Syllabus

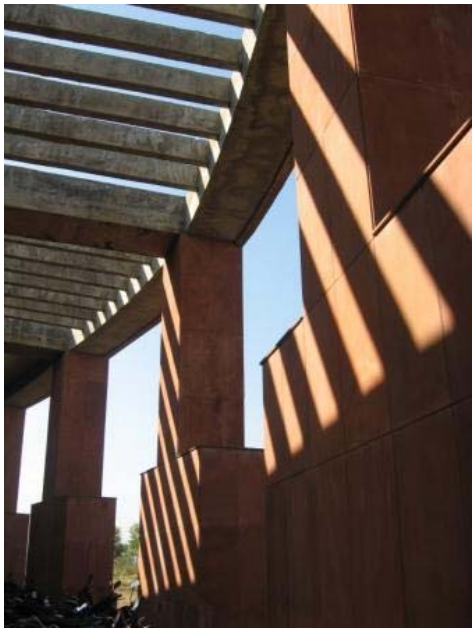
for

B. Tech. in Mechanical Engineering

Dr. Babasaheb Ambedkar Technological University, Lonere 402 103
Taluka - Managaon, Dist. Raigad (M.S.)

Course Structure and Syllabus
for
First Year B. Tech. Programmes

(With effect from the Academic Year 2010-2011)



CHEMICAL ENGINEERING
CIVIL ENGINEERING
COMPUTER ENGINEERING
ELECTRICAL ENGINEERING
ELECTRONICS AND TELECOMMUNICATION ENGINEERING
INFORMATION TECHNOLOGY
MECHANICAL ENGINEERING
PETROCHEMICAL ENGINEERING

DR. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY
LONERE – RAIGAD 402 103 MAHARASHTRA

Mechanical, Chemical and Petrochemical Engineering

Semester I				
Code	**Course of Study**	**L**	**P**	**C**
BH101	Basic Course in Communicative English	3	0	6
BH102	Engineering Mathematics – I	4	0	8
BH103	Engineering Physics – I	3	2	8
BH104	Engineering Chemistry – I	3	2	8
CL105/CL205	Basic Civil Engineering	2	0	4
ID106	Energy and Environmental Engineering	2	0	4
ME107/ME207	Engineering Graphics ***	1	4	6
XB108	Branch Specific Course*	3	0	6
XC109	NCC/NSS/Sports	0	0	0
Total		**21**	**8**	**50**
Semester II				
Code	**Course of Study**	**L**	**P**	**C**
BH201	Basic Course in Human Rights	2	0	4
BH202	Engineering Mathematics – II	4	0	8
BH203	Engineering Physics – II	3	2	8
BH204	Engineering Chemistry – II	3	2	8
EM205/EM105	Engineering Mechanics	3	0	6
ID206	Basic Electrical and Electronics Engineering	2	0	4
WS207/WS107	Workshop Practice	0	4	4
XA208	Branch Specific Programming and Softwares**	3	0	6
XC209	NCC/NSS/Sports	0	0	0
Total		**20**	**8**	**48**

*ME108 Introduction to Mechanical Engineering, for Mechanical Engineering Department
*CH108 Introduction to Chemical Engineering, for Chemical Engineering Department
*PC108 Introduction to Petrochemical Engineering, for Petrochemical Engineering Department
**ME208 Mechanical Engineering: Programming and Softwares, for Mechanical Engineering Department
**CH208 Chemical Engineering: Programming and Softwares, for Chemical Engineering Department
**PE208 Petrochemical Engineering: Programming and Softwares, for Petrochemical Engineering Department
*** Four Hours End Semester Examination

Civil Engineering

Semester I				
Code	**Course of Study**	**L**	**P**	**C**
BH101	Basic Course in Communicative English	3	0	6
BH102	Engineering Mathematics – I	4	0	8
BH103	Engineering Physics – I	3	2	8
BH104	Engineering Chemistry – I	3	2	8
ID105	Energy and Environmental Engineering	2	0	4
ME106/ME206	Basic Mechanical Engineering	2	0	4
ME107/ME207	Engineering Graphics	1	4	6
CL108	Introduction to Civil Engineering	3	0	6
XC109	NCC/NSS/Sports	0	0	0
Total		**21**	**8**	**50**
Semester II				
Code	**Course of Study**	**L**	**P**	**C**
BH201	Basic Course in Human Rights	2	0	4
BH202	Engineering Mathematics – II	4	0	8
BH203	Engineering Physics – II	3	2	8
BH204	Engineering Chemistry – II	3	2	8
EM205/EM105	Engineering Mechanics	3	0	6
ID206	Basic Electrical and Electronics Engineering	2	0	4
WS207/WS107	Workshop Practice	0	4	4
CL208	Civil Engineering: Programming and Softwares	3	0	6
XC209	NCC/NSS/Sports	0	0	0
Total		**20**	**8**	**48**

Electrical, Computer, Electronics and Telecommunication and Information Technology

Semester I				
Code	**Course of Study**	**L**	**P**	**C**
BH101	Basic Course in Communicative English	3	0	6
BH102	Engineering Mathematics – I	4	0	8
BH103	Engineering Physics – I	3	2	8
BH104	Engineering Chemistry – I	3	2	8
EM105/EM205	Engineering Mechanics	3	0	6
ID106	Energy and Environmental Engineering	2	0	4
WS107/WS207	Workshop Practice	0	4	4
XB108	Branch Specific Course*	3	0	6
XC109	NCC/NSS/Sports	0	0	0
Total		**21**	**8**	**50**
Semester II				
Code	**Course of Study**	**L**	**P**	**C**
BH201	Basic Course in Human Rights	2	0	4
BH202	Engineering Mathematics – II	4	0	8
BH203	Engineering Physics – II	3	2	8
BH204	Engineering Chemistry – II	3	2	8
CL205/CL105	Basic Civil Engineering	2	0	4
ME206/ME106	Basic Mechanical Engineering	2	0	4
ME207/ME107	Engineering Graphics***	1	4	6
XA208	Branch Specific Programming and Softwares**	3	0	6
XC209	NCC/NSS/Sports	0	0	0
Total		**20**	**8**	**48**

*EL108 Introduction to Electrical Engineering, for Electrical Engineering Department
*CP108 Introduction to Computer Engineering, for Computer Engineering Department
*EX108 Introduction to Electronics and Telecommunication Engineering, for Extc Department
*IT108 Introduction to Information Technology for Information Technology Department
**EL208 Electrical Engineering: Programming and Softwares, for Electrical Engineering Department
**CP108 Computer Engineering: Programming and Softwares for Computer Engineering Department
**EX108 Electronics and Telecommunication Engineering: Programming and Softwares, for Electronics and Telecommunication Engineering Department
**IT108 Information Technology: Programming and Softwares, for Information Technology Department
*** Four Hours End Semester Examination

BH101 BASIC COURSE IN COMMUNICATIVE ENGLISH (6 Credits)

Unit 1: Communication
An introduction - Its role and importance in the corporate world – Tools of communication – Barriers – Levels of communication.

Unit 2: Listening
Importance to listening in the corporate world - Listening process and practice – Exposure to recorded and structured talks, class room lectures – Problems in comprehension and retention – Note-taking practice – Listening tests.

Unit3: Reading-1
Introduction of different kinds of materials: technical and non-technical – Different reading strategies: skimming, scanning, inferring, predicting and responding to content.

Unit 4: Reading-2
Guessing from context – Note making – Vocabulary extension.

Unit 5:Speaking
Barriers to speaking – Building confidence and fluency – dialogue practice - Extempore speech practice – Speech assessment.

Unit 6:Writing
Effective writing practice – Effective sentences: role of acceptability, appropriateness, brevity and clarity in writing – Cohesive writing practice – Paragraph writing – Discourse writing.

Text Book
Meenakshi Raman and Sangeetha Sharma, *Technical Communication*, Oxford University Press, New Delhi. 2008.

Reference Books

1 M. Ashraf Rizvi, *Effective Technical Communication*, Tata McGraw-Hill, New Delhi, 2005.
2 Golding S.R, Common *Errors in English Language*, Macmillan, 1978.
3 Christopher Turk, *Effective Speaking*, E and FN Spon, London, 1985.

BH102 ENGINEERING MATHEMATICS – I (8 Credits)

Unit 1: Linear Algebra - Matrices
Matrix operations, cofactors, normal form of a matrix, rank, Consistency, Eigen and eigen values, Cayley – Hamilton theorem

Unit 2: Differential Calculus
Successive differentiation, Leibnitz's theorem, Taylor's theorem, Maclaurin's Theorem

Unit 3: Vector Calculus
Differentiation of vectors, Curves in space, Velocity and acceleration, Tangential and normal acceleration

Unit 4: Applications of Vector and Scalar point functions
Vector operator del, Del applied to the Scalar point function – Gradient, Del applied to the Vector point functions – Divergence and Curl, Del applied twice to point function, Line Integral, Surface integral, Volume integral, Divergence theorem, Green's theorem, Stoke's theorem.

Unit 5: Integral Calculus
Double integral, Triple integral, Application to the area, volume, surface area, Moment of Inertia, Center of gravity

Unit 6: Infinite Series
Positive term series – Integral test, Comparison test, D'Alembert ratio test, Cauchy's root test, Raabe's test, Log Test, Alternating Series – Leibnitz rule, absolute and conditional convergence, power series

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Text Books

1 Grewal B. S., *Higher Engineering Mathematics*, Khanna Publication, New Delhi.
2 Kreyszig E., *Advanced Engineering Mathematics*, Wiley Eastern Publication.

BH103 ENGINEERING PHYSICS I (6 Credits)

Unit 1: Wave and Oscillations
Free oscillation, damped oscillation and forced oscillation and resonance. Examples, Longitudinal and transverse wave, wave equation.

Unit 2: Acoustics
Ultrasonic waves Piezoelectric effect, Magnetostriction effect and production of ultrasonic waves, Applications of Ultrasonic waves.

Unit 3: Optics
Interference in thin films, wedge shaped film and Newton's ring application of interference of light, Polarization of light, Methods for production of polarized light, Hygen's theory of double refraction, Laurent's half shade polarimeter, faraday effect, Kerr effect.

Unit 4: Laser and Fiber optics
Principle of Laser, Spontaneous and stimulated emission – Einstein's co-efficient, Types of Laser and its applications , Total internal reflection, materials and types of optical fibers, numerical aperture, fiber optics communication principle and application.

Unit 5: Electron Optics
Motion of charged particles in electric field and magnetic field, Measurement of e/m by Thomson's Method, Millikan's Oil Drop method. Positive Rays, Bainbridge mass spectrograph.

Unit 6: Nuclear Physics and Quantum Mechanics
Nuclear reaction, q-value of Nuclear reaction, G.M.Counter. Duality of Matter, de-Broglie's wave, Electron Diffraction, Davisson and Germer's ē diffraction experiment, Heisenberg's Uncertainty Principle, Schrodinger's time dependent and time independent wave equation, Physical significance of wave function.

Text Books

1 M.N.Avadhanulu and P.G.Kshrisagar, *A Text of Engineering Physics*
2 R.K.Gaur and S.L.Gupta, *Engineering Physics*

Reference Books

1 D.Halliday, R.Resnick and J.Walker, *Fundamental of Physics,* Sixth Edition
2 F.S.Crawford Jr., *Waves – Berkeley Physics Courses,* Volume 3
3 A.Ghatak, *Optics* , Third Edition.

BH104 ENGINEERING CHEMISTRY – I (6 Credits)

Unit 1: Fuels and Lubricants

Fuels: Introduction, classification of fuel, essential properties of fuel, characteristics of good fuel, solid fuels- wood and coal, various types of coal, analysis of coal – Proximate and Ultimate analysis, liquid fuel- refining of petroleum.

Lubricants: Introduction, types of lubrication, classification of lubricants, properties of lubricants.

Unit 2: Physical Properties in liquid state

Additive and Constitutive properties, Surface tension and its determination, Viscosity and its determination, Refractive index and their determination, Optical activity, Specific rotation, Polarimeter.

Unit 3: Chemical Bonding

Types of chemical bonds, Ionic bonding and its characteristics, factors affecting the fomation of ionic bond, Born-Haber cycle for determination of lattice energy, the concept of Molecular Orbital theory, characteristics of bonding and antibonding molecular orbitals, formation of MO, bond order and stability of molecule, energy level sequence, MO diagram of H_2, O_2, etc. Hydrogen bonding.

Unit 4: Corrosion

Introduction, fundamental reason, electrochemical corrosion, direct chemical corrosion, factors affecting the rate of corrosion, types of corrosion- pitting corrosion, microbiological corrosion, stress corrosion, methods to minimize the corrosion – proper design, cathodic and anodic protection, metallic coating, organic coating.

Unit 5: Fundamentals of Organic Chemistry-1

Introduction, E_1 and E_2 reactions, Birch reduction, Oppenauer oxidation, Study of Aromatic compounds: Naphthalene, Anthracene.

Unit 6: Fundamentals of Organic Chemistry-2

Study of Heterocyclic compound: Pyridine and Quinolene. Manufacture of alcohol by fermentation process.

Text Books:

1 Bhal and Bhal, *Advanced Organic Chemistry,* S. Chand and Company, New Delhi, 1995.
2 Jain P. C. and Jain Monica, *Engineering Chemistry*, Dhanpat Rai and Sons, Delhi, 1992.

Reference Books:

1 Finar I. L., *Organic Chemistry* (Vol. I and II), Longman Gr. Ltd. and English Language Book Society, London.
2 Barrow G.M., *Physical Chemistry*, McGraw-Hill Publication, New Delhi.

CL105/CL205 BASIC CIVIL ENGINEERING (4 Credits)

Unit1: Properties and uses of construction materials
Stones, bricks, cement, concrete and steel. Site selection for buildings.

Unit 2: Component of building
Foundation- Shallow and deep foundations

Unit 3: Brick and stone masonry
Plastering- Lintels, beams and columns- Roofs.

Unit 4:Roads
Classification of Rural and urban Roads- Pavement Materials-Traffic signs and road marking-Traffic Signals

Unit 5: Surveying
Classification-Chain Survey-Ranging-Compass Survey-exhibition of different survey equipment.

Unit 6: Water Supply
Quality of Water-Wastewater Treatment units-Their functional utility- Need for conservation of water.

Reference Books

1 Sushil Kumar (2001), *Building Construction*, Standard Publishers Distributors.
2 S.C Rangwala (1996), *Building Materials*, Charotar Publishing House.
3 Lecture notes prepared by Department of Civil Engineering.

ME106/ME206 BASIC MECHANICAL ENGINEERING (4 Credits)

Unit 1: Introduction to Mechanical Engineering: Thermal Engineering, Design Engineering, Manufacturing Engineering.

Unit 2: Introduction to Laws of Thermodynamics with simple examples pertaining to respective branches, IC Engines: Classification, Applications, 2 Stroke and 4 Stroke systems in IC Engines.

Unit 3: Automobiles: Transmission systems, Suspension system, Power Plant: Types of Power plant; Gas power plant, Thermal power plant, Nuclear power plant

Unit 4: Design Basics, Mechanisms, Factor of safety, materials and metallurgical considerations

Unit 5: Engineering materials, machine elements, Transmission, Fasteners, support systems

Unit 6: Manufacturing: Classification, introduction to Lathe machine, Drilling machine, Milling machine, metal joining, Metal forming, casting (A visit to Workshop for demonstration)

Reference Books:

Lecture notes prepared by Department of Mechanical Engineering.

ID106 ENERGY AND ENVIRONMENTAL ENGINEERING (4 Credits)

Unit 1: Power Generation-1
Conventional Vs Non convectional power generation, Renewable and alternative energy trends in power generation in future.

Unit 2: Power Generation-2
Solar, Wind, Bioenergy, Ocean Thermal energy conversion (OTEC), Tidal, Fuel cell, Magneto Hydro Dynamics (MHD).

Unit 3: Power Generation-2
Thermo electric and thermionic generators – Principle and Application - Energy conservation and management- Industry, domestic, case studies.

Unit 4: Pollution-Air
Air pollution- sources- effects- control- air quality standards, air pollution act- measurement,

Unit 5: Pollution-Water
Water pollution- effects- selection of process- Disposal of solid wastes.

Unit 6: Pollution-General
Green house effect- Acid rain- Noise pollution – Thermal pollution- Pollution aspects of various power plants.

Text Books

1 Rai. G. D., Non Conventional Energy Sources, Khanna Publishers, Delhi, 2006.
2 Gilbert M. Masters, *Introduction to Environmental Engineering and Science*, 2nd Edition, Prentice Hall, 2003.

Reference Books

1 Rao S., Parulekar B.B., *Energy Technology-Non conventional, Renewable and Conventional*, Khanna Publishers, Delhi, 2005.
2 Glynn Henry J., Gary W. Heinke, *Environmental Science and Engineering*, Pearson Education, Inc, 2004.

ME107/ME207 ENGINEERING GRAPHICS (6 Credits)

Unit 1: Drawing standard
Drawing standard SP46: Dimensioning, Lettering, type of lines, scaling conventions.

Unit 2: Geometrical constructions
Dividing a given straight line into any number of equal parts, bisecting a given angle, drawing a regular polygon given one side, special methods of constructing a pentagon and a hexagon

Unit 3: orthographic /Isometric projection
Introduction to orthographic projection, drawing orthographic views of objects from their isometric views - Orthographic projections of Points lying in four quarters, Orthographic projection of lines parallel and inclined to

one or both planes. Orthographic projection of planes inclined to one or both planes. Isometric Projection and view of planes and simple solids.

Unit 4: Solids and sectioning
Types of solids, Projections of solids with axis perpendicular to HP, solids with axis perpendicular to VP, solids with axis inclined to one plane. Projection of spheres touching each other Sectioning of solids: section planes perpendicular to one plane and parallel or inclined to other plane.

Unit 5: Studies of surfaces
Intersection of surfaces: intersection of cylinder and cylinder, intersection of cylinder and cone, intersection of prisms.
Development of surfaces: Development of cylindrical and conical surfaces Development of prisms.

Unit 5: Computer Aids
Introduction to computer aided drafting: introduction to computer aided drafting package to make drawings

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TEXT BOOKS
1 N.D. Bhatt, *Engineering Drawing*, Charotar publishing House, 46th Edition, 2003.
2 K.V. Nataraajan, *A text book of Engineering Graphic*, Dhanalakshmi Publishers, Chennai, 2006.

REFERENCE BOOK
K.Venugopal and V.Prabhu Raja, *Engineering Graphics*, New Age International (P) Ltd, 2008.

XB108/PC108 INTRODUCTION TO PETROCHEMICAL ENGINEERING (6 Credits)

Unit 1: Origin, Formation and Composition of Petroleum
Origin and formation of Petroleum, Reserves and deposits of world, Indian Petroleum Industry Composition of Petroleum

Unit 2:Overview of Petroleum Refinery
Petroleum Refinery Processes and operations, Petroleum Refinery flow schemes, Definitions of Refining terms.

Unit 3: Introduction to Unit operations and Unit processes
Development of flow diagrams, Basic tools of Chemical Engineering Physico-Chemical Calculations

Unit 4: Chemical Process Calculations
Material and Energy Balances

Unit 5: Fluid flow and Heat Transfer
Principle and applications of flow of fluids and solids, Fundamental Laws for modes of Heat Transfer

Unit 6: Chemical Kinetics and Mass Transfer
Concept of Diffusion and Mass Transfer, Reaction rates and Chemical Kinetics

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Text Books

1 S. K. Ghosal, S. K. Sanyal and S. Datta, *Introduction to Chemical Engineering*, TMH Book Company, 1998.

2 B. K. Bhaskara Rao, *Modern Petroleum Refining Processes*, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 2005, Fourth Edition.

3 G.N. Sarkar, *Advanced Petroleum Refining*, Khanna Publishers, Delhi, First Edition, 1998.

XB108/ME108 INTRODUCTION TO MECHANICAL ENGINEERING (6 Credits)

Unit 1: Introduction

Role of Mechanical Engineering in industry and society, An historical overview of evolution of Mechanical Systems with examples

Unit 2: Materials and Manufacturing

Role of materials, engineering analysis and manufacturing with case studies, Basics of conventional design and manufacturing processes

Unit 3: Quality and Standards

Role of engineering measurements and quality standards

Unit 4: Mechanisms

Basics of novel mechanisms- Principles of working of machines which made the revolution, Traditional methods of design and analysis; Modern methods- case studies in mechanical design,

Unit 5: Thermal Systems

Principles of working of important thermal systems with examples, The role of basic thermal sciences in the design and analysis of mechanical systems,

Unit 6: Interfacing

Interface between Mechanical and Other Systems.

Reference Books

1 Lecture notes prepared by Department of Mechanical Engineering.

2. K. Venugopal (2005), *Basic Mechanical Engineering*, Anuradha Agencies.

XB108/EL108 INTRODUCTION TO ELECTRICAL ENGINEERING (6 Credits)

Unit 1: Introduction

History and major inventions in electrical engineering, scope and significance, sources of electrical engineering

Unit 2: Energy and Conversions

Concept of resistance and effect of temperature, Ohm's laws, forms of energy and their inter conversion

Unit 3: Basic concepts

Concept of direct and alternating quantities, instantaneous, peak average, R.M.S. values, peak factor, crest factor, phasor representation of alternating quantities, concept of real and reactive power, and power factor.

Unit 4: Magnetics
Study of magnetic circuits, magnetic field, and permeability, retentivity, and hysteresis, B-H curve, study of series and parallel magnetic circuit

Unit 5: Generation and Transmission
Introduction to generation, transmission, distribution power system, Introduction to three phase power system, and study of various power apparatus used in power system.

Unit 6: Computers and Electrical Engineering
Brief overview of software packages and laboratories in EEE department.

Reference:
Lecturer notes prepared by Department of Electrical Engineering.

XB108/CH108 INTRODUCTION TO CHEMICAL ENGINEERING (6 Credits)

Unit 1: Introduction
Introduction to Unit operations and Unit processes – Development of flow diagrams-Basic tools of Chemical Engineering

Unit 2: Process Calculations
Physio-Chemical Calculations. - Material and Energy Balances

Unit 3: Transport processes
Basic concepts of transfer processes, Principle and applications of Flow of Fluids and solids, Measuring devices, Heat Transfer.

Unit 4: Fundamentals of Mass Transfer and Kinetics
Mass Transfer, Chemical Kinetics, concepts of scale up,

Unit 5: Computer applications
Modeling and simulation, computers and their applications.

Unit 6: Resources and Production
Natural Resources and their Utilization, Pollution and its Abatement. Case studies on Refineries, Cement plants, paper and pulp , Textile and Ceramic Industries.

Text Books
1. S.K. Ghosal, S.K., Sanyal and S. Datta, *Introduction to Chemical Engineering*, TMH Book Company, 1998.
2. Anderson L.B and L.A. Wenzel, *Introduction to Chemical Engineering*, McGraw Hill Book Company, 1998.

XB108/CL108 INTRODUCTION TO CIVIL ENGINEERING (6 Credits)

Unit 1: Introduction to Civil Engineering
Role of Civil engineers in society, outstanding accomplishments of the profession, future trends,

Unit 2: Projects in Civil Engineering
Types of projects, stages of projects, Specifications and Scope.

Units 3: Structures
State of the art lectures on structures, Transportation, Water Resources, Environment, geotechnical, and GIS / GPS / RS, Introduction to geology.

Unit 4 Construction Materials
Properties and uses of construction materials such as stones, bricks, cement, concrete and steel.

Unit 5: Buildings
Site selection for buildings – components of building foundation – shallow and deep foundations

Unit 6:
Brick and stone masonry – plastering – lintels, beams and columns – roofs.

Reference Books

1 Sushil Kumar, *Building Construction*, Standard Publishers, 2001
2 Rangwals, S.C, *Building Materials*, Charotar Publishing house, 1996.

XB108/CP108 INTRODUCTION TO COMPUTER SCIENCE AND ENGINEERING (6 Credits)

Unit 1: Introduction
Basic model of computation, principle of mathematical induction,

Unit 2: Programming Basics
Notions of algorithms and programming, iteration and recursion

Unit 3: Programming Details-1
Imperative style of programming, Functional style of programming, correctness and efficiency

Unit 4: Programming Details-2
Features of block-structured languages, Functions and procedures, parameter passing

Unit 4: Programming styles
Top-down style and stepwise-refinement with concrete examples

Unit 6: Case Studies
Case studies with applications of programming

Text and Reference books

1 Subhashis Banerjee, S.Arun Kumar, D.Dubhashi,: *Introduction to Computer Science Manuscript*.

2 Harold Abelson and Gerald Sussman, *Structure and Interpretation of Computer Programs*, MIT Press, 1985.

3 R.J.Dromey, *How to Solve it by Computer*, Prentice Hall India Series

4 A.K. Dewdney, *New Turing Omnibus (New Turning Omnibus: 66 Excursions in Computer Science)*, W.H. Freeman and Company, Revised edition, 1993.

XB108/EX108 INTRODUCTION TO ELECTRONICS AND TELECOMMUNICATION ENGINEERING (6 Credits)

Unit 1: Introduction

History of major inventions in electronics and communication Engineering, Overview of various specializations in ECE,

Unit2: Basics of telecommunication

Basics of telecommunication infrastructure: Different types of channels, Bandwidth, power, range, interference, frequency reuse, fading

Unit 3: Industries and R& D

Industries and R &D institutions in India,

Unit 4 Future Scope

Career opportunities, Avenues for higher studies in India and abroad, In plant training, Internships, Distinguished alumni in India and Abroad.

Unit 5: Library

Introduction to library facility in department, central library and other institutes, National and International journals, Accessing digital library: Science direct and IEEE Explore, e-books and learning resources in the intranet and internet

Unit 6: Departmental Facilities

Brief overview of different laboratories in ECE dept., Electronic test and measurement equipments, Energy sources, Specification for electronic components, Mini projects, Technical report preparation and presentation

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Reference

Lecture notes prepared by Department of Electronics and Telecommunication Engineering.

EM105/EM205 ENGINEERING MECHANICS (6 Credits)

Unit 1: Concurrent forces in a plane

Principles of Statics-Composition of forces-Equilibrium of concurrent forces in a plane-Method of projections-Equilibrium of three forces in a plane Method of Moments – Friction

Unit 2: Forces in plane
Parallel forces in a plane: Two parallel forces- General case of parallel forces in a plane-Center of parallel forces and center of gravity-Centroids of composite plane figures and curves – Distributed forces in a plane
General case of forces in a plane: Composition of forces in a plane-Equilibrium of forces in a plane

Unit 3: Forces in space:
Force systems in space: Concurrent forces in space- method of projections, methods of moments-couples in space-parallel forces in space-center of parallel forces and center of gravity- general case of forces in space.

Unit 4:Rectilinear Translation
Kinematics of rectilinear motion-Principles of dynamics Differential equation of rectilinear motion-Motion of particle acted upon by a constant force D'Alembert's principle-Momentum and impulse-Work and energy- Ideal systems: conservation of energy- Impact

Unit 5: Curvilinear translation
kinematics of curvilinear motion- Differential equations of curvilinear motion-Motion of a projectile-D'Alembert's principle in curvilinear motion.

Unit 6: Rigid Body motion
Rotation of a rigid body about a fixed axis and plane motion of a rigid body.

Text Books

1 Rajasekaran.S. and Sankara Subramanian.G., *Engineering Mechanics – Statics and Dynamics*, Vikas Publishing Comp, 2005
2 S. Timoshenko and D.H. Young, *Engineering Mechanics,* McGraw Hill, 1995.

Reference Books

1. Irving H.Shames, *Engineering Mechanics – Statics and Dynamics*, Pearson Educations, Forth edition, 2003.
2. Beer and Johnston, *Vector Mechanics for Engineers, Vol.1 "Statics" and Vol.2 "Dynamics*, McGraw Hill International Edition, 1995.
3. Suhas Nitsure, *Engineering Mechanics*, Technical Publications, Pune, 2007.

XB108/IT108 INTRODUCTION TO INFORMATION TECHNOLOGY (6 Credits)

Unit 1: Introduction to the world of Computers
Overview, Introduction to computers: Generation of computers, Software and hardware, Types of computers, Computer networks and Internet.

Unit 2: The System Unit: Processing and Memory
Overview, Data and program representation, Inside the system unit, Working of CPU, Making computers faster and better now and in the Future. Storage systems characteristics, Magnetic disk systems, Optical disk systems, Flash memory systems, Other types of storage systems.

Unit 3: Input and Output
Overview, Keyboards, Pointing devices, Scanners, Readers and Digital cameras, Audio input, Display devices, Printers, Audio output.

Unit 4: System Software: Operating Systems and Utility Programs
Overview, System software and Application software, The operating system, Operating systems for Desktop PCs and servers, Operating systems for handheld PCs and other devices, Operating systems for larger computers, Utility programs.

Unit 5: Introduction to Application Software
Overview, Basics of application software, Word processing concepts, Spreadsheet concepts, Database concepts, Presentation graphics concepts, Graphics and multimedia concepts, Other types of application software.

Unit 6: Computer Networks and the Internet
Introduction to networks, Networking and communications applications, Types of networks, Data transmission over network, networking standards and communication protocols, Networking hardware.

Text Books

1 Deborah Morley and Charles S. Parker, *Fundamentals of Computers*, Cengage Learning, India edition, 2009.
2 Peter Norton, *Introduction to Computers*, 6th edition, Tata McGraw Hill publication, 2008.
3 Alexis Leon and Mathews Leon, *Fundamentals of Information Technology,* Vikas Publication, Chennai.

Reference Books

1. Francis Scheid, *Theory and Problems of Introduction to Computer Science*, Schaum's Outline Series, Tata McGraw Hill publication.
2. *Information Technology: Tools and Application,* Ed. UPTEC Computer Consultancy Limited, Elsevier Publication, 2004.

WS107/WS207 WORKSHOP PRACTICE (4 Credits)

Unit 1: Carpentry/Pattern Making
A. Wood sizing exercises in planning, marking, sawing, chiseling and grooving to make half lap joint and cross lap joint
B. Demonstration of power operated tools related to Carpentry skills

Unit 2: Fitting/Plumbing
A. A job involving cutting, filing to saw cut, filing all sides and faces, corner rounding, drilling and tapping on M. S. plates.
B. Demonstration on use of plumbing tools and preparation of plumbing line involving fixing of water tap and use of elbow, tee, union and coupling, etc.
C. Demonstration of power operated tools related to Fitting skills

Unit 3: Sheet Metal Working
A. Making a small parts using GI sheet involving development, marking, cutting, bending, brazing and soldering operations- i)Tray ii) Funnel
B. Demonstration of power operated tools related to sheet metal works

Unit 4: Welding
A. Exercise in MMA welding to make a square butt joint

B. Exercise in resistance (spot) welding to make a lap joint
C. Demonstration of power operated tools related to Welding skills

Unit 5: Machine Shop
Demonstration of step turning of a Mild Steel cylindrical job using center lathe

Instructions to the student:
Each student is required to maintain a 'workshop diary' consisting of drawing / sketches of the jobs and a brief description of tools, equipment, and procedure used for doing the job.

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B. Tech. Mechanical Engineering
Scheme of Syllabus

Semester III

Code	Subject	L	P	C	MSE	ESE
	Materials Science and Metallurgy	4	0	8	30	70
	Strength of Materials	4	0	8	30	70
	Machine Drawing and Computer-aided Drafting	2	0	4	30	70
	Thermodynamics	4	0	8	30	70
	Fluid Mechanics	4	0	8	30	70
	Engineering Mathematics-III	4	0	8	30	70
	Machine Drawing and Computer-aided Drafting Lab	*0*	*2*	*4*	*50*	*50*
	*Seminar Report and Presentation***			*4*		
	NCC/NSS/Sports/Arts					
		22	*2*	*52*	*230*	*470*

*** Self Study Report on any Topic of Choice based on the Subjects studied so far or beyond*

Semester IV

Code	Subject	L	P	C	MSE	ESE
	Manufacturing Processes-I	4	0	8	30	70
	Theory of Machines and Mechanisms-I	3	0	6	30	70
	Machine Design-I	4	0	8	30	70
	Applied Thermodynamics	4	0	8	30	70
	Elective -I	3	0	6	30	70
	*History of Science and Technology**			*4*	*50*	
	Fluid Mechanics Lab	*0*	*2*	*2*	*50*	*50*
	Manufacturing Processes Lab-I	*0*	*2*	*2*	*50*	*50*
	Strength of Materials Lab	*0*	*2*	*2*	*50*	*50*
	Materials Science and Metallurgy Lab	*0*	*2*	*2*	*50*	*50*
	*Industrial Exposure***					
	NCC/NSS/Sports/Arts					
		18	*8*	*48*	*400*	*550*

** Self Study Course (Objective type University Level Common Exam.)*

*** Two weeks in Industry*

Elective I:

- Renewable Energy Sources
- Sheet Metal Processes and Products

Syllabus for B. Tech. Mechanical Engineering
Semester III

Materials Science & Metallurgy

Unit 1: Structure of Materials
Crystal structures, indexing of lattice planes, Indexing of lattice directions, Imperfections in crystals - point defects, line defects, surface and bulk defects, Mechanism of plastic deformation, deformation of single crystal by slip, plastic deformation of polycrystalline materials

Unit 2: Mechanical Properties and their Testing
Tensile test, engineering stress-strain curve, true stress-strain curve, types of stress-strain curves, compression test, bend test, torsion test, formability, hardness testing, different hardness tests- Vickers, Rockwell, Brinnel, Impact test, fatigue test, creep test

Unit 3: Equilibrium Diagrams
Definitions of terms, rules of solid –solubility, Gibb's phase rule, solidification of a pure metal, plotting of equilibrium diagrams, lever rule, Iron-iron carbide equilibrium diagram, critical temperatures, solification and microstructure of slowly cooled steels, non-equilibrium cooling of steels, property variation with microstructures, classification and application of steels,, specification of steels, transformation products of austenite, TTT diagram, critical cooling rate, CCT diagram

Unit 4: Heat Treatment
Heat treatment of steels, cooling media, annealing processes, normalizing, hardening, tempering, quenching and hardenability, surface hardening processes- nitriding, carbonitriding, flame hardening, induction hardening

Unit 5: Metallography
Microscopy, specimen preparation, polishing abrasives and cloths, specimen mounting, electrolytic polishing, etching procedure and reagents, electrolytic etching, optical metallurgical microscope, macroscopy, sulphur printing, flow line observations, examination of fractures, spark test, electron microscope

Unit 6: Strengthening Mechanisms and Non-destructive Testing
Refinement of grain size, cold working/strain hardening, solid solution strengthening, dispersion strengthening, Precipitation hardening,
Magnetic particle inspection, dye penetrant inspection, ultrasonic inspection, radiography, eddy current testing, acoustic emission inspection.

Text Books:

1) V.D. Kodgire and S.V. Kodgire, Material Science and Metallurgy for Engineers, Everest Publishing House, Pune, 24th edition, 2008.

2) W.D. Callister, Jr., Materials Science and Engineering: An Introduction, John Wiley and Sons, 5th edition, 2001.
3) V. Raghvan, Material Science Engineering, Prentice Hall of India Ltd., 1992
4) S.H. Avner, Introduction to Physical Metallurgy, Tata McGraw-Hill, 2nd edition, 1997
5) R.A. Higgins, Engineering Metallurgy: Part I, ELBS, 6th edition, 1996

Reference Books:

- V.B. John, Introduction to Engineering Materials, ELBS, 6th edition, 2001
- G.F. Carter and D.E. Paul, Materials Science and Engineering, ASM International, 3rd edition, 2000
- T.E. Reed-Hill and R. Abbaschian, Physical Metallurgy Principles, Thomson, 3rd edition, 2003

Strength of Materials

Unit 1

Simple Stresses and Strains: Mechanical properties of materials, analysis of internal forces, simple stress and strain, stress-strain curve, Hooke's law, modulus of elasticity, shearing, thermal stress, Hoop stress, Poisson's ratio, volumetric stress, bulk modulus, shear modulus, relationship between elastic constants.

Unit 2

Principle stresses and strains: Uni-axial stress , simple shear, general state of stress for 2D element, ellipse of stress, principle stresses and principal planes, principal strains, shear strains, strain rosettes, Mohr's circle for stresses and strains.

Strain energy and resilience: Load deflection diagram, strain energy, proof resilience, stresses due to gradual, sudden and impact loadings, shear resilience, strain energy in terms of principal stresses.

Unit 3

Combined Stresses: Combined axial and flexural loads, middle third rule, kernel of a section, load applied off the axes of symmetry.

Shear and Moment in Beams: Shear and moment, interpretation of vertical shear and bending moment, relations among load, shear and moment.

Unit 4

Stresses in Beams: Moment of inertia of different sections, bending and shearing stresses in a beam, theory of simple bending, derivation of flexural formula, economic sections, horizontal and vertical shear stress, distribution shear stress for different geometrical sections- rectangular, solid circular, I-section, other sections design for flexure and shear.

Unit 5

Beam Deflections: Differential equation of deflected beam, slope and deflection at a point, calculations of deflection for determinate beams by double integration, Macaulay's method, theorem of area-moment method (Mohr's theorems), moment diagram by parts, deflection of

cantilever beams, deflection in simple supported beams, mid-span deflection, conjugate beam method, deflection by method of superstition.

Unit 6

Torsion: Introduction and assumptions, derivation of torsion formula, torsion of circular shafts, stresses and deformation in determinate solid/ homogeneous/composite shafts, torsional strain energy.

Columns and Struts: Concept of short and long Columns, Euler and Rankine's formulae, limitation of Euler's formula, equivalent length, eccentrically loaded short compression members.

Text Books:

1. S. Ramamrutham, Strength of Materials, Dhanpat Rai & Sons, New Delhi.
2. F.L. Singer and Pytle, Strength of Materials, Harper Collins Publishers, 2002.
3. S. Timoshenko, Strength of Materials: Part-I (Elementary Theory and Problems), CBS Publishers, New Delhi.

Reference Books:

1. E.P. Popov, Introduction to Mechanics of Solid, prentice- Hall, Second Edition 2005.
2. S.H. Crandall, N.C. Dahl.and T.j.Lardner, An introduction to the Mechanics of Solids, Tata McGraw Hill, 1978.
3. S.B. Punmia, Mechanics of Structure, Charotar Publishers, Anand.
4. B.C. Punmia, Ashok Jain, and Arun Jain, Strength of Materials, Laxmi Publications.

Machine Drawing & Computer Aided Drafting

Unit 1

Sectional Views

Full section, half section, partial section, off-set section, revolved sections, removed sections, auxiliary section, guidelines for hatching, examples on all above types of sections of machine elements.

Unit 2

Study of Machine Elements

Study of simple machine elements and components such as screwed fasteners, shaft couplings, pipe joints, riveted and welded joints, bearings, gears, etc.

Unit 3

Interpenetration of surfaces (emphasis on applied cases)

Line or curve of intersection of two penetrating cylinders, Cone and cylinder, prism and a cylinder, cone and prism, Forged ends, etc.

Unit 4

Drawing of Assembly and Details

Assembly and details part drawing of standard machine components such as valves, components of various machine tools, pumps, shaft couplings, joints, pipe fittings, engine parts, etc.

Unit 5

Production Drawing and Reading Blue Prints

Types of production drawings, size, shape and description, limits, fits and tolerances, surface roughness and surface roughness symbols, reading the blue prints.

Unit 6

Computer Aided Drafting

Introduction to Computer Aided Design and Drafting, Advantaged of CADD, study of preliminary AutoCAD commands like drawing, dimensioning, viewing commands. Drawing 3D views in AutoCAD, Introduction AutoLISP programming.

Text books:

1. N.D. Bhatt and Panchal, "Engineering Drawing" Charotar Publishing House, Anand, India.
2. N.D. Bhatt and Panchal, "Machine Drawing" Charotar Publishing House, Anand, India
3. Ajeet Sing, "Working with AutoCAD 2000, "Tata McGraw Hill, New Delhi.
4. George Omura, "ABC of Autolisp " BPB Publications, New Delhi

References Books:

1. Narayana, Kannaiah, Reddy, " Machine Drawing" New Age International Publishers
2. AutoCAD and AutoLISP manuals from Autodesk Corp. U.S.A.
3. IS Code: SP 46- 1988, Standard Drawing Practices for Engineering Institutes.

Thermodynamics

Unit 1

Fundamental Concepts and Definitions: Thermodynamic systems, properties, processes and cycles. Thermodynamic equilibrium, Quasi- static process, Macroscopic vs. Microscopic viewpoint, Work and heat Transfer: Work transfer, p.dv and other types of work, Heat transfer, temperature and its measurement (principle of measurement, various instruments etc.)Zeroth law of thermodynamics, specific heat and latent heat, point function, path function.

Unit 2

First Law of Thermodynamics: Firt law of thermodynamics for a closed system undergoing a cycle and change of state, Energy, different forms of energy, Enthalpy, PMM-I control volume, application of first law of steady flow processes (nozzle, turbine, compressor pump, boiler, throttle valve etc.)

Unit 3

Second Law of Thermodynamics: Limitation of first law of thermodynamics, cycle heat engine, refrigetor and heat pump, Kelvin- Plank and Clausius statements and their equivalence,

Reversibility and Irreversibility, Carnot cycle, Carnot theorem, Absolute thermodynamic temperature scale.

Unit 4
Entropy: Introduction, Clausius theorem, T-s plot, Clausis inequality, Entropy and Irreversibility, Entropy principle and its application, combined I and II law, Entropy and direction, Entropy and disorder.

Unit 5
Availability: Avaibable energy pertaining a cycle, Quality of energy, law of degradation of energy, maximum work in a reversible process, Dead state, Availability in steady flow and non-flow processes, Second law efficiency.

Unit 6
Ideal gas: Avogadro's law, Equation of state, ideal gas and process, relation between and cv, other equation of states.

Properties of Pure Substance : Phase change of pure substance, phase diagram of pure substance, p-v, T-s, and h-s diagrams properties of steam ,property table, representation of processes of steam on p-v, T-s, and diagrams, Dryness fraction and its measurement.

Text Books:
- P.K. Nag, Engineering Thermodynamics, Tata Mc-Graw Hill, 3rd edition, 2005 New Delhi.
- Y.A. Cengel and M.A. Boles, Thermodynamics – An Engineering Approach, McGraw Hill, 5th edition, 2006.

Reference Books:
- G.J. Van Wylen and R.E. Sonntag, Fundamental of Thermodynamics, John Wiley & Sons, 5th edition, 1998.
- M.J.Moran and H.N. Shaprio, Fundamentals of Engineering Thermodynamics, John Wiley and Sons, 4th edition, 2004.

Fluid Mechanics

Unit 1
Basics: Definition of fluid, fluid properties such as viscosity, vapour pressure, compressibility, surface tension, capillarity, Mach number etc, pressure at a point in the static mass of fluid, variation of pressure, Pascal's law, pressure measurement by simple and differential manometers using manometric expression.

Unit 2

Fluid Statics: Hydrostatic forces on the plane and curved surfaces, centre of pressure, Buoyancy, centre of buoyancy, stability of floating bodies, metacentre and metacentric height its application in shipping.

Unit 3

Fluid Kinematics: velocity of fluid particle, types of fluid flow, description of flow, continuity equation, Coordinate free form, acceleration of fluid particle, rotational & irrotational flow, Laplace's equation in velocity potential and Poisson's equation in stream function, flow net.

Unit 4

Fluid Dynamics: Momentum equation, development of Euler's equation, Introduction to Navier-Stokes equation, Integration of Euler's equation to obtain Bernoulli's equation, Bernoulli's theorem , Application of Bernoulli's theorem such as venture meter, orifice meter, rectangular and triangular notch, pitot tube, orifices etc.

Unit 5

a) Laminar Flow: Flow through circular pipe, between parallel plates, Power absorbed in viscous flow in bearings, loss of head due to friction in viscous flow.

b) Turbulent Flow: Reynolds's experiment, frictional loss in pipe flow, shear stress in turbulent flow, major and minor losses, HGL and TEL, flow through series and parallel pipes.

Unit 6

a) Dimensional Analysis: Dimensional homogeneity, Raleigh's method, Buckingham's theorem, Model analysis, similarity laws and dimensionless numbers.

b) Introduction to boundary layer theory and its analysis.

c) Forces on Submerged bodies: Drag, lift, Drag on cylinder, Development of lift in cylinder.

Text Books:

1. Modi and Seth, Fluid Mechanics and Hydraulic Machinery, Standard Book House, Tenth Edition , 1991
2. Robert W. Fox and Alan T. McDonald, Introduction to Fluid Mechanics, John Wiley and Sons, 5^{th} edition.

Reference Books:

1. V.L. Streeter, K.W. Bedford and E.B.Wylie, Fluid Dynamics, McGraw-Hill, 9th edition, 1998.
2. S.K. Som and G. Biswas, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw-Hill, 2^{nd} edition, 2003.

Engineering Mathematics – III

Unit 1: Laplace Transform
Transform of elementary functions, Transform periodic function, Transform of special function, Transform of derivative, Transform of integral, Properties of Laplace Transform, Evaluation of integrals by Laplace Transform

Unit 2: Inverse Laplace Transform
Properties of Inverse Laplace Transform, Other method for finding inverse Laplace Transform, Convolution Theorem for inverse Laplace Transform, application to the differential equations, Simultaneous linear equation with constant coefficients

Unit 3: Partial differential equations and applications
Formation of partial differential equations, Linear equations of the first order, homogeneous linear equations with constant coefficient, rules for finding complementary and particular integrals, working procedure to solve the equation, Non-homogeneous linear equations, Wave equation, One dimensional heat flow equation, Laplace equation

Unit 4: Series solution of differential equation and Special function
Validity of series solution, Series solution when $x = 0$ is an ordinary point, Frobenius method, Bessel's equation, Recurrence relation for $J_n(x)$, Orthogonality of Bessel function

Unit 5: Fourier Transform
Fourier integral – Fourier since and cosine integral – complex forms of Fourier integral, Fourier transform – Fourier sine and cosine transform – finite Fourier sine and cosine transform, properties of F-transform, Convolution theorem for F-transform, Parse Val's identity of for F-transforms

Unit 6: Integral equations
Conversion of linear differential equation to an integral equation and vice versa, conversion of boundary value problem to integral equation using green's function, solution of an integral equation, integral equation of the convolution type, Able's integral equation, integro-differential equation, solution of Fred Holm and Volterra equation by the method of approximation

Text Books

1. Grewal B. S., Higher engineering Mathematics, Khanna Publication, New Delhi
2. Keyszig E., Advanced Engineering Mathematics, Wiley Eastern Publication
3. Peter V. O. Neil, Advanced Engineering mathematics, Thomson Publication

Machine Drawing & Computer Aided Drafting Lab

List of Practicals: (minimum six assignments should be completed)

1. One full imperial drawing sheet consisting the drawing/ sketches of representation of standard components, symbols of pipe joints, weld joints, rivet joint etc, surface finish symbols and grades, limit, fit and tolerance sketches.
2. Two full imperial drawing sheets, one consisting of assembly and the other consisting of details of any one standard component such as valves, components of various machine tools, pumps, joints, engine parts, etc.
3. Two assignment of AutoCAD: Orthographic Projections of any one simple machine component such as bracket, Bearing Housing or Cast component for Engineers such as connecting rod, Piston, etc. with dimensioning and detailing of three views of components
4. 3-D model at least one simple machine component.

Syllabus for B. Tech. Mechanical Engineering
Semester IV

Manufacturing Processes – I

Unit 1: Introduction to Manufacturing
What is manufacturing? Examples of manufactured products, Classification of manufacturing processes, Selection of materials, Types of manufacturing strategies

Unit 2: Metal Casting Processes
Patterns, allowances, moulding sand properties and preparation, Cores, core prints, sand moulding procedure, melting practice and furnaces, solidification of metals, casting defects and inspection, Specialized casting processes such as shell mould casting, die casting, centrifugal casting, investment casting and permanent mould casting

Unit 3: Joining Processes
Gas welding, gas cutting, Electric arc-welding with consumable and non-consumable electrodes (MMAW, GMAW, TIG, SAW), Solid State Welding: resistance welding, spot and seam welding, thermit welding, friction welding, welding defects, Brazing and soldering.

Unit 4: Turning, Shaping and Planing
Centre lathe, lathe operations, taper turning, methods of taper turning, work holding and cutting tool, thread cutting, machining time and power estimation, shaper, Planing machine and their operations

Unit 5: Milling and Gear cutting
Milling machine and its types, milling operations, milling cutters, milling time and power estimates, Gear cutting using indexing mechanism, indexing types - simple, compound and differential indexing, gear shaping, gear forming, gear hobbing, and gear shaving

Unit 6: Drilling, Boring, Broaching
Drilling machine, its types, twist drill, drilling time and power estimates, counter boring, spot facing, boring, reaming, tapping, and broaching, broach tool, broaching types and operations

Text Books:

- P.N. Rao, Manufacturing Technology, Foundry, Forming and Welding, Vol. 1, 3rd edition, Tata Mc Graw Hill Publishing Co. Ltd, New Delhi, 2004
- P.N. Rao, Manufacturing Technology, Metal Cutting and Machine Tools, Vol. 2, 2nd edition, Tata Mc Graw Hill Publishing Co. Ltd, New Delhi, 2002

References Books:

1. M.P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes and systems, Prentice Hall, Upper Saddle River, New Jersey,1999
2. S. Kalpakjian and S.R. Schmid, Manufacturing Engineering and Technology, Addison Wesley Longman (Singapore) Pte. India Ltd., 4th edition, 2000

Theory of Machines & Mechanisms – I

Unit 1
Definition of link, pair, kinematics chain, inversions, inversions of single and double slider crank chain, kinematic diagrams of mechanisms, equivalent linkage of mechanism, degree of freedom.

Unit 2
Study of various mechanisms such as straight line mechanisms, pantograph, Geneva mechanism, steering gear mechanisms and Hooke's joint

Unit 3
Instantaneous centre of rotation, body and space centrodes and their applications, Kennedy's theorem and its applications.

Unit 4
Velocity and acceleration analysis and its purpose, velocity and acceleration diagrams using relative velocity method, Corioli's component of acceleration

Unit 5
Velocity and acceleration analysis by vector methods, coordinate system, Loop closure equation, Chase solutions, velocity and acceleration by vector and complex algebra

Unit 6
Velocity and acceleration of slider crank mechanism by analytical method and Klein's construction.

Text Books:
1. A. Ghosh and A.K. Malik, Theory of Mechanisms and Machines, Affiliated East-West Press Pvt. Ltd., New Delhi.
2. S. S. Rattan, Theory of Machines, Tata-McGraw Hill, New Delhi.

Reference Books:
1. Thomas Beven, Theory of Machines, CBS Publishers and Distributors, Delhi.
2. J.E. Shigely and J.J. Uicker Theory of Machines and Mechanisms, McGraw Hill, New York, International Student Edition, 1995.

Machine Design - I

Unit 1
Mechanical engineering Design Process: Traditional design methods, general industrial design procedure, design considerations, phases in design ,creativity in design, use of standardization, preferred series, introduction to ISO 9000, use of design data book, aesthetic and ergonomic considerations in design.

Unit 2
Design of Machine Elements against Static Loading: Theories of Failure (Yield and Fracture Criteria) - Maximum normal stress theory, Maximum shear stress theory, Maximum distortion energy theory, comparison of various theories of failure, Direct loading and combined loading, Joints subjected to static loading e.g. cotter and knuckle joint, turnbuckle, etc. introduction to fluctuating loads.

Unit 3
Design of Shafts Keys and Couplings: Various design considerations in transmission shafts, splinted shafts, spindle and axles strength, lateral and torsional rigidity, ASME code for designing transmission shaft.

Types of Keys: Classification and fitment in keyways, Design of various types of keys.
Couplings: Design consideration, design of rigid, muff and flange type couplings, design of flexible couplings.

Unit 4
Design of Threaded joints: Stresses in screw fasteners, bolted joints under tension, torque requirement for bolt tightening, preloading of bolt under static loading, eccentrically loaded bolted joints.
Power Screws: Forms of threads used for power screw and their applications, torque analysis for square and trapezoidal threads, efficiency of screw, collar friction, overall efficiency, self locking

in power screws, stresses in the power screw, design of screw and nut, differential and compound screw, re-circulating ball screw.

Unit 5

Welded Joints: Type of welded joints, stresses in butt and fillet welds, strength of welded joints subjected to bending moments.

Unit 6

Mechanical Springs: Stress deflection equation for helical spring, Wahl's factor, style of ends, design of helical compression, tension and torsional spring under static loads, construction and design consideration in leaf springs, nipping, stain energy in helical spring, shot peening.

Text Books:

1. V.B. Bhandari, Design of Machine Elements, Tata McGraw Hill, New Delhi, 2008.
2. R.L. Nortan, Machine Design: An Integrated Approach, Pearson Education Singapore, 2001.
3.

Reference Books:

1. R.C. Juvinall and K.M. Marshek, Fundamental of machine component design , John Wiley & Sons, Inc, New York, Third Edition 2002.
2. B.J. Hamrock, B. Jacobson and Schmid Sr., Fundamentals of Machine Elements, International Edition, New York, Second Edition 1999
3. A.S. Hall, A.R. Holowenko and H.G. Langhlin, "Theory and Problems of Machine Design, Schaum's Outline Series, McGraw Hill book Company, New York, 1982.
4. J.E. Shigley and C. Mischke, Mechanical Engineering Design, McGraw Hill, 7th edition, 2004.
5. M.F. Spotts, Design of Machine Elements, Prentice Hall of India, New Delhi.

Applied Thermodynamics

Unit 1

Fuels and Combination: Types of fuels, calorific values of fuels and its determination, combustion equation for hydrocarbon fuel, determination of minimum air required for combustion and excess air supplied conversion of volumetric analysis to mass analysis, fuel gas analysis.

Unit 2

Steam Generators: Classification of boilers, boiler details, requirements of a good boiler, merits and demerits of fire tube and water tube boilers, boiler mountings and accessories.

Boiler Draught: Classification of draught, natural draught, determination of height and diameter of the chimney, Condition for maximum discharge, efficiency of the chimney, draught losses, types of boiler draught.

Performance of Boilers: Evaporation, equipment evaporation, boiler efficiency, boiler trial and heat balance.

Unit 3

Vapor and gas power cycles: Carnot cycle, ideal Rankine cycle, calculation of thermal efficiency, specific steam consumption, work ratio, Air standard Otto, Diesel and Dual cycle, Strirling cycle, Joule-Brayton cycle

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Unit 4

Steam Nozzles: Types of Nozzles, flow of steam through nozzles, condition for maximum discharge, expansion of steam considering friction, super saturated flow through nozzles, General relationship between area, velocity and pressure.

Unit 5

Steam Turbines: Advantages and classification of steam turbines, compounding of steam turbines, velocitiy diagrams, work one done and efficiencies, losses in turbines.

Condensers and Cooling Towers:

Elements of steam condensing plants, advantages of using condensers, types of condensers, thermodynamic analysis of condensers, efficiencies, cooling towers.

Unit 6

Reciprocating air compressor: Classification constructional details, theoretical and actual indicator diagram, FAD, multi staging, condition for maximum efficiency, capacity control.

Internal combustion engines, applications, nomenclature, engine components, Engine classification, two and four stroke cycle engines; fundamental different between SI and CI engines, valve timing diagames

Text Books:

1. T.D. Eastop and A. McConkey, " Applied Thermodynamics" Addison Wesley Longman
2. P.K. Nag " Basic and Applied Thermodynamics,: Tata McGraw Hill
3. Gill and Smith, " Fundamental of internal combustion engines
4. Sharma and Mathur, " Internal Combustion ngines", Tata McGraw Hill

Reference Books:

1. Yunus A. Cengel, "Thermodynamics- An Engineering Approach, " Tata McGraw Hill
2. Rayner Joel, " Basic engineering Thermodynamics" Addison Wesley Longman
3. P.K. Nag "Power Plant Engineering" ,Tata McGraw Hill, 2nd edition

Elective-I

(a) Renewable Energy Sources

Unit 1: Introduction

Energy resources, Estimation of energy reserves in India, Current status of energy conversion technologies relating to nuclear fission and fusion, Solar energy.

Unit 2: Solar Radiations

Spectral distribution, Solar geometry, Attenuation of solar radiation in Earth's atmosphere, Measurement of solar radiation, Properties of opaque and transparent surfaces.

Unit 3: Solar Collectors

Flat Plate Solar Collectors: Construction of collector, material, selection criteria for flat plate collectors, testing of collectors, Limitation of flat plate collectors, Introduction to ETC. **Concentrating type collectors**: Types of concentrators, Advantages, paraboloid, parabolic trough, Heliostat concentrator, Selection of various materials used in concentrating systems, Tracking.

Unit 4: Solar Energy Applications

Air/Water heating, Space heating/cooling, solar drying, and solar still, Photo-voltaic conversion.

Unit 5: Wind Energy & Biomass

Types of wind mills, Wind power availability, and wind power development in India. Evaluation of sites for bio-conversion and bio-mass, Bio-mass gasification with special reference to agricultural waste,

Unit 6: Introduction to Other Renewable Energy Sources

Tidal, Geo-thermal, OTEC, Mini/micro hydro-electric, Geo-thermal, Wave, Tidal.
System design, components and economics.

Text Books:

1. Chetansingh Solanki, *Renewable Energy Technologies*, Prentice Hall of India, 2008

Reference Books:

1. Sukhatme S.P., *Solar Energy: Principles of Thermal Collection and Storage*, Tata McGraw Hill, New Delhi, 1992.
2. G.D. Rai, *Solar Energy Utilization*, Khanna Publisher, Delhi, 1992.

Elective-I

(b) Sheet Metal Processes and Products

Unit 1

- Introduction and Importance of sheet metal engineering, materials used, desirable properties of materials in sheet metal products

Unit 2

- Basic applications: shearing processes like blanking, piercing, and punching.

Unit 3

- Drawing processes like shallow and deep drawing of cylindrical and rectangular bodies, forming and bending including spring-back.

Unit 4

- Types of dies: compound dies, progressive dies, and combination dies

Unit 5

- Mechanical and hydraulic presses and modern developments in press tools, formability.

Unit 6

- Case studies for manufacturing of sheet metal products in various engineering applications

TEXTS / REFERENCES:

- P. N. Rao, Manufacturing Technology, Foundry, Forming and Welding, Vol. 1, 3rd edition, Tata Mc Graw Hill Publishing Co. Ltd, New Delhi, 2004
- Donaldson et al :Tool Design; Tata McGraw-Hill, New Delhi,1998
- ASM Handbook (10th edition) Vol. 15 on Metal Forming, ASM Publication, Metals Park, Ohio, 1989.
- Die Design Handbook, ASTME, 1989.
- A. S. Deshpande, Sheet Metal Engineering Notes, IIT Bombay, 1999.

Fluid Mechanics Lab

List of Experiments (any eight experiments from the list)

1. Flow visualization technique: characteristics of laminar and turbulent flow patterns using Helleshaw Apparatus
2. Verification of Bernoulli's theorem
3. Determination of Critical Reynolds number using Reynolds Apparatus
4. Determinations of pressure drop in pipes of various cross-sections
5. Determinations of pressure drop in pipes of various pipe fittings etc.
6. Viscosity measurement using viscometer (at least one type)
7. Verification of momentum equation using impact of jet apparatus
8. Determination of metacentric height of a floating body
9. Calibration of a selected flow measuring device and Bourdon pressure gauge
10. Gauge and differential pressure measurements using various types of manometers, Bourdon type pressure gauge. Demonstration of measurement using these instruments in lab
11. Experiment to study hydraulic jump

Manufacturing Processes Lab - I

Each student shall be required to submit one job each of the following term work:

1. Making a job with a process plan involving plain, step and taper turning operations on a centre lathe.
2. Preparation of process planning sheet for a job including operations such as milling, drilling and shaping.
3. Making a spur gear using universal dividing head on milling machine.
4. Making a simple component by sand casting using a split pattern.
5. A cutting of a sheet plate using oxyacetylene flame cutting/plasma cutting.
6. Making a butt joint on two stainless steel plates using TIG Welding.
7. Making a butt joint on two stainless steel plates using TIG Welding.

Strength of Materials Lab

List of Experiments (any 8 experiments from the list)

1. Tension test on ferrous and non-ferrous alloys (mid steel/cast iron/aluminum, etc.
2. Compression test on mild steel, aluminum, concrete, and wood
3. Shear test on mild steel and aluminum (single and double shear tests)
4. Torsion test on mild steel and cast iron solid bars and pipes
5. Flexure test on timber and cast iron beams
6. Deflection test on mild steel and wooden beam specimens
7. Graphical solution method for principal stress problems
8. Impact test on mild steel, brass, aluminum, and cast iron specimens
9. Experiments on thermal stresses
10. Strain measurement in stress analysis by photo-elasticity
11. Strain measurement involving strain gauges/ rosettes
12. Assignment involving computer programming for simple problems of stress, strain computations.

Materials Science & Metallurgy Lab

List of Experiments (any eight experiments from the list):

1. Brinell Hardness Test
2. Rockwell Hardness test
3. Erichson Cupping Test
4. Magnaflux Test
5. Dye Penetrant Test
6. Specimen Preparation for Microscopy
7. Sulphur Print Test
8. Spark Test
9. Study and drawing of microstructures of plain carbon steels of varying carbon percentage
10. Study and drawing of microstructures of heat treated steels
11. Jominy End Quench Test
12. Study and drawing of microstructures of cast irons
13. Study and drawing of microstructures of non-ferrous alloys
14. Hardening of steels of varying carbon percentage

Reference Books:

1. Vander Voort, Metallography: Principles and Practice, McGraw-Hill, 1984
2. K.H. Prabhudev, Handbook of Heat Treatment of Steels, Tata McGraw-Hill, 2000.

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DEPARTMENT OF MECHANICAL ENGINEERING

Effective from 2012 - 2013

Semester V

Code	Subject	L	P	C	TW	OR	UTE	ESE
	Manufacturing Processes-II	3	0	6			30	70
	Theory of Machines & Mechanisms-II	3	0	6			30	70
	Heat Transfer	4	0	8			30	70
	Mechanical Measurements & Metrology	4	0	8			30	70
	Elective II	3	0	6			30	70
	Mechanical Measurements & Metrology Lab	*0*	*2*	*2*	*50*	*50*		
	Theory of Machines & Mechanisms Lab I	*0*	*2*	*2*	*50*	*50*		
	Thermal Engineering Lab	*0*	*2*	*2*	*50*	*50*		
	*Industrial Exposure***			*2*	*50*	*50*		
	NCC/NSS/Sports/Arts							
		17	**6**	**42**	**200**	**200**	**150**	**350**

*** Evaluation of Two weeks Industrial Exposure*

Elective II:

- Engineering Economics
- Quantitative Techniques in Project Management
- Appropriate Technology
- Knowledge Management
- Nuclear Power Plants

Semester VI

Code	Subject	L	P	C	TW	OR	UTE	ESE
	Manufacturing Processes-III	3	0	6			30	70
	Dynamics of Machines	3	0	6			30	70
	Machine Design-II	3	0	6			30	70
	I.C. Engines & Fluid Machinery	4	0	8			30	70
	Elective III	3	0	6			30	70
	Manufacturing Processes Lab-II	*0*	*2*	*2*	*50*	*50*		
	Machine Design Practice-I	*0*	*2*	*2*	*50*	*50*		
	I. C. Engines & Fluid Machinery Lab	*0*	*2*	*2*	*50*	*50*		
	Heat Transfer Lab	*0*	*2*	*2*	*50*	*50*		
	Technical Project on Community Services	*0*	*2*	*2*	*50*	*50*		
	*Industrial Training**							
	NCC/NSS/Sports/Arts							
		16	***10***	***42***	***250***	***250***	***150***	***350***

**Four weeks in Industry*

Elective III:

- Numerical Methods for Engineering
- Sensors for Engineering Applications
- Design of Experiments
- Sustainable Development
- Entrepreneurship Development
- Intellectual Property Rights

SEMESTER- V

Manufacturing Processes –II

Unit 1: Classification of Metal Removal Processes and Machine tools
Introduction to Manufacturing and Machining, Basic working principle, configuration, specification and classification of machine tools, Construction, working principle and applications of shaping, planing and slotting machines, Use of various Attachments in Machine Tools, Estimation of machining time

Unit 2: Mechanics of Machining (Metal Cutting)
Geometry of single point cutting tools, Mechanism of chip formation, Orthogonal and oblique cutting, Use of chip breaker in machining, Machining forces and Merchant's Circle Diagram (MCD), Analytical and Experimental determination of cutting forces, Dynamometers for measuring cutting Forces, Cutting temperature – causes, effects, assessment and control, Control of cutting temperature and cutting fluid application

Unit 3: Machinability
Concept of Machinability and its Improvement, Failure of cutting tools and tool life, Cutting Tool Materials of common use, Advanced Cutting Tool Materials

Unit 4: Abrasive Processes (Grinding and Superfinishing)
Basic principle, purpose and application of grinding, Selection of wheels and their conditioning, Classification of grinding machines and their uses, Superfinishing processes, Honing, Lapping and Superfinishing

Unit 5: Gear Manufacturing Methods
Production of screw threads by Machining, Rolling and Grinding, Manufacturing of Gears, Broaching – Principles and Applications

Unit 6: Jigs and Fixtures for Machine shops
Purposes of jigs and fixtures and their Design principles, Design and Application of typical jigs and fixtures, Principle of location, Clamping principle

TEXTS:

1. P. N. Rao, Manufacturing Technology, Metal Cutting and Machine Tools, Vol. 2, 2nd edition, Tata Mc Graw Hill Publishing Co. Ltd, New Delhi, 2002
2. Amitabha Bhattacharyya, G. C. Sen, Principle of Metal Cutting, New Central Book Agency, 1969
3. M. C. Shaw, Theory of Metal Cutting, 1st Edition, Oxford and I.B.H. publishing, 1994
4. P. H. Joshi, Jigs and Fixtures, Tata McGraw Hill Publishing Co. New Delhi,

REFERENCES

1) Milkell P. Groover, Fundamentals of Modern Manufacturing – Materials, Processes, and systems, 4th Edition, John Wiley and Sons, 2010, New Jersy
2) Serope Kalpakjan and Steven R. Schmid, Manufacturing Engineering and Technology, Addison Wesley Longman (Singapore) Pte. India Ltd. 4th edition, 2000
3) Geoffrey Boothroyd, Winston Knight, Fundamentals of Machining and Machine Tools, Third Edition, Taylors and Francis, 2006

4) Edward G. Hoffman, Jigs and Fixtures Design, Fifth Edition, Cengage Learning, 2004.
5) Paul DeGarmo, J T. Black, Ronald A. Kohser, Materials and Processes in Manufacturing, 10th Edition, Wiley, 2007
6) www.nptel.com, IIT Kharagpur, Manufacturing Processes I

Theory of Machines and Mechanisms –II

Unit 1

Gears : Classification of gears, Terminology of spur gears, Conjugate action, Involute and cycloidal profiles, Path of contact, Contact ratio, Interference, Undercutting, Rack shift, Effect of center distance variations, Friction between gear teeth, Internal gears.

Helical gear terminology, Normal and transverse module, Virtual number of teeth, Torque transmitted by helical gears, Spiral gears, Efficiency of spiral gears, Worm and Bevel gear terminology, Tooth forces and geometric relationship, Torque capacities.

Unit 2

Gear Trains: Velocity ratios, Types of gear trains, Tooth load, Torque transmitted and holding torque.

Flywheel: Turning moment diagram, Fluctuation of energy and speed, Determination of flywheel size for different types of prime movers and machines.

Unit 3

Cams and Followers: Types of cams and followers, Analysis of motion, Jump and ramp of cam, Determination of cam profiles for a given follower motion, Circular arc cam, Tangent cam, Cycloidal cam.

Unit 4

Friction and Lubrication: Dry friction, friction between nut and screw with different types of threads, Uniform wear theory and uniform pressure theory, Frication at pivot and collars, Friction in turning pair, Friction circle and friction axis, Friction in mechanisms.

Lubrication, Viscosity, Viscous flow, Boundary lubrication, Thick film lubrication, Hydrostatic and hydrodynamic lubrications.

Unit 5

Friction Clutches: Single plate and multiplate clutch, Cone clutch, Centrifugal clutch, Torque transmitting capacity, Clutch operating mechanism.

Brakers: Shoe brake, Internal and external shoe brakes, Block brakes, Band brakes, Band and block brakes, Braking torque.

Dynamometers: Different types of absorption and transmission type dynamometers, Construction and working of eddy current dynamometer, Torque measurement.

Unit 6

Belt and Rope Drives: Flat belts, Effect of slip, Centrifugal tension, Creep, Crowing of pulley, Initial tension in belts. V- Belts, Virtual coefficient of friction, Effect of V-groove on torque transmitted. Rope drives, Rope constructions, Advantages of rope drives.

TEXTS:

1. Rattan, S.S.Therory of Machines, Tata McGraw Hill, New Delhi

2. Ballaney P.L. Theory of Machines, Khanna Publishers, New Delhi.

REFERENCES:

1. Beven, T.Theory of machines, CBS Publishers, Delhi.
2. Shigley, J.E. and Vicker, J.J.Therory of Machines and Mechanisms, McGraw Hill International
3. Ghosh, A.and Mallick A.K.Theroy of Mechanisms and Machines, Affiliated East- West Pvt.Ltd.

Heat Transfer

Unit 1

Introduction: Heat transfer mechanism, conduction heat transfer, Thermal conductivity, Convection heat transfer, Radiation heat transfer, laws of heat transfer

Steady State Conduction: General heat conduction equation, Boundary and initial conditions, One-dimensional steady state conduction: the slab, the cylinder, the sphere, composite systems.

Unit 2

Thermal contact resistance, Critical radius of insulation, Electrical analogy, Overall heat transfer coefficient, Heat source systems, Variable thermal conductivity, Extended surfaces.

Unsteady State Conduction: Lumped system analysis, Biot and Fourier number, Heisler chart *(No numericals).*

Unit 3

Principles of Convection: Continuity, Momentum and Energy equations, Hydrodynamic and Thermal boundary layer for a flat plate and pipe flow. Dimensionless groups for convection, relation between fluid friction and heat transfer, turbulent boundary layer heat transfer.

Unit 4

Forced convection: Empirical relations for pipe and tube flow, flow across cylinders, spheres, tube banks.

Free Convection Free convection from a vertical, inclined and horizontal surface, cylinder and sphere.

Unit 5

Boiling & Condensation: Film-wise and drop-wise condensation, pool boiling regimes, forced convection boiling *(Internal flows).*

Introduction to Mass Transfer: Introduction, Mechanism of diffusion, Fick's law of mass transfer, mass diffusion coefficient.

Heat Exchangers: Types of heat exchangers, the overall heat transfer coefficient, Analysis of heat exchangers, the log mean temperature difference (LMTD) method, the effectiveness-NTU method, selection of heat exchangers, Introduction to TEMA standard.

Unit 6

Radiation Heat Transfer: Introduction, Thermal radiation, Black body radiation, radiation laws, Radiation properties, Atmospheric and Solar radiation, The view factor, Radiation heat transfer from black surfaces, gray surfaces, diffuse surfaces, Radiation shields and the radiation effect.

TEXTS:

- F.P. Incoropera & D.P. Dewitt, *Fundamentals of Heat and Mass Transfer,* Fifth Edition, John-Wiley, 1990
- S.P. Sukhatme, *A Textbook on Heat Transfer*, Tata McGraw Hill, Third Edition.

REFERENCES:

- Y.A. Cengel, *Heat Transfer - A Practical Approach*, Tata McGraw Hill, Third Edition, 2006.
- J.P. Holman. *Heat Transfer,* Ninth Edition, McGraw-Hill, 2004

Mechanical Measurements and Metrology

Unit 1: Introduction to Measurements

Introduction to measurements, Errors in measurements, Statistical analysis of experimental data, Regression analysis, correlation, estimation of uncertainty and presentation of data, design of experiments

Unit 2: Measurement of thermo-mechanical properties
Measurement of temperature, pressure, velocity, Measurement of heat flux, volume/mass flow rate, temperature in flowing fluids, Measurement of thermo-physical properties, radiation properties of surfaces, vibration and noise

Unit 3: Measurement of geometrical forms

Measurement of length, measurement of angle, Measurement of geometric forms, straightness, flatness, roundness, etc. Mechanical and optical methods - study of optical projectors, tool maker's microscope, and autocollimators, Measurement of screw threads and gears.
Unit 4: Limits, Fits and Tolerances
Systems of limits, fits and tolerances, Limit gauges and their design, In-process gages
Unit 5: Surface roughness measurement
Quantitative evaluation of surface roughness and texture, 2D and 3D surface roughness parameters, Introduction to CMM, probes for CMM, CMM Software
Unit 6: Inspection and quality monitoring
Inspection methods, Quality control techniques such as Control charts, process capability, acceptance sampling,

TEXTS:

1. Doeblin E.O., Measurements Stystems, Applications and Design, McGraw –Hill 1990
2. Jain R.K. Engineering Metrology, Khanna Publishers, Eighteenth edition,2002

REFERENCES

1. Beckwith Thomos, G, Buck, Mechanical Measurements, Narosa Publishing House, New Delhi.
2. Kumar D.S.Mechanical Measurements and Control, metropolitan, New Delhi.
3. Gayler J.F. and Shotbolt C.R. Metrology for Engineers, ELBS, Fifth Edition 1990
4. www. nptel. iitm/courses/ IIT Madras/ Mechanical/Measurements- Metrology/index.php

Quantitative Techniques in Project Management
(Elective II)

Unit 1

Introduction to Operations Research, Stages of Development of Operations Research, Applications of Operations Research, Limitations of Operations Research Linear programming problem, Formulation, graphical method, Simplex method, artificial variable techniques

Unit 2

Transportation Problem, North west corner method, Least cost method, VAM, Optimality check methods – Stepping stone, MODI method, Assignment Problem, Unbalanced assignment problems, Traveling salesman problem,

Unit 3

Queuing Theory: Classification of queuing models, Model I (Birth and Death model) M/M/I (∞, FCFS), Model II - M/M/I (N/FCFS)

Replacement Theory, Economic Life of an Asset, Replacement of item that deteriorate with time, Replacement of items that failed suddenly.

Unit 4

Inventory Control - Introduction to Inventory Management, Basic Deterministic Models, Purchase Models, Manufacturing Models without Shortages and with Shortages, Reorder level and optimum buffer stock, EOQ problems with price breaks.

Unit 5

Introduction: Difference between project and other manufacturing systems. Defining scope of a project, Necessity of different planning techniques for project managements, Use of Networks for planning of a project, CPM and PERT.

Unit 6

Time and Cost Estimates: Crashing the project duration and its relationship with cost of project, probabilistic treatment of project completion, Resource allocation and Resource leveling.

TEXTS

1. P.K. Gupta and D.S. Hira, Operations Research, S. Chand and Company Ltd. New Delhi,1996.
2. L.C. Jhamb ,Quantitative Techniques for managerial Decisions, vol.I and II , Everest Publishing House, Pune, 1994.
3. S.D. Sharma, Operations Research, Kedar Nath Ram Nath and Co. Meerut.

REFERENCES

1. H. Taha, Operations Research –An Introduction, Maxwell Macmillan, New York.
2. J.K. Sharma, Operations Research –An Introduction, Maxwell Macmillan, New Delhi.
3. Wagner Harvey M. Principles of Operations Research with Applications to Managerial Decisions, Prentice hall of India Private Ltd., New Delhi, Second Edition 2005.
4. Rubin & Lewin, Quantitative Techniques for Managers, Prentice -.Hall of India, New Delhi.

Mechanical Measurements & Metrology Lab

1. Calibration of pressure gauge using dead weight gauge calibrator
2. Measurement of displacement using LVDT
3. Calibration of strain gauge
4. Measurement of flow rate using orifice, venture and Rota meters and their error analysis
5. Measurement of flow rate using microprocessor based magnetic flow meter, vortex, ultrasonic, turbine flow meters
6. Determination of characteristics of thermocouples, RTD, themistors
7. To calibrate the given micrometer using slip gauge as standard
8. Measurement of taper by sine bar
9. To calibrate a dial gauge indicator
10. Study and use of optical flat
11. Surface roughness measurement
12. Tool makers' microscope
13. To measure the major, minor and effective diameter by using floating carriage diameter measuring machine
14. Inspection of gear by Gear Rolling Tester

Theory of Machines and Mechanisms Lab- I

List of Practicals:

1. **Four sheets** (half imperial size)

Graphical solution of problems on velocity, acceleration in mechanisms by relative velocity method, instantaneous centre of rotation method and Klein's construction. At least one problem containing Corioli's component of acceleration.

2. Experiments: (any 2)

a. Experimental determination of velocity and acceleration of Hooke's joint.
b Determination of displacement of slider-crank mechanism with the help of model and to plot velocity and acceleration curves from it.
c. Experiment on Corioli's component of acceleration.

3. Assignment:

Develop a computer program for velocity and acceleration of slider crank mechanism.

Thermal Engineering Lab – I

Any eight experiments from the list:

1. Determination of calorific value by Bomb calorimeter
2. Measurement of dryness fraction of steam using separating & throttling calorimeter.
3. Trial on boiler
4. Trial on convergent/convergent-divergent type) nozzle
5. Performance evaluation of steam turbine (Reaction / Impulse).
6. Performance evaluation of surface condenser.
7. Flue gas analysis using emission measuring instruments

8. Study & trial on single stage/two-stage reciprocating air compressor
9. Trial on centrifugal blower
10. Visit to appropriate industry to study and experience some of the above listed systems.

SEMESTER- VI

Manufacturing Processes –III

Unit 1: Introduction to Numerical control
Numerical Control - Introduction, Role of NC / CNC in CAM, Applications of NC / CNC, Benefits of NC / CNC, Limitations of CNC. Historical developments and their role in control of machine tools, Classification of NC / CNC systems - Based on type of Control (PTP\C\L)

Unit 2: Components of CNC system
Basic Components of CNC system, Machine control unit, Antifriction guideways, LM Guideways, Spindles, Ball screws

Unit 3: Machine tool drives and components
CNC Drives and controls- Servo motors, Stepper motors, Linear motors, CNC Tooling, Presetter, Tool and work holding devices, Automatic Tool Changers, Automatic Pallet Changers

Unit 4: CNC programming
Part programming - Introduction; Part Program and its elements, Methods of Programming - Manual and Computer Assisted Part programming - Custom Macro (Parametric Programming), APT and its variations, Concepts of CAM - Tool path generation and control methods.

Unit 5: Non-conventional machining – Thermo-mechanical type
Introduction and Abrasive Jet Machining, Ultrasonic Machining (USM), Water Jet and Abrasive Water Jet Machining, Electro Chemical Machining, Electro Discharge Machining, Electron Beam and Laser Beam Machining

Unit 6: Introduction to Micromachining
Ultrasonic micromachining, Electro discharge micromachining, Laser beam micromachining, Electro chemical micromachining

TEXTS:

1. P.N. Rao, CAD/CAM: Principles and Applications, Tata McGraw-Hill, Second edition, 2004
2. HMT Ltd, Mechatronics, Tata McGraw-Hill, New Delhi, 1998
3. P. K. Mishra, Non Conventional Machining, Narosa Publishing House, 2010

REFERENCES

1. James Madison, CNC Machining Handbook, Industrial Press Inc,1996
2. V. K. Jain, Editor, Introduction to Micromachining, Narosa Publishing House, New Delhi, 2010
3. Gary F. Benedict, Non Traditional Manufacturing Processes, Mercel Dekker, 1987
4. Amitabha Ghosh, A. K. Mallik, Manufacturing Science, Affiliated East West Press, 2000
5. www.nptel.com, IIT Khargapur, Manufacturing Processes, Module 9
6. www.nptel.com, IIT Madras, CNC Machines, Module 2, 3, 9 and 10.

Dynamics of Machines

Unit 1
Governors: Function of governor, Inertia and centrifugal type of governors, Controlling force analysis, Governor Effort and governor power, Sensitivity, stability, Isochronisms and Hunting, Friction insensitiveness.

Unit 2
Gyroscope: Principles of gyroscopic action, Precession and gyroscopic acceleration, gyroscopic couple, Effect of the gyroscopic couple on ships, aeroplanes and vehicles, inclined rotating discs, gyroscopic stabilization.

Unit 3
Mechanical Vibration: Single degree of freedom system, SHM, Undamped free vibrations, damped free vibrations, Types of damping.

Unit 4
Forced Vibration: Effect of excitation, Excitation due to reciprocating and rotating unbalance, Vibration isolation and transmissibility.
Critical Speeds: Whirling of vertical and horizontal shaft carrying single rotor with damped and un-damped system, Whirling speed of multi rotor shafts.

Unit 5
Torsional Vibrations: Single degree of freedom system Forced an free damped and undamped vibratins, Two rotor and three rotor system, Geared rotor system , Natural frequency , Modes of vibrations, Torsional dampers, Introduction to Holzer's method for multi rotor system.

Unit 6
Balancing: Balancing of rotating masses in one and several planes, Balancing of reciprocating, masses in single and multi cylinder engine viz, inclined, radial and v-type engines, Primary and secondary balancing analysis, Concept of direct and reverse cranks, Balancing of locomotive engines, Effect of partial balancing, Static and dynamic balancing.

TEXTS:

1. Rattan, S.S., Theory of Machines, Tata McGraw-Hill, New Delhi.
2. Thomas Beven, Theory of Machines, CBS Publishers, Delhi, 1984.
3. Kelly, Graham S., Mechanical Vibrations, Schaum's Outline Series, McGraw Hill, New York, 1996.
4. Rao, J.S., Introductory Course on Theory and Practice of Mechanical Vibration, New age International (P) Ltd, New Delhi, Second Edition, 1999.

REFERENCE:

1. Rao Singiresu, Mechanical Vibrations, Pearson Education, New Delhi, Fourth Edition 2004.
2. Shigley J.E. and Vicker J.J.(Jr.), Theory of machine and Mechanisms, McGraw Hill International, New York.
3. Holowenko, Dynamics of Machinery, Wiley International.

Machine Design- II

Unit 1

Design Against Fluctuating Loads: stress concentration, stress concentration factors, fluctuating stresses, fatigue failure, endurance limit, notch sensitivity, approximate estimation of endurance limit, design for finite life and finite life under reversed stresses, cumulative damage in fatigue, Soderberg and Goodman diagrams, fatigue design under combined stresses.

Unit 2

Rolling Contact Bearings: Types, Static and dynamic load carrying capacities, Stribeck's Equation, Equivalent load, load and life relationship, selection of bearing life, Load factor, selection of bearing from manufacturer's catalogue, Taper roller bearings and their selection, Cyclic loads and speeds, Design for probability of survival other than 90 % Lubrication and mountings of rolling contact bearings.

Unit 3

Sliding Contact Bearings: Methods of lubrication, Viscosity and its measurement, Effect of temperature, viscous flow through rectangular slot, Hydrostatic step bearing, Load capacity and energy losses, Reynolds equation, Ramondi and Boyd method, temperature rise, Constructional details of bearing, Bearing material, Lubrication oils, Additives and greases, Sintered metal bearings, Comparison of rolling and sliding contact bearings.

Unit 4

Spur Gears: Gear drives, Classification of gears, Law of gearing, Terminology of spur gear, Standard system of gear tooth force analysis, gear tooth failures, Selection of materials Constructional, Number of teeth, Face with, Beam strength equation, Effective load on gear tooth, Estimation of module based on beam strength, Design for maximum power capacity, Lubrication of gears.

Unit 5

Helical Gears: Terminology, Virtual number of teeth, Tooth proportions, Force analysis, Beam strength equation, Effective load on gear tooth, Wear strength equation.

Unit 6

Belt and Chain Drives: Flat and V belts, Geometric relationship , analysis of belt tensions, condition for maximum power, Selection of flat and V belts from manufacturer's catalogue, Adjustment of belt tensions. Roller chains, Geometric relationship, polygonal effect, power rating of roller chain, sprocket wheels, and Silent chains.

TEXTS:

1. Bhandari, V.B. Design of machine Elements, Tata McGraw Hill, New Delhi 1998
2. Nortan, R.L. Machine Design: An Integrated Approach, Pearson Education.

REFERENCES:

1. Shigley J.E.and Mischke C, Mechanical Engineering Design ,McGraw Hill Inc, New York, Sixth Edition ,2003
2. Juvinall R.C.Marshek K.M.Fundamentals of Machine Component Design , John Wiley & Sons,Inc, New York, 2002

3. Hall, Holowenko, Langhlin, "Theory and Problems of Machine Design" Schaum's outline Series, McGraw Hill Book Company, New York,1982
4. Hamrock B.J.jacobson N.Schmid S.R. Fundamentals of Machine Elements, McGraw Hill, International Editon ,New York, Second Edition ,2005

Internal Combustion Engines and Fluid Machinery

Unit 1

Momentum principle and its application

Impulse- momentum principle, Calculation of force exerted on fixed plate, moving flat plates & curved vanes, Calculation force exerted on series of moving vanes, velocity diagrams & their analysis.

Unit 2

Turbines

Classification, Various heads & efficiencies, Main components and constructional features of Pelton Wheel, Kaplan and Francis turbines, Velocity diagrams & analysis of Pelton, Francis turbines, Cavitation in water turbines, Governing mechanism, safety devices, Performance characteristics.

Unit 3

Pumps

Classification, Constructional details, working and selection of various types of (Reciprocating and Rotary) pumps and Compressors, Characteristics curves, Specific speeds, Introduction to Jet pumps and Submersible pumps.

Unit 4

Power Cycles: Valve timing diagrams, Fuel-Air cycles, deviation of actual cycles from ideal cycles

Combustion: Introduction, important qualities and ratings of SI Engines fuels; qualities and ratings of CI Engine fuels; dopes.

Combustion in S.I. Engines, flame speed, ignition delay, normal and abnormal combustion, effect of engine variables on flame propagation and ignition delay, Combustion in C.I. Engines, combustion of a fuel drop, stages of combustion, ignition delay, combustion knock; effect of engine variables on ignition delay/knock, Types of SI and CI Engine combustion chambers.

Unit 5

Various Engine Systems: Fuel Supply Systems, Engine cooling, Ignition system, Engine friction and lubrication Systems

Unit 6

Engine Testing and Performance of SI and CI Engines: Parameters, Type of tests and characteristic curves.

Super charging in IC Engine: Effect of attitude on power output, types of supercharging.

Engine Emissions & control: Pollutants from S.I. and C.I. engines and their control, emission regulations such as Bharat and Euro.

Alternate fuels for S.I. and C.I. engines

TEXTS:

1. Modi & Seth, *Fluid Mechanics and Hydraulic Machinery*, Standard Book House New Delhi, Tenth Edition, 1991.
2. Ganeshan, V., *Internal Combustion Engine,* Tata McGraw-Hill, New Delhi, Second Edition, 2003.

REFERENCES:

1. Jagdish Lal, *Hydraulic Machines*, Metropolitan Book Co. Pvt. Ltd.
2. S.K. Som and G. Biswas, *Introduction to Fluid Mechanics and Fluid Machines*, Tata McGraw-Hill, Second Edition, 2003.
3. Heywood, J.B., *Internal Combustion Engine Fundamentals*, McGraw-Hill, New York, International Edition, 1988

Manufacturing Processes Lab – II

Each student shall be required to complete and submit the manual for at least 6 experiments from the given list of experiments

1. Effect of type and work material on types of chips formed during oblique turning process.
2. Effect of process parameters on chip formation mechanism and chip morphology in oblique turning process
3. Effect of process parameters on surface roughness in external turning operation on CNC turning lathe
4. Study the effect of machining environment on machinability in terms of surface roughness and chip characteristic in turning
5. Effect of process parameter and cutting length on tool flank wears in CNC turning of aluminum alloy
6. Measurement of turning forces using cutting tool dynamometer in oblique turning process
7. Measurement of turning forces using cutting tool dynamometer in Milling process
8. To examine the effect of Process parameters on MRR and TWR in Ultrasonic Machining
9. Design of jigs
10. Design of fixtures

Machine Design Practice –I

1. The term work shall consist of two design projects based on the syllabus of Machine Design I and II .Each design project shall consist of two imperial size sheets- on e involving assembly drawings with a part list and overall dimensions and other sheet involving drawings of individual components. Manufacturing tolerances, surface finish symbols and geometric tolerances should be specified, wherever necessary, so as to make it working drawing .A design report giving all necessary calculations for the design of components and assembly should submitted in a separate file.

2. Two assignments based on topics of syllabus of Machine Design I and II

Internal Combustion Engines and Fluid Machinery Lab

A. Fluid Machines (Any four experiments from the list)

1. Trial to study hydraulic jump
2. Trial on Pelton Turbine for performance testing.
3. Trial on Francis Turbine for performance testing.
4. Trial on Kaplan Turbine for performance testing.
5. Trial on Centrifugal Pump with constant and variable speed.
6. Trial on Gear Pump/Reciprocating Pump for performance testing.
7. Visit to Hydel Power Plant

B. I C Engines (Any four experiments from the list)

1. Study of modern carburettor, fuel injector and pump, combustion chambers, engine cut sections etc.
2. Trial on Diesel engine- variable load test and energy balance.
3. Trial on Petrol engine- variable speed test and energy balance.
4. Trial on Petrol Engine- Morse Test.
5. Measurements of exhaust emissions of Petrol engine & Diesel engine.
6. Visit to Industry related to Automobiles.

Heat Transfer Lab

Any eight experiments from the list:

1. Determination of thermal conductivity of a metal rod.
2. Determination of thermal conductivity of insulating powder.
3. Determination of conductivity of a composite slab.
4. Temperature distribution on a fin surface.
5. Determination of film heat transfer coefficient for nature convection.
6. Determination of film heat transfer coefficient for forced convection.
7. Determination of heat transfer coefficient for cylinder in cross flow in forced convection.
8. Performance of Double pipe Heat Exchanger / Shell and Tube Heat Exchanger.
9. Determination of emissivity of a metal surface.
10. Determination of Stefan Boltzman's constant.
11. Determination of critical heat flux.
12. Calibration of measuring instruments pressure gauge, thermocouple, flow-meter etc.

Technical Project on Community Services

Rationale:

The role of technical institutes in giving technical and advisory services to the surrounding community need not be emphasized. It is desirable faculty members and students be involved in rendering services to community and economy. Moreover, as envisaged in the Act of this University, technical services to community, particularly the backward areas, is one of the basic objects of the University. In view of this, "Technical Project on Community Services" has been included in the curriculum. This will ensure the participation of each student as well as faculty in the Department in this activity. The nature of this mini-project will be as follows:

Course Contents:

The projects may be of varying nature such as a technical study/survey, design/development of an "appropriate technology" solution for an identified need, infusion/transfer of technology, etc. For instance, projects can be done on topics such as development of a low-cost mango harvester, bike- and hand-powered water pump, ground nut stripping devise, cashew nut breaker, snake catching devise and energy efficient chulha, to name a few.

All this will be within the ambit of technology, expertise and resources available within the Department and the University. The student may form small groups, typically of 2 to 3 students, and carry out the project under the supervision of a faculty member.

Industrial Training (Four Weeks)

Guidelines for Industrial Training

- Name of the organization, address, contact details, owner / proprietor / chairman / president
- Vision/mission/values/objectives of the organization
- Brief history of the organization
- Products/Services, Technical specifications of products, Product applications,
- Market demand, Competitors of the company
- Company turnover / future plans for expansion
- Branches
- Marketing offices
- Organization structure/chart
- Various departments in the organization & their functions (in brief)
- Describe in brief various production processes / operations that are carried out to convert raw material into finish products. Draw suitable figures/sketches wherever possible.
- Assembly/methods of assembly
- Plant layout
- Production planning & control
- Industrial engineering / productivity improvement
- Quality management /assurance
- Plant maintenance
- Human resource management / incentives / employee welfare
- Safety management / environmental aspects /energy auditing
- Case studies/ hands-on experience
- Any other relevant information

Note: These are only guidelines. The students may include any other appropriate and relevant topic while undergoing the training. It is possible that the students interested in doing industry-related projects in the final year may get a suitable topic for the project during the training.

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DEPARTMENT OF MECHANICAL ENGINEERING

Effective from 2013 - 2014

Semester VII

Code	Subject	L	P	C	TW	OR	MSE	ESE
	CAD/CAM	3	0	6			30	70
	Machine Design-III	3	0	6			30	70
	Refrigeration & Air-conditioning	3	0	6			30	70
	Elective-IV	3	0	6			30	70
	Manufacturing Processes Lab-III	*0*	*4*	*4*	*50*	*50*		
	Theory of Machines & Mechanisms Lab-II	*0*	*2*	*2*	*50*	*50*		
	CAD/CAM Lab	*0*	*2*	*2*	*50*	*50*		
	Seminar		*2*	*4*	*50*	*50*		
	*Industrial Training**			*4*	*50*	*50*		
	Project Stage-I		*2*	*4*	*50*	*50*		
		12	*12*	*44*	*300*	*300*	*120*	*280*

* *Evaluation of Four weeks Industrial Training*

Elective IV:

- Engineering Tribology
- Piping Engineering (also open to Chem/Pertro/Civil)
- Tool Condition Monitoring
- Robotics
- Manufacturing Automation
- Computational Fluid Dynamics (also open to Chem/Pertro)
- Biomechanics
- Failure Analysis and Design
- Advanced Methods in Engineering Design
- Machine Tool Design
- Alternative Fuels and Advances in I.C. Engines
- Numerical Heat Transfer (also open to Chem/Pertro)
- Nanotechnology (open to all)
- Heat Exchanger Design (also open to Chem/Pertro)
- M. Tech. subjects**

*** Students opting for M. Tech Course as Elective IV and V will be awarded 4 additional credits.*

Semester VIII

Code	Subject	L	P	C	TW	OR	MSE	ESE
	Mechatronics	3	0	6			30	70
	Power Plant Technology	4	0	8			30	70
	Industrial Engineering & Management	4	0	8			30	70
	Elective-V	3	0	6			30	70
	Refrigeration AC & Renewable Energy Lab	*0*	*2*	*2*	*50*	*50*		
	Mechatronics Lab	*0*	*2*	*2*	*50*	*50*		
	Machine Design Practice II	*0*	*2*	*2*	*50*	*50*		
	Project Stage-II		*4*	*8*	*50*	*50*		
		14	*10*	*42*	*200*	*200*	*120*	*280*

Elective V

- Tool Design
- Process Equipment Design
- Surface Engineering
- Manufacturing Planning and Control
- Automobile Engineering
- Experimental Stress Analysis (also open to Civil)
- Product Life-cycle Management (open to all)
- Design for Quality (open to all)
- Analysis and Synthesis of Mechanisms
- Finite Element Method (also open to Chem/Pertro)
- Advanced Refrigeration (also open to Chem/Pertro)
- Advanced Power Generation (also open to Electrical)
- Cryogenic Systems (also open to Chem/Pertro)
- M. Tech. subject**

*** Students opting for M. Tech Course as Elective IV and V will be awarded 4 additional credits.*

SEMESTER- VII

Computer Aided Design and Manufacturing

Unit 1

Computer Aided Design (CAD): Hardware required for CAD: Interactive input output devices, Graphics software: general requirements and ground rules, 2D curves like Line, Circle, etc and their algorithms, 2D and 3D transformations such as Translation, Scaling, Rotation and Mirror

Unit 2

Bezier and B-splines curves: equations and Applications, window and view port clipping algorithms, 3D geometries, CSG, B-rep, wire frame, surface and solid modeling and their relative advantages, limitations and applications,

Unit 3

Computer Aided Manufacturing (CAM): Numerical Control, Elements of a NC system, Steps in NC based manufacturing, Point to point, straight line and contouring control, Manual and Computer Assisted Part Programming, NC and APT programming, Adaptive control, Distributed Numerical Control.

Unit 4

Finite Element Methods: Introduction, Types of elements, Degrees of freedom, Field variable, Shape function, Boundary conditions, Meshing, Nodal displacements, Plain stress and plain strain problems, 1D, 2D and 3D problems, Static, dynamic and thermal analysis, Preprocessors – solvers – postprocessor

Unit 5

Flexible manufacturing System: Introduction, Components of FMS, Group Technology, Part classification and families, Composite part, Types of FMS layouts, Advantages of FMS

Robotics: Robot configurations, Drives for robots, Sensors used in robotics, Programming technique, Programming languages, Applications, Latest development in robotics

Unit 6

Computer Aided Process Planning: Introduction, Retrieval and Generative CAPP systems, generation of Machining Data

Computer Integrated Manufacturing: Introduction, Types of data, Types of interfaces, Computer network structures, Computerized production management systems, Inventory management, MRP, Operation scheduling, Process monitoring, Computer aided quality control, Testing/Inspection methods.

Texts/References:

1. Zeid, Ibrahim, CAD/CAM Theory and Practice, Tata McGraw Hill Publication.
2. Grover, M.P., Zeemer, CAD/CAM/CIM, Prentice Hall, India.
3. www.nptel.com

Machine Design – III

Unit – I

Bevel gears: Type of bevel gears, Terminology of straight bevel, force analysis, Beam and wear strength, effective load on gear tooth.

Worm gears: Terminology, proportions, force analysis, friction in worm gears, vector method, selection of materials, strength and wear rating, thermal considerations.

Unit – II

Flywheel: Introduction, types of flywheel, stresses in disc and armed flywheel.

Unit – III

Brakes and clutches: Types of clutches, torque capacity, single and multi-plate clutches, cone clutch, centrifugal clutch, friction materials.

Types of brakes, energy equation, block with shoe brake, pivoted brake with long shoe, internal expanding shoe brake, thermal considerations.

Unit – IV

Statistical considerations in design: Deterministic and probabilistic designs, random variables, mean, mode, median, variance, standard deviation, regression, normal distribution, population combination, design and natural tolerance, reliability concept and study.

Unit – V

Pressure vessel: thin cylinders, thick cylinders, principal stresses, Lame's equation, Clavirino and Birnie's equation, cylinder with external pressure, autofrettage, compounding of cylinders, gasketed joint, unfired pressure vessel, thickness of cylindrical and spherical pressure shells, end closure, opening in pressure vessel, area compensation method

Unit –VI

Design optimization:

Introduction to optimization, engineering applications, statement of optimization problem, classical optimization technique, single variable optimization.

Texts:

1. Bhandari, V. B., Design of Machine elements, Tata McGraw Hill, New Delhi
2. Nortron R. L., Machine Design: Integrated approach, Pearson education.

References:

1. Shigley J. E. & Mischke C. Mechanical Engineering Design, McGraw Hill Inc. New York, 6^{th} Edition.
2. Burr, A.H. and Cheatham, J. B., Mechanical Analysis and Design, Prentice Hall of India Private Ltd., New Delhi, 2^{nd} Edition, 2001.
3. Juvinall R. C. and Marshek K. M. Fundamentals of Machine Component Design, John Wiley & sons, Inc, New York.
4. Hall, Holowenko, Langhlin "Theory and Problems in Machine Design" Schaum's outline series, McGraw Hill book company, New York, 1982.

5. Hamrock B. J. , Jacobson N., & Schmid S.R. Fundamental of Machine Elements, McGraw Hill, International edition, New York, Second edition, 2005
6. www.nptel.com

Refrigeration and Air-Conditioning

Unit 1

Introduction: History, Fundamentals of refrigeration, Unit, Applications, Methods of producing cooling, Refrigeration systems, Thermodynamics of Refrigeration, Primary and secondary refrigeration, Heat Pump

Air Refrigeration System: Bell-Coleman cycle, air craft refrigeration, necessity, air craft refrigeration systems, Liquidation of gases

Unit 2

Vapour Compression System: Thermodynamics analysis, theoretical and actual cycle, use for P-h and T-s charts for problem solving, C.O.P., effect of evaporator and condenser temperature on cycle performance, effects of suction superheating.

Liquid sub-cooling, liquid-vapour heat exchanger, estimation of compressor displacement, C.O.P. and power requirement, waste heat recovery opportunities

Unit 3

Compound Vapour Compression System: Multi-evaporator, multi-compressor systems, cascade system (no mathematical treatment).

Vapour Absorption System: Aqua-ammonia system, lithium bromide-water system, electrolux refrigerator, comparison with vapour compression cycle (descriptive treatment only), P-T-ξ chart, thermodynamic analysis and capacity control, Solar refrigeration system

Unit 4

Refrigerants for Vapour Compression System: Desirable properties, selection, Zeotrops and Azeotropes, necessity for replacement of CFC refrigerants, natural refrigerants

Air Conditioning: Psychrometry, properties of moist air, psychrometric chart.

Thermal comfort: Heat transfer from human body by sensible and latent heat transfer. Metabolic heat generation, steady state model for heat transfer, effect of clothing and definition of effective temperatures, comfort conditions, human comforts, comfort chart

Unit 5

Air Conditioning Process Calculations: Sensible and latent heat loads SHF, GSHF, RSHF, out side conditions, indoor conditions, estimation of coil capacity required, bypass factor, evaporative cooling.

Unit 6

Distribution of Air: Principle of air distribution, duct design methods, friction chart, duct materials, methods of noise control.

All air System, all water system, unitary systems; window air-conditioner, split air-conditioners, refrigeration and air conditioning controls.

Texts:

1. Arora, C.P., Refrigeration and Air Conditioning, Tata McGraw Hills, New Delhi, Second Edition, 2000.
2. Stoeker, W.F. and Jones, J.P., Principles of Refrigeration and Air Conditioning, McGraw Hill, New York, Second Edition, 1982.

References:

1. ASHRAE Handbook - Fundamentals and Equipment, 1993.
2. ASHRAE Handbook – Applications, 1961.
3. ISHRAE Handbook
4. NPTL Lectures by Prof. RamGopal, IIT Kharagpur
5. Carrier Hadbook
6. Jordan, R.C. and Priester, G.B., Refrigeration and Air Conditioning, Prentice – Hall of India Ltd., New Delhi, 1969
7. Threlkeld, J. L., Thermal Environmental Engineering, Prentice Hall, New York, 1970.
8. www.nptel.com

Elective-IV

Engineering Tribology

Unit 1

Introduction: Definition of tribology, friction, wear and lubrication, importance of the tribological studies.

Surface Topography: Methods of assessment, measurement of surface roughness-different statistical parameters (R_a, R_z, R_{max}, etc.), contact between surfaces, deformation between single and multiple asperity contact, contact theories involved

Unit 2

Friction: Coulomb and Amontons laws of friction, its applicability and limitations, comparison between static, rolling and kinetic friction, friction theories, mechanical interlocking, molecular attraction, electrostatic forces and welding, shearing and ploughing, models for asperity deformation.

Unit 3

Lubrication: Types of lubrication, viscosity, characteristics of fluids as lubricant, hydrodynamic lubrication, Reynold's equation, elastohydrodynamic lubrication- partial and mixed, boundary lubrication, various additives, solid lubrication.

Unit 4

Wear: Sliding wear: Abrasion, adhesion and galling, testing methods pin-on-disc, block-on-ring, etc., theory of sliding wear, un-lubricated wear of metals, lubricated wear of metals, fretting wear of metals, wear of ceramics and polymers. Wearing by plastic deformation and brittle fracture. Wear by hard particles: Two-body abrasive wear, three-body abrasive wear, erosion, effects of hardness shape and size of particles.

Unit 5

Wear and Design: Introduction, estimation of wear rates, the systems approach, reducing wear by changing the operating variables, effect of lubrication on sliding wear, selection of materials and surface engineering. principles and applications of tribodesign.

Unit 6

Materials for Bearings: Introduction, Rolling bearings, Fluid film lubricated bearings, marginally lubricated and dry bearings, gas bearings.

Texts:

1. Hutchings I.M., Tribology, Friction and Wear Engineering Materials, Edward Arnold, London.
2. Gunther R.C., Lubrication, Baily Brothers and Swinfen Limited.
3. Barwell F.T., Bearing Systems, Principles and Practice, Oxford Univercity Press.

References:

1. Majumdar B.C., Introduction to Tribology of Bearings, A.H. Wheeler & Co. Private Limited, Allahabad.
2. Dudley D.F., Theory and Practice of Lubrication for Engineers, John Willey and Sons.
3. Halling J., Principles of Tribology, McMillan Press Limited.
4. Cameron Alas Tair, Basic Lubrication Theory, Wiley Eastern Limited.
5. Neale M.J., Tribology Hand book, Butterworths.
6. Fuller D.D., Lubrication.

Robotics

Unit 1:

Introduction, robot configurations, Robot Anatomy

Basic Components of Robot Systems: Manipulators, end effectors, sensors, controllers etc.

Unit 2

Mechanical System in Robotics: Robot motion analysis and control, Homogeneous transformations and robot kinematics, Kinematic chains, position analysis.

Unit 3

Drives for Robot: Stepper motor, DC motors, AC motors, hydraulic and pneumatic systems, drive selection for robotics joints

Sensors in Robotics: Position sensor, velocity sensor, proximity sensors, touch sensors, force sensors.

Unit 4

Robot Programming: Path planning, introduction to programming languages, such as AL, AML, RAIL, RPL, VAL

Unit 5

Applications: Application of robots in Material Handling, process operations and Assembly and inspection

Unit 6

Robot Implementation Issues: Approach for implementing Robotics, Safety, Training and Maintenance

Social Aspects of Robotics

TEXTS:

1. M. P. Grroover, Industrial Robotics: Technology, Programming and Applications, McGraw-Hill International Editions

REFERENCES:

1. Y. Koren, Robotics for Engineers, McGraw Hill International Editions
2. Saeed B. Niku, Introduction to Robotics, Analysis, Systems, Applications, Pearson Education
3. Richard D. Klafter, at.el., Robotic Engineering: An Integrated Approach, Prentice Hall of India

Computational Fluid Dynamics

Unit 1

Introduction to Computational Fluid Dynamics and Principles of Conservation: Computational Fluid Dynamics: What, When, and Why?, CFD Applications, Numerical vs Analytical vs Experimental, Modelingvs Experimentation, Fundamental principles of conservation, Reynolds transport theorem, Conservation of mass, Conservation of linear momentum: Navier-Stokes equation, Conservation of Energy, General scalar transport equation

Classification of Partial Differential Equations and Physical Behaviour: Mathematical classification of Partial Differential Equation, Illustrative examples of elliptic, parabolic and hyperbolic equations, Physical examples of elliptic, parabolic and hyperbolic partial differential equations

Unit 2

Approximate Solutions of Differential Equations: Error Minimization Principles, Functional involving higher order derivatives, Approximate solution of differential equations through variational formulation, Boundary conditions in the variational form: Primary and secondary variables, Essential and natural boundary conditions, Approximate solutions of differential equations, Properties of variational form, Weighted residual approach: trial function and weighting function, Requirement of trial function and weighting function, Least square method, Point Collocation method, Galerkin's method, Rayleigh-Ritz method

Fundamentals of Discretization: Discretization principles: Pre-processing, Solution, Post-processing, Finite Element Method, Finite difference method, Well posed boundary value problem, Possible types of boundary conditions, Conservativeness, Boundedness, Transportiveness, Finite volume method (FVM), Illustrative examples: 1-D steady state heat conduction without and with constant source term

Unit 3

Finite Volume Method: Some Conceptual Basics and Illustrations through 1-D Steady State Diffusion Problems: Physical consistency, Overall balance, FV Discretization of a 1-D steady state diffusion type problem, Composite material with position dependent thermal conductivity, Four basic rules for FV Discretization of 1-D steady state diffusion type problem, Source term linearization, Implementation of boundary conditions

Discretization of Unsteady State Problems:1-D unsteady state diffusion problems: implicit, fully explicit and Crank-Nicholson scheme

Important Consequences of Discretization of Time Dependent Diffusion Type Problems: Consequences of time-discretization in finite discretization, Consistency, Stability,

Convergence, LAX Equivalence theorem, Grid independent and time independent study, Stability analysis of parabolic equations (1-D unsteady state diffusion problems): FTCS (Forward time central space) scheme, Stability analysis of parabolic equations (1-D unsteady state diffusion problems): CTCS scheme (Leap frog scheme), Dufort-Frankel scheme, Stability analysis of hyperbolic equations: FTCS, FTFS, FTBS and CTCS Schemes, Stability analysis of 2nd order hyperbolic equations: CTCS scheme

Finite Volume Discretization of 2-D unsteady State Diffusion type Problems:FVM for 2-D unsteady state diffusion problems

Unit 4

Solution of Systems of Linear Algebraic Equations: Criteria for unique solution, infinite number of solutions and no solution, Solution techniques for systems of linear algebraic equations: Elimination, Iteration and Gradient Search method, Elimination method: Forward elimination and backward substitution, Assessment of number of computations, L-U decomposition technique, Tridiagonal matrix algorithm (TDMA): Thomas algorithm, Illustrative examples, Norm of a vector, Norm of a matrix, Some important properties of matrix norm, Error analysis of elimination methods, Iteration methods: Jacobi's method and Gauss Siedel method, Generalized analysis of the iterative methods, Sufficient condition for convergence, Rate of convergence, Scarborough criteria of sufficient condition for convergence in Gauss Siedel Method, Illustrative examples of Jacobi's method and Gauss-Siedel method, Relaxation methods, Preferential characteristics of iterative methods, Multigrid method, Line by line TDMA, ADI (Alternating direction implicit) method, Gradient search methods: Steepest descent method and Conjugate gradient method.

Unit 5

Discretization of Convection-Diffusion Equations: A Finite Volume Approach: Finite volume discretization of convection-diffusion problem: Central difference scheme, Upwind scheme, Exponential scheme and Hybrid scheme, Power law scheme, Generalized convection-diffusion formulation, Finite volume discretization of two-dimensional convection-diffusion problem, The concept of false diffusion, QUICK scheme.

Discretization of Navier Stokes Equations: Discretization of the Momentum Equation: Stream Function-Vorticity approach and Primitive variable approach, Staggered grid and Collocated grid, SIMPLE Algorithm, SIMPLER Algorithm.

Unit 6

Unstructured Grid Formulation: Discretization of the Momentum Equation using unstructured grid.

What is there in implementing a CFD code?: The basic structure of a CFD code: Pre-processor, Solver and Post-processor, User-defined-subroutines, Solution to some basic problems in heat transfer and fluid flow

Introduction to Turbulence Modeling: Important features of turbulent flow, Vorticity transport equation, Statistical representation of turbulent flows: Homogeneous turbulence and isotropic turbulence, General Properties of turbulent quantities, Reynolds average Navier stokes (RANS)

equation, Closure problem in turbulence: Necessity of turbulence modeling, Different types of turbulence model: Eddy viscosity models, Mixing length model, Turbulent kinetic energy and dissipation, The κ-ε model, Advantages and disadvantages of κ-ε model, More two-equation models: RNG κ-ε model and κ-ω model, Reynolds stress model (RSM),Large eddy Simulation (LES),Direct numerical simulation (DNS)

References:

1. S. V. Patankar, Numerical Heat Transfer and Fluid Flow, McGraw-Hill.
2. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press.
3. H. K. Versteeg& W. Malalasekera, An Introduction to Computational Fluid Dynamics, Longman Scientific & Technical.
4. J. H. Ferziger and M. Peric, Computational Methods for Fluid Dynamics, Springer.
5. John C. Tannehill, Dale A. Anderson and Richard H. Pletcher, Computational Fluid Mechanics and Heat Transfer, Taylor &Francis.
6. John D. Anderson Jr, Computational Fluid Dynamics, McGraw Hill Book Company.
7. J. Blazek, Computational Fluid Dynamics:Principles and Applications, Elsevier.
8. http://www.nptel.iitm.ac.in/syllabus/112105045/

Failure Analysis and Design

Unit 1

Theories of Failure: Maximum shear stress theory, Maximum normal stress theory, Maximum distortion energy theory, Maximum strain theory, Applicability of theories of failure.

Unit 2

Fracture: Type of fracture, Theoretical cohesive strength of metals, Griffith theory of brittle fracture, fracture single crystals, Metallographic aspects of fracture, Dislocation theories of brittle fracture, Ductile fracture, Notch effects, Fracture under combined stresses.

Unit 3

Elements of Fracture Mechanics: Strain- energy release rate, Stress intensity factor, Fracture toughness, Plane - strain toughness testing, Crack-opening displacement, J- Integral to solve energy of crack formation, R-curves, Toughness of material.

Fatigue Failure: Stress cycle, S-N curve, Description of fatigue fractured parts, Phases of fatigue fracture, Fatigue crack propagation, Effects of metallurgical variables, Temperature, Stress concentration, Size and surface factors, Fatigue under combined stresses.

Unit 4

Creep Failure: Creep curve, Structural changes and mechanisms during creep, Activation energy for steady-state creep, Fracture at elevated temperature.

Brittle Fracture: Transition temperature curves, Fracture analysis diagrams, Various types of embitterment, Fracture under very rapid loading.

Unit 5

Ductile Fracture: Condition for necking, Dislocation and void formation activities, Types of fractured parts.
Assessment of Types of Fractures by Observation: Comparison between different fractured parts undergoing various type of fracture.

Unit 6
Design Application of the Knowledge of Failure: Design considering fatigue-Geber's parabola, Soderberg equation, Lubricating optimally to combat bearing failures. Selection of materials to prevent seizure, galling, etc. Wear reduction techniques, Fracture toughness consideration in design.

Texts/ References:

1. Madoyag, F., Metal Fatigue Design and Theory.
2. Sors, L., Fatigue Design of Machine Components, Pergamon Press.
3. Rolfe, S.T. and Barson, J.M., Fracture and Fatigue Control Structures, Prentice Hall.
4. Broek,D., Elementary Engineering Fracture Mechanics, Noordnoff.
5. Dieter, G.E., Mechanical Metallurgy, McGraw Hill Book Co., New Delhi.

Advanced Methods in Engineering Design

Unit 1
Engineering Optimisation: Engineering applications of optimisation, statement of optimisation problem, classification of optimisation problem, Classical optimisation-Introduction, single variable optimisation, multivariable optimisation with no constraint, equality constraint, inequality constraint, Linear programming problem, unconstrained optimisation problem

Unit 2
Theory of Plates: The elasticity approach, assumptions of classical plate theory, moment curvature relations, equilibrium equations, governing biharmonic equation, boundary conditions, solution of problem, strain energy of plate, analysis of rectangular plate using Navier's and Levy's methods.

Unit 3
Fracture Mechanics: Introduction to linear elastic fracture mechanics, modes of fracture, stress intensity factor, crack initiation and crack opening phenomenon, stress distribution around the crack tip under various loading conditions, fracture toughness G_{Ic} , R-curves, critical strain energy release rate.

Unit 4
Fatigue Failure: Stress cycles, S-N curve, Goodman diagram, description of fatigue fractured parts, fatigue curve, fatigue crack propagation, low cycle fatigue, high cycle fatigue, mechanism of fatigue failure, effects of various variables on fatigue, fatigue under combined stresses.
Creep Failure: Creep curve, structural changes and mechanisms during creep, activation energy for steady-state creep, fracture at elevated temperature.

Unit 5

Design of Composites: Basic concepts and terminology, classification, advantages and limitations, Hooke's law for anisotropic, monoclinic, orthotropic, specially orthotropic, transversely isotropic and isotropic materials, Hooke's law for 2-D unidirectional lamina

Unit 6

Design for Reliability: Reliability definition, failure, failure density, failure rate, hazard rate, mean time to failure, MTBF, maintainability, availability, pdf, cdf, safety and reliability, quality assurance and reliability, bath tub curve, stress strength interaction

Texts/ References:

1. S.S. Rao, Engineering Optimization-Theory & Practice, New Age Int. Publication
2. R. Ganguli, Engineering Optimization-A Modern Approach, Universities Press
3. T.K. Vardan and K. Bhaskar, Analysis of Plates-Theory and Problems, Narosa Publishing
4. House
5. S.P. Timoshenko and S. Woinowsky-Krieger, Theory of Plates and Shells, Tata McGraw
6. Hill Book Company
7. T.L. Anderson, Fracture Mechanics-Fundamentals and Applications, CRC Press
8. D Broek, Elementary Engineering Fracture Mechanics, Noordnoff
9. G.E. Dieter, Mechanical Metallurgy, McGraw Hill Book Company
10. R.M. Jones, Mechanics of Composites, Taylor and Francis Inc.
11. D. Hull and T.W. Clyne, An Introduction to Composite Materials, Cambridge University
12. Press
13. L.P. Kollar and G.S. Springer, Mechanics of Composite Structure, Cambridge University
14. Press
15. J.N. Reddy, Mechanics of Laminated Composite Plates and Shells-Theory and Analysis,
16. CRC Press
17. L.S. Srinath, Concepts of Reliability Engineering, Affiliated East-West Press (P) Ltd.
18. A.K. Govil, Reliability Engineering, Tata McGraw- Hill Publishing Co. Ltd.

Alternative Fuels and Advances in IC Engines

Unit 1

Petroleum based liquid fuels and refining, Liquid alternative Fuels, Advantages, potential, problems associated with utilization,

Unit 2

Vegetable oils, Biodiesel, Emulsified fuels, Effect on Lubricating oils, Gaseous fuels

Unit 3

Combustion and Fuels, Combustion process in SI and CI engines.

Unit 4

Alternative Fuels, Hydrogen, Compressed Natural Gas, Liquified petroleum Gas, Di-methyl ether, Hythane, Multi-fuel engines.

Unit 5

Modern developments in IC Engines: EGR, MPFI, GDI, HCCI, Turbocharged engines, Optical Measurement techniques, Fuel atomization and spray visualization techniques, Laser Doppler and Anemometry, Particle image velocimetry, 3D and Holographic PIV, optical engines,

Unit 6
Sources and Nature of various types of pollutants: Pollution monitoring instruments and techniques, Control measures, emission legislations.

Texts:

1. V Ganesan, Internal Combustion Engines, Tata McGraw-Hill Publishing Co.
2. J.B. Heywood, Internal Combustion Engine Fundamentals, McGraw Hill International Editions, 1989.
3. B. P. Pundir, Engine Emissions: Pollutant Formation and Advances in Control Technology, Narosa Publishing House, New Delhi, 2007.
4. Handbook of Air Pollution from Internal Combustion Engines: Pollutant Formation and Control, Ed. Eran Sher, Academic Press, 1998.

References:

1. Internal Combustion Engines by E F Obert.
2. Internal Combustion Engine Handbook, Ed. Richard Van Basshuysen and Fred Schafer, SAE International, 2004.
3. C.R. Ferguson, A. T. Kirkpatrick, Internal. Combustion Engines, 2nd Edition, John Wiley & Sons, 2001.

Numerical heat transfer

Unit 1
Introduction: Basic approach in solving a problem by Numerical Methods, Finite difference method, Method of descritization, control volume approach, Numerical error, Grid independence test

Unit 2
Partial Differential equations: Classification of PDEs, Elliptic, Parabolic and Hyperbolic Equations, Initial and Boundary conditions, Initial and boundary value problems

Unit 3
Numerical Methods for conduction heat transfer (Part 1): Application of heat conduction, steady and unsteady heat conduction, Dimensionality in conduction, Basic approach in Numerical Heat conduction, one dimensional steady state problem

Unit 4
Numerical Methods for conduction heat transfer (Part 2): Two dimensional problems, Transient one dimensional problem, Eular, crank – Nicholson and pure implicit method, stability

Unit 5

Numerical methods for incompressible fluid flow: Introduction, Governing equations, Navier Stokes Equations, Stream function velocity method, general algorithm inviscid flow

Unit 6

Numerical methods for convection heat transfer: Introduction, Convection diffusion, Thermal boundary layer flow, transient free convection

Texts:

1. P S Ghoshdastidar, Computer Simulation of Flow and heat transfer, Tata McGraw Hill New Delhi
2. M. Necati Ozisik, Finite Difference Methods in Heat transfer, CRC Press.
3. Suhas V Patankar, Numerical Heat Transfer and Fluid Flow, McGraw Hill Book Company.
4. Varsteeg and Malalasekera, An introduction to Computational Fluid Dynamics The finite volume method, Pearson Prentice hall

Heat Exchanger Design

Unit 1

Introduction: Classification, overview of heat exchanger design methodology, Design specifications, thermo hydraulic design, and other considerations.

Unit 2

Basic design theory: LMTD method, ε-NTU method, P-NTU method, ψ-P method and P1-P2 method.

Unit 3

Heat exchanger design procedures: Design of double pipe, shell and tube, tube fin, plate type and plate-fin heat exchanger.

Unit 4

Selection of heat exchangers: selection criteria, general selection guidelines of shell and tube heat exchanger, plate type heat exchanger.

Unit 5

Header design: Flow mal-distribution, fouling and corrosion, advances in heat exchangers.

Unit 6

Introduction to Mechanical Design of Heat Exchanger. Use of codes and standards for Mechanical Design.

Texts/ References:

1. R.K.Shah and Deusan P.Sekulic, *Fundamentals of heat exchanger design*, 2003, John Willeyand Sons.
2. S. Kakac, Heat *Exchangers – Thermal Hydraulic Fundamentals and Design*, Hemisphere, Mc Graw-Hill.

3. D. Q. Kern and A. D. Kraus; *Extended Surface Heat transfer*, McGraw-Hill.

Manufacturing Processes Lab – 3

Each student shall be required to complete and submit the manual for at least 7 experiments from the given list of experiments. Each experiment will last for 2 turns.

1. To develop a manual part program of a given component on CNC Lathe using G and M codes.
2. To develop a manual part program of a given component on CNC Lathe using stock removal cycle.
3. To develop a manual part program of a given component on CNC Lathe using canned cycle.
4. To develop a manual part program of a given component on CNC Milling machine using G and M code.
5. To develop a manual part program of a given component on CNC Milling machine using pocket milling cycles.
6. To develop a manual part program of a given component on CNC Milling machine using canned drilling cycle.
7. To examine the effect of electrical parameters on MRR and TWR in electro discharge machining.
8. Experiments on micromachining using Photo Chemical Machining.
9. Machining accuracy in EDM.
10. Machining accuracy in PCM.

Theory of Machines Laboratory – II

Term work should consist of total 10 experiments from the below given list.

1. Study of various types of gear boxes such as Industrial gear box, Synchromesh gear box, Differential gear box, etc.
2. To draw conjugate profile for any general shape of gear tooth
3. To generate gear tooth profile and to study the effects under cutting and rack shift using models
4. To draw cam profile for various types of follower motions
5. To study various types of lubricating systems
6. To study various types of dynamometers
7. To determine speed vs. lift characteristic curve of a centrifugal governor and to find its coefficient of insensitiveness and stability.
8. Verification of principle of gyroscope and gyroscopic couple using motorized gyroscope
9. Study of any tow gyro-controlled systems
10. To study the dynamic balancing machine and to balance a rotor such as a fan or the rotor of electric motor or disc on the machine
11. To determine the natural frequency of damped vibration of a single degree of freedom system and to find its damping coefficient
12. To verify natural frequency of torsional vibration of two rotor system and position of node
13. To determine critical speed of a single rotor system

14. To determine transverse natural frequency of a beam experimentally using frequency measurement setup
15. To determine the frequency response curve under different damping conditions for the single degree of freedom system
16. To study shock absorbers and to measure transmissibility of force and motion.
17. Study of epicyclic gear train and its dynamic behaviour.

CAD/CAM Lab

1. Part modeling of machine elements using any one of the CAD software out of ProE, CATIA, Unigraphics or Autodesk Inventor Professional.
2. Assembly modeling of assembly or subassembly of engineering products using any one of the CAD software out of ProE, CATIA, Unigraphics or Autodesk Inventor Professional.
3. Drafting of Parts and Assembly of a engineering assembly using any one of the CAD software out of ProE, CATIA, Unigraphics, or Autodesk Inventor Professional.
4. Minimum 4 structural analysis problems to be solved using a CAE software like Ansys, Hyperworks, etc.
5. Minimum 2 Jobs (Programs) on CNC Turning operations
6. Minimum 2 Jobs (programs) on CNC Milling operation
7. Case Study of an Industrial Robot

Semester VIII

Mechatronics

Unit 1

Introduction to Mechatronic systems, elements, advantages and practical examples of mechatronic systems.

Sensors and Transducers: Various types of sensors and transducers used in mechatronic system such as pressure sensors, temperature sensors, velocity sensors, acceleration sensors, proximity sensors, position sensors, force sensors, Optical encoders, Capacitive level sensor, tuctile sensors, Selection of sensors.

Unit 2

Signal Conditioning and Data Representation: Types of electronic signals, Need for signal processing, Operational amplifiers: Types, classification and applications, Opto-isolators, Protection devices, Analogue to Digital and Digital to Analog Converters, Interfacing devices, Electro-magnetic Relays, Data representation systems, Displays, Seven segment displays, LCD displays, Printers, Data loggers, Data Acquisition Cards/Systems

Unit 3

Drives:

Electrical Drives: Types of Electrical Motors, AC and DC motors, DC servomotors, Stepper motors, linear motors, etc.

Pneumatics and Hydraulics: Components of Pneumatic systems, actuators, direction control valves, pneumatic air preparation, FRL unit, methods of actuation of valves, Sequencing of Pneumatic cylinders using Cascade and shift register methods. Electro-pneumatic valves, Electro-pneumatic circuits using single and double solenoid methods.

Hydraulic cylinders, design of cylinder, Design of Piston and piston rod, Valves, poppet valve, house pipes and design of tubing, Meter-in and Meter-out circuits.

Unit 4

Microprocessor and Microcontroller: 8085 microprocessor, architecture, various types of registers and their functions in 8085μP, Instruction sets, interfacing, applications.

8081 microcontroller, architecture, Instruction sets, various pins and their functions interfacing, applications.

Programmable Logic Controller: Introduction, Architecture, Types of inputs/outputs, Specifications, guidelines for selection of PLCs, Programming: Ladder logic and FBD

Unit 5

Control Systems: Open and closed loop system; block diagram manipulation/reduction, Transfer function, Modeling of Mechanical Systems using Spring, Dashpot and Mass equivalence.

Unit 6

Stability of Systems: On/Off controller, Proportional Control, Integral control, Derivative Control; PI, PD and PID Controllers, Introduction to control using state variable system models, Bode Plots and stsbility criteria.

Texts/References:

1. HMT Limited, Mechatronics, Tata McGraw-Hill, 1998.
2. Bolton, W., Mechatronics; Electronic Control System in Mechanical Engineering, Pearson Education Asia, 1999.
3. Raven, Automatic Control Engineering, McGraw Hill, New York, 1986.
4. www.nptel.com

Power Plant Technology

Unit 1

Sources of Energy for Power Plant: Fossil fuels, petroleum products, Hydel, Nuclear, Wind, Tidal and Geo-thermal energy etc.

Cycle for Steam and Gas Turbine Power Plant: Rankine cycle, Reheat cycle, Regenerative cycle, Reheat-regenerative cycle, Binary cycle, Topping cycle, Cogeneration, Regeneration, Intercooling.

Unit 2

High Pressure Boilers: Introduction, Advantages of high pressure boilers, Lamont boiler, Benson boiler, Loeffler boiler, Schmidt-Hartmann boiler, Velox boiler, super critical boiler, Design consideration for modern boilers, Introduction to IBR.

Unit 3

Thermal Power Plant: Introduction, general layout of modern thermal power plant, working, site selection and material requirements.

Fuel and Ash Handling: Introduction, out-plant and in-plant handling of coal, coal storage, coal crushing and pulverized coal systems, coal burning methods, overfeed underfeed stokers, pulverized fuels and their advantages, pulverized fuel burners, ash handling systems, different types of dust collectors, ash and dust disposal.

Unit 4

Diesel Power Plant: Introduction, field of use, plant layout, comparison of diesel power plant with other power plants, recent developments.

Gas Turbine Power Plant (GTPP): Introduction, classification and comparison with other types, types GTPP, advantages and disadvantages over other power plants, gas handling, present and future trends.

Unit 5

Hydro-Electric Power Plant: Introduction, general layout of hydro-electric power plant, Site selection, Classification, Run-off river plants with and without pondage, store reservoir plants, pump-storage plants, Advantages of hydro-electric power plant, Safety measures.

Nuclear Power Plant: Introduction, nuclear reactions, nuclear fuels, site selection, components of reactors, types of reactors, material requirement, effect of nuclear radiation, disposal of nuclear waste, safety requirement of nuclear power plant.

Unit 6

Economy Analysis of Power plants: Introduction, load calculation, load curve, diversity factor, load factor, plant use factor, meeting fluctuating load by various power plants, cost of electrical energy, performance and operating characteristics of power plants, load division among generators.
Non-conventional Power Generation: Solar Energy Collector Types, Low, medium and high temperature power plants, OTEC, wind power plants, tidal & geothermal power plants, solar photovoltaic power plants.
Fuel Cells.

Texts:
1. Nag P.K., Power Plant Engineering, Tata McGraw Hill Co.
2. Wakil, E.L., Power Plant Technology, McGraw Hill Publishing Co.

References:
1. Arora, S.C. and Domkundwar, S.*A*., Course in Power Plant Engineering, Dhanpat Rai and Sons, New Delhi.
2. Frederick, T. and Morse, Power Plant Engineering, Affiliated East - West Press Pvt Ltd, New Delhi.
3. www.nptel.com

Industrial Engineering & Management

Unit 1
Introduction: Managing and managers, management- science, theory and practice, functions of management, evolution of management theory, contributions of Taylor, Fayol and others.
Planning: The nature and purpose of planning, objectives, strategies, policies and planning premises, decision making.
Organizing: The nature and purpose of organizing, departmenation, Line/ staff authority and decentralization, effective organizing and organizational culture.

Unit 2
Staffing: Human resource management and selection, orientation, apprentice training and Apprentice Act (1961), performance appraisal and career strategy, job evolution and merit rating, incentive schemes.
Leading: Managing and human factor, motivation, leadership, morale, team building, and communication.
Controlling: The system and process of controlling control techniques, overall and preventive control.

Unit 3
Production/Operations Management: Operations management in corporate profitability and competitiveness, types and characteristics of manufacturing systems, types and characteristics of services systems.
Operations Planning and Control: Forecasting for operations, materials requirement planning, operations scheduling.

Unit 4

Design of Operational Systems: Product/process design and technological choice, capacity planning, plant location, facilities layout, assembly line balancing, perspectives on operations systems of the future.

Unit 5

Introduction to Industrial Engineering: Scope and functions, history, contributions of Taylor, Gibreth, Gantt and others.

Work Study and Method Study: Charting techniques, workplace design, motion economy principles.

Work Measurement: Stopwatch time study, micromotion study, predetermined time system (PTS), work sampling.

Unit 6

Ergonomics: Basic principles of ergonomics

Concurrent Engineering: Producibility, manufacturability, productivity improvement.

Total Quality Management: Just in time (JIT), total quality control, quality circles, six sigma.

Texts:

1. Koontz, H. and Weirich, H., Essentials of Management, McGraw-Hill book Co., Singapore, International Edition, 5th Edition, 1990.
2. Buffa, E.S. and Sarin, R.K., Modern Production/Operations Management, John Wiley & Sons, New York, International Edition, 8th Edition, 1987.
3. Hicks, P.E., Industrial Engineering and Management: A New Perspective, McGraw-Hill Book Co., Singapore, International Edition, 2nd Edition, 1994.

References:

1. Riggs, J.L., Production Systems: Planning, Analysis and Control, John Wiley & Sons, New York, International Edition, 4th Edition, 1987.
2. Amrine, H.T., Ritchey, J.A., Moodie, C.L. and Kmec, J.F. Manufacturing Organization and Management, 6th Ed., Pearson Education, 2004.
3. International Labour Organization (ILO), Introduction to Work Study, International Labour Office, Geneva, 3rd Ed., 1987.
4. www.nptel.com

Elective-V

Automobile Engineering

Unit 1:

Introduction: Engine types, types of pistons, piston rings, automobile engines – brief introduction of various parts & systems, power overlap for four, six & eight cylinder in line engines, antifreeze, mixtures, oil additives.

Unit 2:

Chasis Construction: Conventional construction, subframes, defects in frames, frameless construction, vehicle dimensions.

Unit 3:

Clutches: Function of clutch, Requirements of a clutch, principles of clutch, types of clutches – single plate clutch, multi-plate clutch, semi centrifugal clutch, centrifugal clutch, fluid flywheel, clutch plate, clutch facing materials.

Transmission System: Function of transmission, necessity of transmission, types of transmission – sliding mesh, constant mesh and synchromech gear boxes, epicyclic gear box, principle of automatic transmission, transfer box, propeller shaft & universal joints, rear axlew, differential lock.

Unit 4:

Suspension System and Steering: Front axle, road springs, shock absorbers, independent suspension, Road wheels & tyres, Factors of wheel alignment, steering geometry, correct steering angle, corning power, over steering and understanding. Brief idea about power steering.

Unit 5:

Brakes: Principle of brakes, braking requirements, general terms related with brakes, types of brakes – Drum and disc brakes, hydraulic brakes, Mechanical, vacuum and electrical methods of brakes education, servo brakes, bleeding of brakes.

Electrical System: Storage battery (lead-acid type), various components, charging starter, lighting system.

Unit 6:

Miscellaneous Topics: Essential and desirable automotive accessories, wind screen, wipers and flashing direction indicator, Principle of car air conditioning, safety considerations for automobiles, modern developments in automobiles.

Texts:

1. Singh, K., Automobile Engineering (Vol. I & II), Dhanpat Rai & Sons, New Delhi.
2. Crouse, W.H., Automobile Mechanics.

References:

1. Newton & Steed, Motor Vehicles
2. Judge, A.W., Motor Manuals (Vol I to VII).
3. Heitner, J., Automotive Mechanics.

Experimental Stress Analysis

Unit 1

Introduction: Need of stress analysis; Why experimental methods?; Merits and demerits of experimental methods.

Unit 2

Basics of Elasticity: Stress at a point; stress equations of equillibrium; 2-D state of stress; Strains and displacements; Stress strain relationship for 2-D state of stress; Plane stress and plane strain approach.

Unit 3

Measurement of Strain: Strain gauges: Mechanical, optical, electrical, acoustical and semiconductor; Grid method of strain analysis.

Unit 4

Electrical Strain Gauges: Gauge construction; Strain gauge adhesives and mounting techniques; Gauge sensitivity and gauge factor; Strain gauge linearity, hysteresis and zero shift; Temperature compensation; Environmental effects: moisture, humidity and hydrostatic pressure, high and cryogenic temperatures; The Wheatstone bridge; Calibration of strain gauge circuit; Strain analysis method: 3-element rectangular rosette, torque gauge.

Unit 5

Basics of Optics: Nature of light; Wave theory of light; Optical instruments; Plane and circular polariscopes.

Unit 6

Theory of Photoelasticity: Stress optics law; Effects of a stressed model in a plane polariscope; Effects of principal stress directions; Effects of principal stress difference; Effects of a stressed model in circular polariscope in dark and light field arrangements; 2-D Photoelasticity; Isochromatic and isoclinic fringe patterns; Materials for 2-D Photoelasticity; Introduction to moiré fringe technique and coating methods.

Texts/ References:

1. Dally, J.W. and Riley, W.F., Experimental Stress Analysis, 3rd Ed., McGraw-Hill Inc.

Analysis and Synthesis of Mechanisms

Unit 1

Basic Concepts: Definitions and assumptions, planar and spatial mechanisms, kinematic pairs, degree of freedom

Unit 2

Kinematic Analysis of Complex Mechanisms: Velocity-acceleration analysis of complex mechanisms by the normal acceleration and auxiliary point method

Unit 3

Dynamic Analysis of Planar Mechanisms: Inertial forces in linkages, kinetostatic anlaysis of mechanisms by matrix method, analysis of elastic mechanisms, beam element, displacement

fields for beam element, element mass and stiffness matrices, system of matrices, elastic linkage model, equations of motion

Unit 4

Curvature Theory: Fixed and moving centrodes, inflection circle, Euler-Savy equation, Bobillier constructions, cubic of stationary curvature, Ball's point, applications of dwell mechanisms

Unit 5

Graphical Synthesis of Planar Mechanisms: Type, number and dimensional synthesis, function generation, path generation and rigid body guidance problems, accuracy (precision) points, Chebychev spacing, types of errors, Graphical synthesis for function generation and rigid body guidance with two, three and four accuracy points using pole method, centre point and circle point curves, Bermester points, synthesis for five accuracy points, branch and order defects, synthesis for path generation

Unit 6

Analytical Synthesis of Planar Mechanisms: Analytical synthesis of four-bar and slider-crank mechanism, Freudenstein's equation, synthesis for four accuracy points, compatibility condition, synthesis of four-bar for prescribed angular velocities and accelerations using complex numbers. Complex number method for sysnthesis

Texts/ References:

1. A. Ghosh and A.K. Mallik, Theory of Machines and Mechanisms, Affiliated East-West Press
2. R.S. Hartenberg and J. Denavit, Kinematic Synthesis of Linkages, McGraw Hill Inc
3. A.G. Erdman and G.N. Sandor, Mechanism Design-Analysis and Synthesis (Vol. 1 and 2), Prentice Hall of India Ltd.
4. J.E. Shigley and J.J. Uicker, Theory of Machines and Mechanisms, McGraw Hill Inc
5. R.L. Norton, Design of Machinery: An Introduction to Synthesis and Analysis of Mechanisms and Machines, Tata McGraw Hill Inc.
6. A.S. Hall, Kinematics of Linkage Design, Prentice Hall of India Ltd.

Finite Element Method

Unit 1

Introduction: Finite element analysis and its need; Advantages and limitations of finite element analysis (FEA); FEA procedure.

Unit 2

Elements of Elasticity: Stress at a point; Stress equation of equillibrium; 2-D state of stress; Strains and displacements; Stress-strain relationship for 2-D state of stress; Plane stress and plane strain approach.

Unit 3

Relevant Matrix Algebra: Addition, subtraction and multiplication of matrices; Differentiation and integration of matrices; Inverse of a matrix; Eigen values and eigen vectors; Positive definite matrix; Gauss elimination.

Unit 4

One-dimensional Problems: Introduction; FE modelling; Bar element; Shape functions; Potential energy approach; Global stiffness matrix; Boundary conditions and their treatments; Examples.

Unit 5

Trusses and Frames: Introduction; Plane trusses; Element stiffness matrix; Stress calculations; Plane frames; examples.

Unit 6

Two-dimensional Problems: Introduction and scope of 2-D FEA; FE modelling of 2-D problem; Constant strain triangle; Other finite elements (no mathematical treatment included); Boundary conditions.

Texts:

1. Chandrupatla, T.R. and Belegundu, A.D., Introduction to Finite Elements in Engineering, Third Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.
2. Seshu, P., A Textbook of Finite Element Analysis, Prentice-Hall of India Pvt. Ltd., New Delhi, 2003.

References:

1. Bathe, K.J., Finite Element Procedures, Prentice-Hall of India Pvt. Ltd., 2006.
2. Cook, R.D., Malkus, D.S., Plesha, M.E. and Witt, R.J., Concepts and Applications of Finite Element Analysis, John Wiley & Sons, Inc.
3. www.nptel.com

Advanced Refrigeration

Unit 1

Vapour compression refrigeration, actual cycle, second law efficiency, multistage compression with inter-cooling, Multi-evaporator systems, Cascade systems.

Unit 2

Performance characteristics and capacity control of reciprocating and centrifugal compressors, screw compressor and scroll compressor.

Unit 3

Design, selection of evaporators, condensers, system balance, control systems, motor selection.

Unit 4
History, Nomenclature, Refrigerants, alternative refrigerants, CFC/HCFC phase-out regulations, action with lubricating oil, retrofitting, refrigerant blends, effects on refrigeration components.Thermoelectric and nonconventional refrigeration systems, adiabatic de-magnetization

Unit 5
Vapor absorption refrigeration, Li-Br and aqua ammonia system, calculation of mass flow rate and system performance, energy balance, controls, analysis of rectifier and analyzer, single effect and double effect systems, vapour transformer.

Unit 6
Refrigeration controls, Expansion devices: design and selection, refrigeration system piping design

Texts/References:

1. Stoecker W. F. and Jones J. P. ,Principles of Refrigeration and air-conditioning, McGraw Hill
2. Arora C. P., Refrigeration and air-conditioning, Tata McGraw Hill.
3. Gosney W. B., Principles of refrigeration, Cambridge University Press.
4. Stoecker W. F., H. B. of Industrial refrigeration, McGraw Hill Companies, Inc.
5. Dossat R. J., Principles of Refrigeration, Pearson Education
6. ASHRAE H. B. – Refrigeration
7. ASHARAE H. B. - Fundamental

Advanced Power Plants

Unit-1
Gas Turbine (GT) Power plants: Closed cycle and open cycle plants ; Analysis of a Gas Turbine plant; optimum pressure ratio, regeneration, reheating, inter-cooling ; Performance; Components of Gas Turbine plant- compressor, combustion chamber, Turbine; Gas turbine materials.

Unit- 2
Combined Cycle (CC) Power Plants: Limitations of steam turbine (ST) and gas turbine (GT) power plants; Thermodynamics of multi-fluid coupled cycles; Combined Brayton and Rankine Cycle and GT-ST plants; Advantages of CC plants; Effect of supplementary heating ; Gas-based CC plants- choices of GT and ST plants; Coal based CC plants-PFBC and IGCC plants ; STIG and Repowering; Environmental impact; Scope of CC plants.

Unit-3
Futuristic Technologies: Fuel Cells; MHD-steam plant; Thermoelectric – steam plant Thermionic steam plant.

Unit-4

Fluidized Bed Technology: Theory of fluidization – regimes, packed bed, bubbling bed, turbulent bed and fast bed ; Terminal Velocity and elutriation; Hydrodynamics and heat transfer ;Combustion in fluidized beds; Pressurized fluidized beds; Coal gasifiers; IGCC plants; Fluidized bed boilers – bubbling bed and circulating bed boilers ; Cyclone separators; Pressurized fluid bed boilers; Advantages and scope of CFB boilers.

Unit-6

Energy Storage: Objective and scope- energy management ; Methods of energy storage – pumped hydro, Compressed air energy storage, flywheels, electrochemical , magnetic, Thermal and chemical energy storage; Hydrogen energy – production, storage and utilization.

Developments in wind turbines, solar power plant: photovoltaic cells, solar thermal power generation.

Texts/References:

1. V.Ganeshan: Gas Turbines; Tata McGraw Hill Publishing Co. Ltd. New Delhi,2003.
2. P.K.Nag, Power Plant Engineering; TMH Publishing Co. Ltd., New Delhi, 2001.
3. Circulating Fluidized Bed Boilers – Dr. Prabir Basu & Scot Fraser, Butterworth, Canada / USA,1991

Cryogenic Systems

Unit 1

Introduction: Introduction**,** Industrial applications, recent development, properties of cryogenic fluids-oxygen, nitrogen, air, hydrogen and helium.

Behaviour of structural materials at Cryogenic temperature: Mechanical properties, thermal properties, thermoelectric properties.

Unit 2

Liquefaction of Cryogenic Gases: Ideal cycle, system performance parameters, Joule Thomson effect, adiabatic expansion, liquefaction systems; Simple Linde-Hampson system, Precooled Linde-Hampson system, Cascade system, Claude system

Unit 3

Liquefaction systems for Neon, Hydrogen and Helium: Precooled Linde-Hampson system fpr neon and hydrogen, Claude system for hydrogen, Helium refrigerated hydrogen liquefaction system

Unit 4

Cryogenic Refrigeration Systems

Ideal refrigeration systems, Philips refrigerator, Vuilleumier refrigerator, Solvay refrigerator, Gifford-McMohan refrigerator, Pulse tube refrigerator, Megnetic cooling

Unit 5

Separation of Gases: Principles of rectification**,** Rectifiers column, separation column design; plate calculation, Types of rectification columns

Unit 6

Insulation: Vacuum insulation, fibrous materials, Solid foams, Gas filled power, comparison, critical thickness.

Vacuum Technology: Importance, Pump down time, Flow regimes, Components of vacuum systems, Vacuum pumps

Texts:

1. Barron F. Randall, Cryogenic Systems Oxford University Press, New York
2. Guy, K White, Experimental *Techniques in low Temperature Physics*, Claredon Press, Oxford, 1987.
3. *Advanced Cryogenic Engineering*, Proceedings of Cryogenic Engineering Conference, Vol 1-145, Plenum press, New York, 1968.

References:

1. Marshall Sitting and Stephen Kidd, Cryogenic *Research and Applications*, D. Van Nostrand, Inc USA, 1963.

Refrigeration AC and Renewable Energy Lab

List of Practical

Refrigeration (Any Three)

1. Trial on vapour compression Refrigeration system
2. Trial on Ice Plant
3. Trial on Window Air Conditioner
4. Trial on Water to Water Heat Pump
5. Trial on Air to Water Heat Pump
6. Trial on Vortex Tube Refrigeration system
7. Trial on Electrolux Vapour Absorption Refrigeration system

Air-conditioning (Any Three)

8. Study and practice of sensible heating and cooling Air- conditioning process
9. Study and practice of cooling and dehumidification Air- conditioning process
10. Study and practice of heating and humidification Air- conditioning process
11. Study and practice of adiabatic air mixing Air- conditioning process
12. Study and practice of reheating Air- conditioning process
13. Study and practice of direct Evaporative cooling Air- conditioning system
14. Study and practice of indirect – direct Evaporative cooling Air- conditioning system
15. Study and practice of Hybrid Air- conditioning system

Renewable Energy (Any Three)

16. Performance Test on Solar Water Heater
17. Performance Test on Solar Air Heater
18. Performance Test on Solar Photovoltaic Cells
19. Performance Test on Solar Still
20. Performance Test on Solar Cooker (Box type/ Dish type)
21. Power Plant Visit (At least One visit to Thermal/Hydro-electric/Nuclear/Wind Power Plant)

Mechatronics Lab

List of Practicals:

1. Study and demonstration of various types of sensors
2. Speed control of various types of Electrical Motors
3. Minimum two circuits on Pneumatics to be developed on Pneumatic trainer kit
4. Minimum two circuits on Electro-Pneumatics to be developed on Electro-Pneumatic trainer kit
5. Minimum two circuits on Hydraulics and Electro-hydraulics to be developed on Hydraulic trainer kit
6. Programming of Microprocessor and Microcontroller
7. Programming on PLC
8. Demonstration of Process control such as temperature, level, flow, etc. control using PID controller

Machine Design Practice –II

1. The term work shall consist of two design projects based on the syllabus of the Machine design III. Each design project shall consist of two full imperial size sheets –one involving assembly drawing with part list and overall dimensions and other involving drawings of individual components. Manufacturing tolerances, surface finish symbols, geometric tolerances should be specified, wherever necessary so as to make it a working drawing. A design report giving all necessary calculations for the design of components and assembly should be submitted in a separate file.

2. Two assignments based on the topics of syllabus of machine design III.

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