.

Free Elective-I [PE 705]

PE 705-A
Automotive Engineering
Contact Hours: 3L
Credit: 3

Module No.	Description of Topic	Lectures Hours
1	**Automotive engine classification:** S.I. and C.I. engines, combustion chamber types, engine balancing, multicylinder arrangements.	02
2	**Automobile engine parts:** Cylinder block, cylinder head, crank case, oil pan, cylinder liners, piston, arrangements to control piston slap, piston rings, connecting rods, crank shaft, valves, valve actuating mechanism, valves layout, materials used, valve and port timing diagrams.	04
3	**Fuel supply system:** Simple carburetor, constant choke, constant vacuum carburetor, types of carburetor, mixture strength requirements, fuel pumps for petrol engines, petrol injections, diesel fuel pump and fuel injector for diesel engines.	04
4	**Ignition system:** Battery ignition system, comparison between battery ignition and magnetic ignition system, ignition advance methods, electronic ignition.	02
5	**Cooling system:** Necessity, methods of cooling.	02
6	**Lubrication system:** Objectives, system of engine lubrication, crank case ventilation.	02
7	**Chasis construction:** The frame and its functions, layout of the components of transmission system in four wheel rear drive vehicles.	03
8	**Clutches:** purpose, requirements, relative merits and demerits of different types of clutches.	03
9	**Gear box:** Purpose, sliding mesh gear box, constant mesh gear box, power flow diagrams, torque converter, automatic transmission - an overview, calculation for road resistance, tractive power. Universal coupling, propeller shaft, final drive - types, functions. Differential - purpose, construction.	05
10	**Rear axle types:** semifloating, full floating and three quarter floating construction, working. Steering mechanisms, steering linkages, steering gears - for rigid front axle and independent front wheel suspension	04
11	**Brakes:** types of brakes, numerical problems relating to brake torque, minimum stopping distance with front wheel braking, rear wheel braking, wheel braking and heat dissipation.	03
12	**Electrical equipment:** Generator, voltage regulator and cut-out, starter, lighting circuit. Application of CNG in automotive engines.	02
	Total	36

References:
1. Motor Vehicle by Newton, Steed and Garrette, 2nd ed., Butterworth.
2. Automobile Engineering Vols - I & II by Kirpal Singh, Standard Publishers Distributers.
3. Automotive Mechanics by Heitner Joseph, East west Press.
4. Automotive Mechanics by Crouse, Mc Grawhill.
5. Automobile Mechanics by N. K. Giri, 7th ed., Khanna Publishers.

PE 705-B
Refrigeration and Air-Conditioning
Contact Hours: 3L
Credit: 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 ph 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.	05

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.	**05**
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, Sensible Heat Factors.	**05**
8	Heat Load estimation: Simple cases of Cooling and Dehumidification.	**03**
9	Duct Sizing & Design.	**02**
10	Air-conditioning equipment: Airhandling units, Cooling Towers.	**04**
	Total	**36**

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.

PE 705-C
Sensors and Data Acquisition
Contact: 3L
Credit: 3

Module No.	Description of Topic	Lectures Hours
1	**DISPLACEMENT:** LVDT, capacitive type transducers- Theory, applications. **ACCELEROMETER AND VIBROMETER** – seismic instrument for acceleration measurement, velocity measurement, piezoelectric accelerometer, and 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 drums 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	**5**

	voltmeters and multimeters; Electromechanical XT and XY recorders; Analog Cathode-ray oscilloscope.	
	Total	**36**

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. Alan S Morris, "Measurement and Instrumentation Principles", Butterworth.

Practical/Sessional
PE 791
CAD-CAM Laboratory
Contact Hours: 3P
Credits : 2

1. Modeling of intricate 3D surfaces and solid through Softwares like CATIA, ProE or Inventor. **[two numbers]**
2. Free form surface generation through Softwares like CATIA, ProE or Inventor. **[two numbers]**
3. Experiments to demonstrate the features of CNC machines, CNC programming on turning and milling machines **[two jobs have to accomplish including one in** CNC lathes [step turning, taper turning, grooving, thread cutting, drilling, boring, facing, contouring etc] and the other in milling [pocketing, island pocketing, grooving, peck drilling]].
4. Study of the geometry of the robot manipulators, grippers and exercises on robot programming.
5. Demonstration of basic CAD-CAM systems, generation of tool path from product geometry using CAD-CAM simulation tools Like DelCAM,

PE 781
Viva-voce on Vacational Training
Credits : 2

Students undergoing Vacational training at the end of Semester - VI will be given credit in Semester - VII. Students shall have to submit a project report to be signed by the Industry Training Manager/ Lab-in-charge of R & D Organisation.

PE 782
Project: Part I
Contacts: 3P
Credits: 2

Students will be exposed to lecture modules on Project and Thesis work followed by assignment of group (not exceeding 6 candidates/group) projects involving manufacturing / production / design of an engineering product. An industrial project may also be undertaken by the student to be supervised jointly by Industry personnel and the teacher.

HU781
Soft Skill Development and Group Discussion
Contacts: 2P
Credits: 2

Students have to be given exposure to:

a) Quantitative aptitudes: 4× 3P=12P
b) Logical Reasoning: 4× 3P=12P
c) Group Discussion: 6× 3P=18P

PE 801
Engineering Economy and Financial Management
Contact: 3L
Credit: 3

Coverage	Details of coverage	Available lectures
1	**Engineering Economy:** Interaction between Economic theory and production; concept of firm, industry and economy; Consumer behaviour, Utility, indifference curves and maps; Consumer supply and demand function.	5
2	**Production and Cost Functions:** Production function; Effect of technology; Short and long run cost function.	3
3	**Monopoly and Pricing:** Monopoly and competition; Determination of price, price discrimination, Pricing of product.	4
4	**Financial Management:** Function of financial management and financial executive Nature of risk; interrelationship between risk and return; Analysis and interpretation of standard financial statements.	6
5	**Working Capital, Leverage and project indices:** Concept of operating cycle and working capital Management: Planning of profit and leverage (operating and financial): Project evaluation indices like NPV, IRR.	6

Details of Syllabus of 8th Semester

6	**Cost Accounting:** Definition and scope of cost accountancy and costing methods, Elements of cost identification Recording, ascertainment of direct material and labour cost; Overhead classification, distribution and	6
7	**Costing Methods and Case Study:** Absorption **Costing**. Process costing, uniform, marginal and standard costing methods; Case study showing application of financial management and costing methods	6
	Total	36

References:
1. Cost Accounting by M. Y. Khan, P. K. Jain, Tata McGraw Hill.
2. Financial Management: theory and Practice by Prasanna Chandra, Tata McGraw Hill.
3. Modern Microeconomics by A. Koutsoyiannis, Macmillan Press Ltd.
4. Managerial Economics by H. Craig Petersen, W. Cris Lewis, Prentice Hall of India.

Professional Elective-VI [PE 802]

PE 802-A
Reliability Engineering and Plant Maintenance
Contacts: 3L
Credits : 3

Coverage	Details of coverage	Available lectures
1.	**Definition and basic concepts**: Definition of Reliability, Availability and Maintainability. Random events, Frequency distributions and measures of location, Random variables with examples and probability distributions. **Failure data, failure modes**: Mean time to failure, MTBF, Failure analysis, Fault tree analysis, FMECA.	5
2.	**Reliability in terms of hazard rate and failure density function:** Reliability function, Hazard rate function, PDF, CDF. **Hazard models and bath tub curve**: Constant, linear and non-linear hazard models. Applicability of Weibull distribution. **Reliability calculation:** Series, parallel and parallel-series systems, Low level and High level redundancy.	6
3.	**Reliability calculations for maintained and stand-by systems:** Markov analysis, Load sharing system, standby systems, Three component standby systems.	7
4.	**Types of Maintenance**: Definition of maintenance, Role and scope of maintenance in total organizational context. Objectives and characteristics of maintenance; Centralised vs Decentralised maintenance.corrective, planned, preventive and predictive maintenance. Factors affecting maintenance; Opportunistic maintenance. **Measurement of maintenance work**: Mean time to repair, Median time to repair, Mean system down time, Mean time to restore.	7
5.	**Rating of maintenance work and allowances**: Maintenance performance indices. Maintenance cost budgets; Maintenance planning and scheduling; MIS in maintenance.	6
6.	Measurement of maintenance effectiveness and maintenance audit.	5
	Total	36

Reference:
1. Mechanical Reliability Engineering by ADS Carter, Macmilan.
2. Reliabilities for the technologies by L.A. Doty, Industrial Press Inc.
3. Introduction to Reliability Engineering by Dhilon & Singh.
4. Reliability evaluation of engineering systems by Roy Billington and R.N. Allen, Pitman.

PE 802-B
Computer Integrated Manufacturing
Contacts: 3L
Credits : 3

Module No.	Description of Topic	Lectures Hours
1	Concept of Computer Integrated Manufacturing (CIM); Market Requirements vis-à-vis Manufacturing Control Requirement. Basic components of CIM; Distributed database system; distributed communication system, computer networks for manufacturing; future	**6**

	automated factory; social and economic factors, Concurrent Engineering, Integrated Automation.	
2	Computer Aided Design (CAD): CAD hardware and software; product modeling, automatic drafting; engineering analysis; FEM design review and evaluation; Group Technology Centre.	**8**
3	Computer Aided Manufacturing (CAM): Computer assisted NC part programming; Computer assisted robot programming; computer aided process planning (CAPP); computer aided material requirements planning (MRP); computer aided production scheduling; computer aided inspection planning; computer aided inventory planning;	**12**
4	Flexible manufacturing system (FMS): concept of flexible manufacturing; Integrating NC machines, robots, AGVs, and other NC equipment;	**6**
5	Computer aided quality control; business functions, computer aided forecasting; office automation.	**4**
	Total	**36**

References:
1. CAD, CAM, CIM by P. Radhakrishnan and S. Subramanyan, New Age International Publishers.
2. Computer Integrated Manufacturing by Paul G. Rankey, Prentice Hall.
3. Computer Integrated Manufacturing by Harrington J. Jr., Industrial Press, Inc., New York.
4. Computer Integrated Manufacturing by K. Rathmill and P. Macconal, IFS Publications.

PE 802-C
Tribology and Terotechnology
Contacts: 3L
Credits : 3

Module No.	Description of Topic	Lectures Hours
1	Introduction to tribological systems and their characteristic features: Physico-mechanical interactions at interfacial contact surfaces; Analysis and assessment of topography; Deterministic and stochastic tribo-models for asperity contact, frictional resistance and wear; Frictional instability and stick-slip phenomenon; Kinetics of solid state interfacial interactions.	**12**
2	Principles of lubrication: Hydro-dynamic, hydro-static, elatso-hydrodynamic cases; Boundary film lubrication; Solid lubricants; Tribological design of machine elements and systems; Principles of life-cycle analysis and their application.	**10**
3	Terotechnology: Introduction, Life cycle cost analysis of plants and concept of terotechnology; Various maintenance management strategies; Production maintenance interface and terotechnology based planning and control; Maintenance policy determination; Fixed time replacement prior to failure; Concept of health and usage monitoring of plants (HUM); Condition based maintenance; Opportunity maintenance; Design out maintenance; Preventive maintenance; Reliability, maintainability and availability of plants and equipments; Replacement strategies, Computer application in terotechnology based critical analyses.	**14**
	Total	

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

Free Elective-II [PE 803]
PE 803-A
Supply Chain Management
Contact Hours: 3L
Credit: 3

Module No.	Description of Topic	Lectures Hours
1	**Introduction: Evolution of SCM, Building blocks of a supply chain network. Decision in a Supply Chain; Strategic, tactical, and operational decisions, SCM in Indian Context.**	**3**
2	**Supply chain Strategy and performance measures:** Customer service and cost trade-	**4**

	off; order delivery lead time; supply chain responsiveness; delivery reliability, product variety; Benchmarking supply chain performance using financial data. Supply chain optimization, integration and restructuring.	
3	**Supply chain inventory management:** Types of Inventory, inventory related costs, managing cycle stock, managing safety stock, managing seasonal stock, Supply chain redesign on the inventory, Inventory of short life cycle products. Newsboy, Base-stock, and (Q,r) models, multi-echelon supply chains, Performance modeling of supply chains using Markov chains and queuing networks.	**6**
4	**Modes of transportation:** choice and their performance measure, Vehicle Scheduling, Transportation costs in E retailing.	**3**
5.	**Network designing and operation:** planning for network operations, design of networks, Data for network design, location of Service outlets.	**3**
6.	**Demand forecasting:** Qualitative forecasting methods, Quantitative Forecasting methods, Time series forecasting models.	**3**
7	**Web based SCM:** Internet-enabled supply chains: e-marketplaces, e-procurement, e-logistics, customer relationship management, web services, supply chain automation, and supply chain integration.	**3**
8	**Supply chain Integration:** Internal and External, Building relationship and trust; Vendor management, customer response.	**4**
9	**Supply chain Restructuring: Value addition curve, Entry point of customer,** Supply chain mapping, point of differentiation, Postponing for cost reduction, Change in the value addition curve.	**4**
10	**Agile Supply chain, Pricing and revenue management.**	**3**
	Total	**36**

References:

1. Supply Chain Management: Text and Cases by Janat Shah, Pearson Education India, 2009.
2. Supply Chain Management, 3rd Ed by Sunil Chopra, Pearson Education India, 2009

PE 803-B
Entrepreneurship Development
Contact Hours: 3L
Credit: 3

Module No.	Description of Topic	Lectures Hours
1	Introduction: Concept of Entrepreneurship - need and scope for entrepreneurship - Entrepreneur and society - qualities of entrepreneur Risks, relevance and benefits of small scale Industry - definition of tiny, small ancillary industry - prevailing industrial policy of SSI - incentives and benefits of SSI units.	**6**
2	Motivation theories - Maslow, McCllend - Motivation model - need, want, motive and behavior - attitude towards work - self assessment and goal setting - Achievement, motivation and behavior measurement, SWOT analysis, TA analysis - Stress and conflict management; coping with uncertainty; creativity and innovation.	**6**
3	Project identification and formulation: Sources of information - opportunity guidance - choice of technology and its evaluation;	**6**
4	consumer behavior; market survey and research; demand and resource based industry-servicing industry - import substitution- Techno-economic feasibility assessment - short listing, preliminary project report, detailed project report, assessing viability and feasibility of a report.	**6**
5.	Forms of business organizations/ownership - formation of a Company - procedures and formalities for setting up of new industry-sources of information to contact for what and where - subsidies and concessions for SSI - role of State and Central Government Agencies in promotion of Small Scale Industry. Sickness and nursing of sickness in SSI.	**6**
6.	Labor Laws - The Factories Act 1948, Minimum Wages Act - Payment of Wages 1936, Workmen Compensation Act, 1923.	**3**
7	Taxation - State and Central - Concessions.	**3**
	Total	**36**

References:

1. Entrepreneurship Development by S. Anil Kumar, New Age International (P) Ltd.
2. Entrepreneurship Development by K Ramachanran, Tata McGraw Hill.
3. Entrepreneurship Development and Management by Dr. A. K. Singh, University Science Press.

ME 803-C
Total Quality Management
Contacts: 3L
Credits : 3

Coverage	Details of coverage	Available lectures
1.	**Basic concepts, definitions and history of quality control: Quality function and concept of quality circle, Quality policy and objectives:** Quality- A Look at History; Quality- The changing Business condition - "Quality" Defined; The Quality Function; Managing for Quality; Quality policy; Quality circle; Perspective on Quality—Internal versus External.	4
2.	**Economics of quality and measurement of the cost of quality. Quality considerations in design:** Cost of poor Quality; Categories of Quality Cost; Analysis of Quality costs; Economic models of Quality of conformance; Quality measurement in design	5
3.	**Process control, Machine and process capability analysis Use of control charts and process engineering techniques for Use of control charts and process engineering techniques for implementing the quality plan:** Definition and Importance of statistical process control; Statistical Control charts; Steps in setting up a control chart; Control chart for variables data; Process Capability; Estimating Inherent or potential Capability from a Control –chart analysis; Measuring process performance; Attribute Control Charts**.**	7
4.	**Acceptance sampling: single, double and multiple sampling, lot quality protection, Features and types of acceptane tables, Acceptance sampling of variables and statistical tolerance analysis:** The concept of Acceptance Sampling; Economies of Inspection; Sampling Risk: The Operating Characteristic curve; Analysis of some Rule-of –Thumb Sampling; Quality Indices for Acceptance Plan; Types of Sampling Plan; Single Sampling, Double Sampling and Multiple Sampling; Characteristic of a good Sampling Plan; Dodge-Roming Sampling Tables; Acceptance Sampling by Variables	7
5.	**Quality education, principles of participation and participative approaches to quality improvement:** Quality Planning & Quality Control; Quality Improvement; Theories of motivation; Create and maintain awareness of Quality; Provide Participation as a Means of Inspiring Action.	5
6.	**Emerging concepts of quality management: Taguchi's concept of off-line quality control:** Elements of TQM; Traditional versus modern quality management; Deming's philosophy; The Juran Philosophy; Strength and Weakness of Taguchi's ideas; Just In Time (JIT); benchmarking; Business Process Re-engineering (BPR); Supply Chain Management (SCM). Ishikawa's cause and effect diagram.	8
	Total	36

References:
1. Quality Planning and Analysis by JM Juran and Gryna,
2. Total Quality Management by K. Shridhara Bhat.
3. Total Quality Management – An Introductory Text by Paul James, Prentice Hall.
4. Quality Control and Applications by Housen & Ghose.
5. Industrial Engineering Management by O. P. Khanna.

Practical/Sessional

PE 891
Industrial Engineering Laboratory
Contacts: 3P
Credits: 2
Experiments and computational work involving production planning and scheduling, process planning, resource allocation, machine loading and optimization;
Plant facility layout models, mechanical, electro-analogue models for optimal plant facility location analysis, analogue and computer aided models for physical path analysis of production program/project activity; Network analysis and optimization; product quality planning and control analysis models; production system simulation, simulated system in maintenance programs, system dynamics, computer applications in Plant Location and Layout.

PE 881
Project: Part II
Contacts: 12P
Credits: 8

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.

PE 882
Comprehensive Viva-voce
Credits: 2