Department of Mechanical Engineering

Jalpaiguri Govt. Engg. College
(A Govt. Autonomous College)
Jalpaiguri – 735102
Syllabus for UG Classes effective from the Academic Year 2013-14 -for the new batch only

COURSE STRUCTURE

First Semester

A. THEORY							
Sl. No.	Field	Theory	Contact Hours/Week				Credits
			L	T	P	Total	
01	HU-101	English Language & Technical Communication	2	0	0	2	02
02	PH-101	Physics – I	3	1	0	4	04
03	M-101	Mathematics-I	3	1	0	4	04
04	CS-101	Principles of Computer Programming	3	1	0	4	04
05	ME-101	Engineering Mechanics	3	1	0	4	04
Total of Theory			14	04	00	18	18
B. PRACTICAL							
01	PH-191	Physics – I Lab.	0	0	3	3	02
02	CS-191	Principles of Computer Prog. Lab.	0	0	3	3	02
03	ME-191	Engineering Drawing & Graphics	0	0	3	3	02
Total of Practical			00	00	09	09	06
C. SESSIONAL							
01	HU-181	English Language & Technical Communication Lab.	0	0	3	3	02
02	XC-181	Extra Curricular Activities(NSS/NCC/NSO etc)	0	0	2	2	01
Total of Sessional			00	00	05	05	03
Total of Semester			14	04	14	32	27

Second Semester

A. THEORY							
Sl. No.	Field	Theory	Contact Hours/Week				Credits
			L	T	P	Total	
01	HU-202	Economics for Engineers	3	0	0	3	03
02	EE-201	Basic Electrical Engineering	3	1	0	4	04
03	CH-201	Chemistry -I	3	1	0	4	04
04	M-201	Mathematics-II	3	1	0	4	04
05	EC-201	Basic Electronics Engineering	3	1	0	4	04
Total of Theory			15	04	00	19	19
B. PRACTICAL							
01	EE-291	Basic Electrical Engineering Lab.	0	0	3	3	02
02	CH-291	Chemistry -I Lab.	0	0	3	3	02
03	EC-291	Basic Electronic Engineering Lab.	0	0	3	3	02
04	ME-292	Workshop Practice	0	0	3	3	02
Total of Practical			00	00	12	12	08
C. SESSIONAL							
Total of Sessional			00	00	00	00	00
Total of Semester			15	04	12	31	27

SEMESTER – III

Theory:

Sl. No.	CODE	Paper	Contacts periods Per weeks			Total periods	Credits
			L	T	P		
1.	HU 301	Values & Ethics in Profession	3	0	0	3	3
2.	PH 301	Physics-II	3	0	0	3	3
3.	EE (ME) 301	Electrical Machines	3	0	0	3	3
4.	ME 301	Thermodynamics	3	1	0	4	4
5.	ME 302	Strength of Materials	3	1	0	4	4
6.	ME 303	Engineering Materials	3	0	0	3	3
		Total of Theory	**18**	**2**	**0**	**20**	**20**

Practical:

Sl. No.	Code	Paper	Contacts period per week			Total	Credits
			L	T	P		
1.	ME 391	Machine Drawing-I	0	0	3	3	2
2.	CE(ME) 392	Strength of Materials Lab	0	0	3	3	2
3.	EE (ME) 391	Electrical Machines Lab	0	0	3	3	2
4.	ME 392	Workshop Practice	0	0	3	3	2
		Total of Practical	0	0	12	12	8
Total of Semester:			**18**	**2**	**12**	**32**	**28**

SEMESTER – IV

Theory:

Sl. No.	CODE	Paper	Contacts periods Per weeks			Totals	Credits
			L	T	P		
1.	M 402	Mathematics_III	3	0	0	3	3
2.	M(CS) 401	Numerical Methods	3	0	0	3	3
3.	ME 401	Kinematics of Machines	3	1	0	4	4
4.	ME 402	Primary Manufacturing Processes	3	0	0	3	3
5.	ME 403	Fluid Mechanics & Machinery	3	1	0	4	4
6.	CH 401	Basic Environmental Engineering & Elementary Biology	3	0	0	3	3
		Total of Theory	**18**	**2**	**0**	**20**	**20**

Practical:

Sl. No.	Code	Paper	Contacts period per week			Total	Credits
			L	T	P		
1.	M(CS) 491	Numerical Methods Lab	0	0	3	3	2
2.	ME 491	Machine Drawing-II	0	0	3	3	2
3.	ME 492	Manufacturing Process Lab	0	0	3	3	2
4.	ME 493	Fluid Mechanics & Machinery Lab	0	0	3	3	2
		Total of Practical	0	0	12	12	8
Total of Semester:			**18**	**2**	**12**	**32**	**28**

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SEMESTER – V

Theory:

Sl. No.	CODE	Paper	Contacts periods Per weeks			Totals	Credits
			L	T	P		
1.	HU 501	Principles of Management	3	0	0	3	3
2.	ME 501	Heat Transfer	3	1	0	4	4
3.	ME 502	Dynamics of Machines	3	0	0	3	3
4.	ME 503	Machining & Machine Tools	3	0	0	3	3
5.	ME 504	Design of Machine Elements	3	1	0	4	4
6.	ME 505	Elective-I	3	0	0	3	3
		Total of Theory	**18**	**2**	**0**	**20**	**20**

Elective-I

a) ME 505A Refrigeration & Air Conditioning
b) ME 505B Computational Fluid Dynamics
c) ME 505C Mechatronics
d) ME 505D Quality & Reliability Engineering

Practical:

Sl. No.	Code	Paper	Contacts period per week			Total	Credits
			L	T	P		
1.	ME 591	Heat Transfer Lab	0	0	3	3	2
2.	ME 592	Dynamics of Machines Lab	0	0	3	3	2
3.	ME 593	Machine Tools Lab	0	0	3	3	2
4.	ME 594	Design Practice-I	0	0	3	3	2
		Total of Practical	0	0	12	12	8
Total of Semester:			**18**	**2**	**12**	**32**	**28**

SEMESTER – VI

Theory :

Sl. No.	CODE	Paper	Contacts periods Per weeks			Totals	Credits
			L	T	P		
1.	ME 601	I.C.Engine & Gas Turbine	3	1	0	4	4
2.	ME 602	Machine Design	3	1	0	4	4
3.	ME 603	Power Plant Engineering	3	1	0	4	4
4.	ME 604	Advanced Machine Tools	3	1	0	4	4
5.	ME 605	Elective-II	4	0	0	4	4
		Total of Theory	**16**	**4**	**0**	**20**	**20**

Elective-II

a) ME 605A Finite Element Methods
b) ME 605B Materials Handling
c) ME 605C Fluid Power Control
d) ME 605D Industrial Robotics
e) ME 605E Mechanics of Composite Materials

Practical:

Sl. No.	Code	Paper	Contacts period per week			Total	Credits
			L	T	P		
1.	ME 691	I.C.Engine Lab	0	0	3	3	2
2.	ME 692	Design Practice-II	0	0	3	3	2
3.	ME 693	Seminar	0	0	3	3	2
4.	ME 694	Advanced Machine Tools Lab	0	0	3	3	2
		Total of Practical	0	0	12	12	8
Total of Semester:			**16**	**4**	**12**	**32**	**28**

Students will have to undergo an Industrial Training at the end of 6th Semester

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SEMESTER – VII

Theory:

Sl. No.	CODE	Paper	Contacts periods Per weeks			Totals	Credits
			L	T	P		
1.	HU 701	Financial Management & Accounts	3	0	0	3	3
2.	ME 701	Advanced Manufacturing Technology	3	0	0	3	3
3.	ME 702	Metrology & Measurement	4	0	0	4	4
4.	ME 703	Elective-III	4	0	0	4	4
5.	ME 704	Elective-IV	4	0	0	4	4
		Total of Theory	18	0	0	18	18

Elective-III

a) ME 703A Advanced Welding Technology
b) ME 703B Advanced Mechanical Vibration
c) ME 703C Total Quality Management
d) ME 703D Non Destructive Testing

Elective-IV

a) ME 704A Operation Research
b) ME 704B Computational Heat Transfer
c) ME 704C Theory of Combustion & Emissions
d) ME 704D Tribology
e) ME 704E Safety & Occupational Health

Practical:

Sl. No.	Code	Paper	Contacts period per week			Total	Credits
			L	T	P		
1.	ME 791	CAD/CAM Lab	0	0	3	3	2
2.	ME 792	Metrology & Measurement Lab	0	0	3	3	2
3.	ME 793	Project-I	0	0	6	6	4
4.	ME 781	Industrial Training Evaluation	0	0	3	3	2
		Total of Practical	0	0	15	15	10
Total of Semester:			**18**	**0**	**15**	**33**	**28**

SEMESTER – VIII

Theory:

Sl. No.	CODE	Paper	Contacts periods Per weeks			Totals	Credits
			L	T	P		
1.	ME 801	Industrial Engineering & Management	4	0	0	4	4
2.	ME 802	Elective-V	4	0	0	4	4
3.	ME 803	Elective-VI	4	0	0	4	4
		Total of Theory	12	0	0	12	12

Elective-V

a) ME 802A Renewable Energy Studies
b) ME 802B Experimental Stress Analysis
c) ME 802C Computer Graphics & Solid Modeling
d) ME 802D Industrial & Organizational Psychology

Elective-VI

a) ME 803A Fracture Mechanics
b) ME 803B Energy Conservation & Management
c) ME 803C Automobile Engineering
d) ME 803D Advanced Mechanics of Materials

Practical:

Sl. No.	Code	Paper	Contacts period per week			Total	Credits
			L	T	P		
1.	ME 891	Industrial Engineering Lab	0	0	3	3	2
2.	ME 892	Grand Viva Voce	0	0	0	0	4
3.	ME 893	Project-II	0	0	9	9	6
		Total of Practical	0	0	12	12	12
Total of Semester:			**12**	**0**	**12**	**24**	**24**

DETAILED SYLLABUS

1st semester:

HU-101 English Language & Technical Communication 2-0-0-2-2:

Guidelines for Course Execution:

Objectives of the Course: This Course has been designed

1. To impart advanced skills of Technical Communication in English through Language Lab. Practice Sessions to 1st Semester UG students of Engineering &Technology.
2. To enable them to communicate confidently and competently in English Language in all spheres.

Desired Entry Behaviour:

The students must have basic command of English to Talk about day-to-day events and experiences of life. Comprehend Lectures delivered in English. Read and understand relevant materials written in English. Write grammatically correct English. Strategies for Course Execution:

1. It is a Course that aims to develop Technical Communication Skills. It is, therefore, *Lab*- based and practical in orientation. Students should be involved in Practice Sessions.
2. The content topics should be conveyed through real-life situations. Lecture classes should be conducted as Lecture cum Tutorial classes.
3. Keeping in view the requirements of students, the teachers may have to prepare some learning aids task materials.
4. Some time should be spent in teaching stress and intonation.
5. In teaching 'Speaking skill,' emphasis should be on *clarity, intelligibility, fluency, (as well as accepted pronunciation).*
6. Micro Presentation and Group Discussion Sessions should be used for developing Communicative Competence
7. The Language Lab, device should be used for giving audio-visual inputs to elicit students' responses by way of Micro-Presentation, Pair Conversation, Group Talk and Class Discussion.
8. The teacher must function as *a creative monitor in the Language Lab for the following:*

A. **Developing Listening Comprehension Skill;**

1. Developing Listening Comprehension through Language Lab Device
2. Developing sub skills of the Listening Skill by Conversational Practice Sessions
3. Focusing on intelligent and advanced Listening Sessions e.g. Seminars, Paper Presentation, Mock Interviews etc.
4. Conducting Conversational Practice: Face to Face & Via Media (Telephone, Audio, Video + Clips)

B. **Developing Speaking Competence:**

a) Helping students in achieving *clarity and fluency*; manipulating paralinguistic features of speaking (*voice modulation ,pitch , tone stress , effective pauses)*

Conducting *Task oriented interpersonal ,informal and semiformal Speaking / Classroom Presentation* 4

b) Teaching strategies for Group Discussion

Teaching Cohesion and Coherence

Teaching effective communication & strategies for handling criticism and adverse remarks

Teaching strategies of Turn- taking, effective intervention, kinesics (use of body language) and courtesies and all componentss of softskills.

C. **Developing Reading Comprehension Skill:**

a) Developing Reading Skill through Non Technical (Literary) Texts (See Recommended Book 5)

1. The Thief by Ruskin Bond
2. The Open Window by Saki
3. Marriage is a private Affair by Chinua Achebe
4. The Moon in the Earthen Pot by Gopini Karunakar

b) Developing Reading Skill through Radio Commentary, Technical Texts and Case Studies (Refer to Recommended Book 1.) * Freedom by G. B. Shaw (Radio Commentary)

a) Guiding students for Intensive & Extensive Reading(See Recommended Book 1)

D. **Developing Writing Competence:**

a) Teaching all varieties of Technical Report, Business Letters and Job Application (Expressing Ideas within restricted word limit through paragraph division, Listing Reference Materials through Charts , Graphs ,Tables and Diagrams);
b) Teaching correct Punctuation & Spelling, Semantics of Connectives, Modifiers and Modals, variety of sentences and paragraphs
c) Teaching Organizational Communication: Memo, Notice, Circular, Agenda / Minutes etc.

SYLLABUS -- DETAILED OUTLINES

A. ENGLISH LANGUAGE GRAMMAR: 5L

Correction of Errors in Sentences, Building Vocabulary, Word formation, Single Word for a group of Words, Fill in the blanks using correct Words, Sentence Structures and Transformation, Active & Passive Voice, Direct & Indirect Narration, (MCQ Practice during classes)

B. READING COMPREHENSION:

Strategies for Reading Comprehension 1L
Practicing Technical & Non Technical Texts for Global/Local/Inferential/Referential comprehension; 3L
Precis Writing

C. TECHNICAL COMMUNICATION

The Theory of Communication –Definition & Scope, Barriers of Communication, Different Communication Models, Effective Communication (Verbal / Non verbal), Presentation / Public Speaking Skills 5L
(MCQ Practice during classes) 5

D. MASTERING TECHNICAL COMMUNICATION

Technical Report (formal drafting) 3L
Business Letter (formal drafting) 4L
Job Application (formal drafting) 3L
Organizational Communication (see page 3) 3L
Group Discussion –Principle & Practice 3L
Total Lectures 30

MARKS SCHEME (Written Examination) Total Marks 70
1. 10 Multiple Choice Questions(Communication & Eng. Language-Vocabulary & Syntax) Marks 10
2. Short Questions & Precis writing on unseen passages Marks 15 (10+5)
3. 3 Essay type Questions on Technical Communication (Technical Report / Business Letter / Job Application / Organizational Communication etc,) Marks 45-15*3

MARKS SCHEME (Internal Examination) Total Marks 30
1. Attendance Marks 5
2. Testing Speaking Ability Marks 5
3. Testing Listening Ability Marks 5
4. 2 Unit Tests Marks 15

HU -181 English Language & Technical Communication Lab 0-0-3-3-2:

a) Honing 'Listening Skill' and its sub skills through Language Lab Audio device; 3P
b) Honing 'Speaking Skill' and its sub skills; 2P
c) Helping them master Linguistic/Paralinguistic features (Pronunciation/Phonetics/Voice modulation/ Stress/ Intonation/ Pitch &Accent) of connected speech; 2P
j) Honing 'Conversation Skill' using Language Lab Audio –Visual input; Conversational Practice Sessions (Face to Face / via Telephone , Mobile phone & Role Play Mode); 2P
k) Introducing 'Group Discussion' through audio –Visual input and acquainting them with key strategies for success; 2P
f) G D Practice Sessions for helping them internalize basic Principles (turn- taking, creative intervention, by using correct body language, courtesies & other soft skills) of GD; 4P
g) Honing 'Reading Skills' and its sub skills using Visual / Graphics/Diagrams /Chart Display/Technical/Non Technical Passages; Learning Global / Contextual / Inferential Comprehension; 2P
h) Honing 'Writing Skill' and its sub skills by using Language Lab Audio –Visual input; Practice Sessions 2P

Total Practical Classes 17

Books Recommended:

Dr. D. Sudharani: Manual for English Language Laboratory Pearson Education (WB edition),2010
Board of Editors: Contemporary Communicative English for Technical Communication Pearson Longman, 2010

PH-_101 Physics-I 3-1-0-4-4:

Module 1: Oscillation:

1.1 Simple Harmonic motion: Preliminary concepts, Superposition of Simple Harmonic motions in two mutually perpendicular directions: Lissajous figure.
1.2 Damped vibration: Differential equation and its solution, Logarithimic decrement, Quality Factor.
1.3 Forced vibration: Differential equation and its solution, Amplitude and velocity resonance, Sharpness of resonance. Application in L-C-R circuit. (2L+3L+3L)

Module 2: Optics I:

2.1 Interference of electromagnetic waves: Condition for sustained interference, double slit as an example. Qualitative idea of Spatial and Temporal Coherence, conservation of energy and intensity distribution, Newton's ring.
2.2 Diffraction of light: Fresnel and Fraunhoffer class. Fraunhoffer diffraction for single slit and double slit. Intensity distribution of N-slits and plane diffraction grating (No deduction of the intensity distributions for N-slit), Missing orders. Rayleigh criterion, resolving power of grating and microscope. (3L+5L)

Module3: Optics II

3.1 Polarization: General concept of polarization, Plane of vibration, Qualitative discussion on plane, circularly and elliptically polarized light. Polarization through reflection and Brewster's law. Double refraction (birefringence) – Ordinary and Extra-ordinary rays. Nicol's prism, Polaroid, Half wave and quarter wave plate.
3.2 Laser: Spontaneous and Stimulated emission of radiation, Population inversion, Einstein's A & B co-efficient (derivation of the mutual relation), Optical resonator and condition necessary for active Laser action, Ruby Laser, He-Ne Laser, application of laser.
3.3 Holography: Theory of holography, viewing of hologram, applications. (4L+4l+3L)

Module 4: Quantum Physics:

4.1 Concept of dependence of mass with velocity, mass energy equivalence, energy-momentum relation (no deduction required), Blackbody radiation: Rayleigh Jean's law (derivation without the calculation of number of states), Ultraviolet catastrophe, Wien's law, Planck's radiation law (calculation of average energy of the oscillator), Derivation of Wein's law and Stephan's law from Planck's radiation law. Rayleigh Jean's law and Wien's law as limiting case of Planck's law. Compton's effect (calculation of Compton wavelength is required).
4.2 Wave-particle duality and de Broglie's hypothesis. Concept of matter waves, Davission-Germer experiment, Concept of wave packets and Heisenberg's uncertainty principle. (5L+4L)

Module 5: Crystallography:

5.1 Elementary ideas of crystal structure: Lattice, Basis, Unit cell, fundamental types of lattice-Bravais Lattice, simple cubic, FCC and BCC lattices (use of models in class during teaching is desirable), Miller indices and Miller planes, coordination number and atomic packing factor.
5.2 X-rays: origin of characteristic and continuous x-rays, Bragg's law (no derivation), determination of lattice constant.

PH-_191 Physics-I Lab. 0-0-3-3-2:

Group 1: Experiment from Higher Secondary knowledge of Physics

1. Determination of thermal conductivity of a good conductor by Searle's method.
2. Determination of thermal conductivity of a bad conductor by Lees and Charlton's method.
3. Determination of dispersive power of the material of given prism.
4. Use of Carry Foster's bridge to determine unknown resistance.
5.

Group 2: Experiments on General properties of matter

6. Determination of Young's modulus by Flexure method and calculation of bending moment and shear force at a point on the beam.
7. Determination of modulus of rigidity by static / dynamic method.
8. Determination of co-efficient of viscosity by Poiseulle's capillary flow method.

Group 3: Optics

9. Determination of wavelength of light by Newton's ring method.
10. Determination of wavelength of light by Fresnel's bi-prism method.
11. Determination of wavelength of light by Laser diffraction method.
12. Determination of numerical aperture and the energy losses related to optical fibre experiment.

Innovative experiment:

One more experiment designed by the student or the concerned teacher or both.

CS- 101 Principles of Computer Programming 3-1-0-4-4:

Fundamentals of Computer:

History of Computer, Generation of Computer, Classification of Computers 2L

Basic Anatomy of Computer System, Primary & Secondary Memory, Processing Unit, Input & Output Devices 3L

Binary & Allied number systems representation of signed and unsigned numbers. BCD, ASII. Binary Arithmetic & logic gates 6L

Assembly language, high level language, compiler and assembler (basic concepts) 2L

Basic concepts of operating systems like MS DOS, MS WINDOW, UNIX, Algorithm & flow chart 2L

C Fundamentals:

The C character set identifiers and keywords, data type & sizes, variable names, declaration, statements 3L

Operators & Expressions:

Arithmetic operators, relational and logical operators, type, conversion, increment and decrement operators, bit wise operators, assignment operators and expressions, precedence and order of evaluation. Input and Output: Standard input and output, formatted output -- printf, formatted input scanf. 5L

Flow of Control:

Statement and blocks, if - else, switch, loops - while, for do while, break and continue, go to and labels 2L

Fundamentals and Program Structures:

Basic of functions, function types, functions returning values, functions not returning values, auto, external, static and register variables, scope rules, recursion, function prototypes, C preprocessor, command line arguments. 6L

Arrays and Pointers:

One dimensional arrays, pointers and functions, multidimensional arrays. 6L

Structures Union and Files:

Basic of structures, structures and functions, arrays of structures, bit fields, formatted and unformatted files. 5L

Recommended reference Books:

Introduction To Computing (TMH WBUT Series), E. Balagurusamy,TMH
Kerninghan, B.W. The Elements of Programming Style
Yourdon, E. Techniques of Program Structures and Design
Schied F.S. T heory and Problems of Computers and Programming
Gottfried Programming with C Schaum
Kerninghan B.W. & Ritchie D.M. The C Programming Language
Rajaraman V. Fundamental of Computers
Balaguruswamy Programming in C
Kanetkar Y. Let us C
M.M.Oka Computer Fundamentals,EPH
Leon Introduction to Computers,Vikas
Leon- Fundamental of Information Technology,Vikas

Ram B.	Computer Fundamentals, New Age International
Ravichandran D.	Programming in C, New Age International
Xavier C. C	Language & Numerical Methods, New Age Inter.
Xavier C.	Introduction to Computers, New Age International
Rao S.B.	Numerical Methods with Programs in Basic Fortran Pascal & C++,
Dutta N.	Computer Programming & Numerical Analysis, Universities Press
Bhanu Pratap	Computer Fundamentals
Rajaram	Computer Concepts & C Program, Scitech

CS-_191 Principles of Computer Programming Lab 0-0-3-3-2:

Exercises should include but not limited to:

1. DOS System commands and Editors (Preliminaries)
2. UNIX system commands and vi (Preliminaries)
3. Simple Programs: simple and compound interest. To check whether a given number is a palindrome or not, evaluate summation series, factorial of a number , generate Pascal's triangle, find roots of a quadratic equation
4. Programs to demonstrate control structure : text processing, use of break and continue, etc.
5. Programs involving functions and recursion
6. Programs involving the use of arrays with subscripts and pointers
7. Programs using structures and files.

M-101 Mathematics-I 3-1-0-4-4:

Module I

Matrix: Determinant of a square matrix, Minors and Cofactors, Laplace's method of expansion of a determinant, Product of two determinants, Adjoint of a determinant, Jacobi's theorem on adjoint determinant. Singular and non-singular matrices, Adjoint of a matrix, Inverse of a non-singular matrix and its properties, orthogonal matrix and its properties, Trace of a matrix. Rank of a matrix and its determination using elementary row and column operations, Solution of simultaneous linear equations by matrix inversion method, Consistency and inconsistency of a system of homogeneous and inhomogeneous linear simultaneous equations, Eigen values and eigen vectors of a square matrix (of order 2 or 3), Caley-Hamilton theorem and its applications. **9L**

Module II

Successive differentiation: Higher order derivatives of a function of single variable, Leibnitz's theorem (statement only and its application, Problems of the type of recurrence relations in derivatives of different orders and also to find $(y_n)_0$. **2L**

Mean Value Theorems & Expansion of Functions: Rolle's theorem and its application, Mean Value theorems – Lagrange & Cauchy and their application, Taylor's theorem with Lagrange's and Cauchy's form of remainders and its application, Expansions of functions by Taylor's and Maclaurin's theorem, Maclaurin's infinite series expansion of the functions: $\sin x, \cos x, e^x, log(1+x), (a+x)^n$, n being an integer or a fraction. **5L**

Reduction formula: Reduction formulae both for indefinite and definite integrals of types

$$\int sin^n x\,dx, \int cos^n x\,dx, \int sin^m x cos^n x\,dx, \int cos^m x \sin nx\,dx, \int \frac{dx}{(x^2+a^2)^n}$$

where m, n are positive integers. **2L**

Module III

Calculus of Functions of Several Variables: Introduction to functions of several variables with examples, Knowledge of limit and continuity, Partial derivatives and related problems, Homogeneous functions and Euler's theorem and related problems up to three variables, Chain rules, Differentiation of implicit functions, Total differentials and their related

problems, Jacobians up to three variables and related problems, Maxima, minima and saddle points of functions and related problems, Concept of line integrals, Double and triple integrals. **9L**

Module IV

Infinite Series: Preliminary ideas of sequence, Infinite series and their convergence/divergence, Infinite series of positive terms, Tests for convergence: Comparison test, Cauchy's Root test, D' Alembert's Ratio test and Raabe's test (statements and related problems on these tests), Alternating series, Leibnitz's Test (statement, definition) illustrated by simple example, Absolute convergence and Conditional convergence. **5L**

Module-V

Vector Algebra and Vector Calculus: Scalar and vector fields – definition and terminologies, dot and cross products, scalar and vector triple products and related problems, Equation of straight line, plane and sphere, Vector function of a scalar variable, Differentiation of a vector function, Scalar and vector point functions, Gradient of a scalar point function, divergence and curl of a vector point function, Directional derivative. Related problems on these topics. Green's theorem, Gauss Divergence Theorem and Stoke's theorem (Statements and applications). **8L**

Total 40 Lectures

Suggested Reference Books

1. **Advanced Engineering Mathematics** 8e by Erwin Kreyszig is published by Wiley India
2. **Engineering Mathematics**: B.S. Grewal
5**. Calculus**: M. J. Strauss, G. L. Bradley and K. L. Smith (3PrdP Edition, 1PstP Indian Edition 2007, Pearson Education)
6**. Engineering Mathematics**: S. S. Sastry (PHI)
7. **Advanced Engineering Mathematics, 3E**: M.C. Potter, J.L. Goldberg and E.F. Abonfadel (OUP),Indian Edition.
8. **Differential Calculas**, Ghosh & Maity (Central)
9. **Integral Calculus**, Ghosh & Maity (Central)
10. **Higher Algebra-Classical & Modern**, J.G. Chakravorty and P.R. Ghosh(U.N. Dhur)
11. **Vector Analysis (Schaum Series),** M. R. Spiegel (MGH)

ME – 101: Engineering Mechanics

Contacts: 3L + 1T = 4

Credits = 4

Module – 1

Importance of mechanics in Engineering; Introduction to Statics; Concept of particle and of Rigid Body; Types of Forces: 2L

Introduction to Vector Algebra; Parallelogram Law; Triangle and Polygon Law; Addition and Subtraction of Vector; Unit Vector; Dot product and Cross product of Vectors and their applications. Types of Vectors (Sliding Vector, Bound Vector). 4L+1T

Two dimensional force system, Resolution of forces; Moments; Varignon's theorem; Couple; Equivalence of Force and Force –Couple system. 4L+2T

Module – II

Equilibrium of a body under two dimensional force system and under two dimensional force-moment system; Free body diagram; Lami's Theorem. 3L+1T

Friction; Co-efficient of friction; Laws of friction; Angle of Repose; Wedge friction. 3L+1T

Module-III

Truss & Frames - Basic ideas, Simple problems. 2L+1T

Module –IV

Centroid and Centre of Gravity; Centroid of Triangle, Quadrant of a circle and rectangle; Centroid of a composite area; Theorem of Pappus. 3L+1T

Moment of Inertia of a plane figure about Co-planer axes; Parallel axis theorem; Polar Moment of Inertia; Mass Moment of Inertia of cylinder, sphere and cone about the axis of symmetry. 3L+1T

Module – V

Virtual Work, Principle of virtual work. Problems on virtual work. 2L+1T

Module –VI

Introduction to Dynamics; Kinematics and Kinetics; Plane rectilinear motion under uniform and non-uniform acceleration 3L+1T

x-t, v-t and a-t graphs; Motion under gravity; Plane Curvilinear motion; Circular motion; Projectile motion. 3L+1T

Module –VII

Kinetics of particles; Newton's second Law; D' Alembert's principle; Principle of work, Energy and power; Principle of conservation of energy. 3L+1T

Module VIII

Impulse and Momentum- Principle of conservation of momentum (both linear and angular). Impact, collision- elastic and inelastic 3L+1T

Books Recommended :

1. Engineering mechanics by Timoshenko, Young, Rao & Pati. – TMH.
2. Engineering Mechanics by Basudeb Bhattacharya- Oxford University press.
3. Fundamentals of Engineering Mechanics by Debabrata Nag & abhijit Chanda – Chhaya Prakashani.
4. Engineering mechanics : Statics and dynamics by I.H. Shames, 4th ed. – PHI.
5. Engineering Mechanics: Statics & Dynamics by Hibbeler & Gupta, 11th ed. – pearson.
6. Engineering mechanics [vol-1 & II] by Meriam & kraige, 5th ed. – Wiley india.

Engineering Drawing & Computer Graphics
ME 191
Contacts : 3P
Credits : 3

A. THEORETICAL PART

1. Introduction to Lines , Lettering, Dimensioning, Scales. – 1L
2. Geometrical Construction and curves. – 1L
3. Projection of points, Lines and Surfaces. – 2L
4. Projection of solids. – 2L
5. Isometric Views. – 1L
6. Sectional Views. - 1L
7. Development of Surfaces. – 1L
8. Introduction to Computer Aided Drafting. – 3L

B. PRACTICAL PART

1. LINES, LETTERING, DIMENSIONING, SCALES: Plain scale, Diagonal scale. - 6hrs.
2. GEOMETRICAL CONSTRUCTION AND CURVES : Construction of Polygons, Parabola, Hyperbola , Ellipse. – 6 hrs.
3. PROJECTION OF POINTS, LINES, SURFACES : Orthographic projection – 1st and 3rd angle projection, Projection of lines and surfaces – Hexagon. – 3 hrs.
4. PROJECTION OF SOLIDS : Cube, Pyramid, prism, Cylinder, Cone. – 6 hrs.
5. DRAWING ISOMETRIC VIEW FROM ORTHOGONAL / SECTIONAL VIEWS OF SIMPLE SOLID OBJECTS. – 3 hrs.

6. FULL AND HALF SECTIONAL VIEWS OF SOLIDS. – 3 hrs.
7. DEVELOPMENT OF SURFACES : Prism , Cylinder, Cone. – 3 hrs.

Books Recommended :

1. Narayana, K.L. and Kannaiah, P. Text Book of engineering Drawing " Engineering Graphics", scitech Bhatt, N.D. "Elementary Engineering Drawing", Charotar Book Stall, Anand,1998.
2. Lakhsminarayanan, v. and Vaish Wanar, R.S., " Engineering Graphics", Jain brothers, New Delhi,1998.
3. Chandra, A.M. and Chandra Satish, " Engineering Graphics", Narosa, 1998.
4. Jolhe, " Engineering Graphics", Tata Mc Graw –Hill – WBUT Series.
5. Gill, P.S., " A Text Book of Engineering Drawing", Katson Publishing House (Kataria and Sons).
6. Venugopal, K., " Engineering Drawing & Graphics+ AUTO CAD", New Age International.
7. Venkata Reddy K., " Text Book of Engineering Drawing (2nd Edition)", BS Publication.

XC -181 Extra Curricular Activities 0-0-2-2-1:

a) Creating awareness in social issues
b) Participating in mass education programmes
c) Proposal for local slum area development
d) Waste disposal
e) Environmental awareness
f) Production Oriented Programmes
g) Relief & Rehabilitation work during Natural calamities

Creating awareness in social issues:

1. Women's development – includes health, income-generation, rights awareness.
2. Hospital activities – Eg. writing letters for patients, guiding visitors
3. Old age home – visiting the aging in-mates, arranging for their entertainment.
4. Children's Homes - visiting the young in-mates, arranging for their entertainment
5. Linking with NGOs to work on other social issues. (Eg. Children of sex-workers)
6. Gender issues- Developing an awareness, to link it with Women's Cell of college

Participating in mass education programmes

1.Adult education
2. Children's education

Proposal for local slum area development

One or two slums to be identified and according to the needs, activities to be developed and proposals and reports are to be submitted.

Environmental awareness

- Resource conservation – Awareness to be developed on water, energy,soil.
- Preservation of heritage monuments- Marches, poster campaigns
- Alternative energy consciousness amongst younger school-children.
- Plantation and beautification- Plantation of trees, their preservation and upkeep, developing NSS parks.
- Waste disposal- Proper methods of domestic waste disposal.

Production Oriented Programmes

5. Working with people and explaining and teaching improved agricultural practices
6. Rodent control land pest control practices;
7. Soil-testing, soil health care and soil conservation;
8. Assistance in repair of agriculture machinery;
9. Work for the promotion and strengthening of cooperative societies in villages;
10. Assistance and guidance in poultry farming, animal husbandry, care of animal health etc.;
11. Popularization of small savings and
12. Assistance in procuring bank loans

Relief & Rehabilitation work during Natural calamities

g) Assisting the authorities in distribution of rations, medicine, clothes etc.;
h) Assisting the health authorities in inoculation and immunization, supply of medicine etc.;
i) Working with the local people in reconstruction of their huts, cleaning of wells, building roads etc.;
j) Assisting and working with local authorities in relief and rescue operation;Collection of clothes and other materials, and sending the same to the affected areas;

2nd semester:

HU-202 Economics for Engineers 3-0-0-3-3:

1. **Financial Accounting**: Meaning, Nature and scope of Financial Accounting, Accounting concepts & conventions, Business Transactions, Different types of Vouchers, Analysis of Transactions, Recording in Journals and cash books, Posting of Ledgers, Preparation of Trial balance, Preparation of Final Accounts (Trading Account, Profit & Loss A/C and Balance Sheet)
2. **Cost Accounting:** Introduction, Classification of Costs; Break-even Analysis; Budgeting & Budgetary Control, Objectives, Advantages & Limitations of Budgeting, Cash Budget, Flexible Budget, Master Budget, etc
3. **Financial Management:** Cost of Capital: Capital Budgeting, Working Capital Management
4. **Economics**

   Introduction: Scarcity and Choice. Definition and Scope of Economics. Concept of Equilibrium. Concept of Market.

   Demand and Revenue Analysis: Meaning of demand, Determinants of demand, Exception to the law of demand. Elasticity of demand- Meaning, Price Elasticity of demand. Price Elasticity of Supply.

   Cost and Production Analysis: Cost concept: Classification of cost- Cost output relationship- Cost function and its determinants, uses of Cost function. Production: Meaning, Factors of production- Land, Labour, capital and organization.

References

1 Modern Accountancy A. Mukherjee & M. Hanif Tata McGraw- Hill
2 Accountancy (Vol.1) Dr. S.K. Paul New Central Book Agency
3 Practice in Accountancy S. P. Basu & Monilal Das Rabindra Library
4 Modern Economic Theory K.K. Dewett S.Chand
5 Fundamentals of Economic Principles and problems : A. Banerjee & D. Maumder; ABS Publishing House
6 Economics for Business John Sloman & Mark Sutdiffe Pearson Education
7 Management Accounting R.K. Sharma & S. Gupta Kalyani Publishers
8 Financial Management Dr. S. Kr. Paul New Central Book Agency
9 Financial Management Dr. D. Majumder; Sk. Raju Ali & Lutfun Nesha; ABS Publishing
10. S. A. Sherlekar & V.S. Sherlekar : Modern Business Organization & Management, Himalay Publishing House

EE-201: Basic Electrical Engineering 3-1-0-4-4

Introduction: Overview of Source of energy, Generation, Transmission and Distribution of Electric Power.

DC Network: Introduction of Electric Circuit, Loop Analysis, Node-voltage analysis. Star - Delta & Delta-star Transformations, Superposition Theorem, Thevenin's Theorem, Norton's theorems, Analysis of dc network in presence of one non-linear element, Transients in R-L , R-C and R-L-C circuits.

Single-phase AC Network: Single-phase AC Circuits, Generation of Sinusoidal Voltage Waveform (AC) and Some Fundamental Concepts, Representation of Sinusoidal Signal by a Phasor, Current and Resonance in R-L-C Series and parallel Circuits.

Three-phase AC Network: Three-phase AC Circuits, Three-phase Balanced Supply, Three-phase Delta-Connected Balanced Load, Power in a Three-phase Circuit.

Magnetic Circuits: Magnetic circuits, Core losses, Eddy Current & Hysteresis Loss.

Transformer: Ideal & Practical Transformer, Testing, Efficiency & Regulation, Three Phase Transformer, Auto-Transformer, Problem solving on Transformers

Three-phase Induction Motor: Construction, Principle of Operation, Rotating Magnetic Field, Equivalent Circuit, Power Flow Diagram, Torque-Slip (speed) Characteristics in Three-phase Induction Motor, Starters for Induction Motor.
DC Machines: , Constructional Features, Principle of Operation, EMF & Torque Equation of D.C Machines, D.C Generators, D.C Motors, Losses, Efficiency and Testing of D.C. Machines, Problem Solving on D.C Machines.
Measuring Instruments: Study of DC-AC Measuring Instruments, Study of Electro-Dynamic Type Instrument, Study of Single Phase Induction Type Energy Meter.
General structure of electrical power system: Power generation to distribution through overhead lines and under ground cables with single lone diagram.

Text books:

1. Basic Electrical engineering, D.P Kothari & I.J Nagrath, TMH, Second Edition
2. Fundamental of electrical Engineering, Rajendra Prasad, PHI, Edition 2005.
3. Basic Electrical Engineering, V.N Mittle & Arvind Mittal, TMH, Second Edition
4. Basic Electrical Engineering, J.P. Tewari, New age international publication

Reference books:

1. Basic Electrical Engineering(TMH WBUT Series), Abhijit Chakrabarti & Sudipta Nath, TMH
2. Electrical Engineering Fundamental, Vincent.D.Toro, Pearson Education, Second Edition.
2. Hughes Electrical & Electronics Technology, 8/e, Hughes, Pearson Education.
3. Basic Electrical Engineering, T.K. Nagsarkar & M.S. Sukhija, Oxford
4. Introduction to Electrical Engineering, M.S. Naidu & S, Kamakshaiah, TMH
5. Basic Electrical Engineering, J.J. Cathey & S.A Nasar, TMH, Second Edition.

EE-291: Basic Electrical Engineering Lab. 0-0-3-3-2

List of Experiments:
1. Characteristics of Fluorescent lamps
2. Characteristics of Tungsten and Carbon filament lamps
3. (a) Verification of Thevenin's theorem.
   (b) Verification of Norton's theorems.
4. Verification of Maximum power theorem.
5. Verification of Superposition theorem
6. Study of R-L-C Series circuit
7. Study of R-L-C parallel circuit
8. Calibration of ammeter and voltmeter.
9. Open circuit and Short circuit test of a single phase Transformer.
10. No load characteristics of D.C shunt Generators
11. Starting and reversing of speed of a D.C. shunt
12. Speed control of DC shunt motor.
13. Measurement of power in a three phase circuit by two wattmeter method

CH-201 Chemistry-I 3-1-0-4-4:

Module 1: Chemical Thermodynamics

Concept of Thermodynamic system: Definition with example of diathermal wall, adiabatic wall, isolated system, closed system, open system, extensive property, intensive property.
Introduction to first law of thermodynamics: Different statements, mathematical form.
Internal energy: Definition, example, characteristics, physical significance, mathematical expression for change in internal energy, expression for change in internal energy for ideal gas.
Enthalpy: Definition, characteristics, physical significance, Mathematical expression for change in Enthalpy, Expression for change in enthalpy for ideal gas. **3L**

Heat Capacity: Definition, classification of heat capacity (C_p and C_V): Definition and general expression of C_p–C_V. Expression of C_p–C_V for ideal gas.

Reversible and irreversible processes: Definition, work done in isothermal reversible and isothermal irreversible process for ideal gas, adiabatic changes: Work done in adiabatic process, interrelation between thermodynamic parameters (P, V and T), slope of P–V curve in adiabatic and isothermal process.

Application of first law of thermodynamics to chemical processes: exothermic, endothermic processes, law of Lavoisier and Laplace, Hess's law of constant heat summation, Kirchhoff's law. **3L**

2nd law of thermodynamics: Statement, mathematical form of 2nd law of thermodynamics (Carnot cycle). Joule Thomson and throttling processes; Joule Thomson coefficient for ideal gas, concept of inversion temperature. Evaluation of entropy: Characteristics and expression, entropy change in irreversible cyclic process, entropy change for irreversible isothermal expansion of an ideal gas, entropy change of a mixture of gases. **2L**

Work function and free energy: Definition, characteristics, physical significance, mathematical expression of ΔA and ΔG for ideal gas, Maxwell's Expression (only the derivation of four different forms), Gibbs Helmholtz equation, condition of spontaneity and equilibrium reaction. **2L**

Module 2: Industrial Chemistry and Polymerization

Industrial chemistry

Solid Fuel: Coal, classification of coal, constituents of coal, carbonization of coal (HTC and LTC), coal analysis: Proximate and ultimate analysis.

Liquid fuel: Petroleum, classification of petroleum, refining, petroleum distillation, thermal cracking, octane number, cetane number, aviation fuel (aviation gasoline, jet gasoline), and bio-diesel.

Gaseous fuels: Natural gas, water gas, coal gas, bio-gas. **5L**

Polymerization

Concepts, classifications and industrial applications

Polymer molecular weight (number avg. weight avg. viscosity avg.: Theory and mathematical expression only), Poly dispersity index (PDI).

Polymerization processes (addition and condensation polymerization), degree of polymerization, copolymerization.

Preparation, structure and use of some common polymers: plastic (PE: HDPE, LDPE), rubber (natural rubber, SBR), fibre (nylon 6.6). Vulcanization, conducting and semi-conducting polymers.

Module 3: Reaction dynamics, and structure and reactivity of organic molecules

Reaction dynamics: Reaction laws: rate and order; molecularity; zero, first and second order kinetics. Pseudounimolecular reaction, Arrhenius equation. Mechanism and theories of reaction rates (Transition state theory, Collision theory:). Catalysis: Homogeneous catalysis (Definition, example, mechanism, kinetics). **3L**

Structure and reactivity of Organic molecules

Electronegativity, electron affinity, hybridisation, Inductive effect, resonance, hyperconjugation, electromeric effect, carbocation, carbanion and free radicals. Brief studies on some addition, elimination, and substitution reactions. **3L**

Module 4: Electrochemistry

Conductance: Conductance of electrolytic solutions, specific conductance, equivalent conductance, molar conductance and ion conductance, effect of temperature and concentration (strong and weak electrolyte). Kohlrausch's law of independent migration of ions, transport numbers, and hydration of ions.

Conductometric titrations: SA vs SB & SA vs WB; precipitation titration KCl vs $AgNO_3$. **2L**

Electrochemical cell: Cell EMF and its thermodynamic derivation of the EMF of a Galvanic cell (Nernst equation), single electrode potentials, hydrogen half cell, quinhydrone half cell and calomel half cell (construction, representation, cell reaction, expression of potential, discussion, application). Storage cell, fuel cell (construction, representation, cell reaction, expression of potential, discussion, application). Application of EMF measurement on (a) ascertain the change in thermodynamic function (ΔG, ΔH, ΔS) (b) ascertain the equilibrium constant of a reversible chemical reaction (c) ascertain the valency of an ion. **3L**

Module 5: Solid state and coordination chemistry

Solid state Chemistry: Introduction to stoichiometric defects (Schottky & Frenkel) and non – stoichiometric defects (Metal excess and metal deficiency). Role of silicon and germanium in the field of semiconductor. **2L**

Coordination chemistry: Double salt, complex salt, Werner's theory of coordination compounds, coordination number, ligand, chelate, stability constant: stepwise and overall. **2L**

Reference Books

1. P. C. Rakshit, Physical Chemistry, Sarat Book House (7th Edition).
2. S. Glasstone, Text Book of Physical Chemistry, Macmillan India Limited.
3. S. Pahari, Physical Chemistry, New Central Book Agency.
4. S. Sarkar, Fuels and Combustion, Taylor & Francis (3rd Edition), 2009
5. P. Ghosh, Polymer Science and Technology of Plastics and Rubbers, Tata McGraw Hill Publishing Company Limited.
6. F.W. Billmeyer: Textbook of Polymer Science is published by Wiley India (is now an Indian print).
7. Joel R. Fried, Polymer Science and Technology, Pearson Education (2nd Edition).
8. I. L. Finar, Organic Chemistry, Addison Wesley Longman, Inc.
9. Physical Chemistry, Atkins, 6th Edition, Oxford Publishers.
10. Organic Chemistry, Mark Loudon, 4th Edition, Oxford Publishers.
11. Inorganic Chemistry–R. L. Dutta, Current Distributors

CH-291 Chemistry-I Lab. 0-0-3-3-2:

List of Experiments

1. To Determine the alkalinity in a given water sample.
2. Redox titration (estimation of iron using permanganometry)
3. To determine calcium and magnesium hardness of a given water sample separately.
4. Estimation of available chlorine in bleaching powder.
5. To determine chloride ion in a given water sample by argentometric method (using chromate indicator solution).
6. Heterogeneous equilibrium (determination of partition coefficient of acetic acid between n-butanol and water)
7. Viscosity of solutions (determination of percentage composition of sugar solution from viscosity)
8. Conductometric titration for determination of the strength of a given HCl solution by titration against a standard NaOH solution.
9. pH- metric titration for determination of strength of a given HCl solution against a standard NaOH solution.
10. Determination of dissolved oxygen present in a given water sample.
11. Estimation of available oxygen in pyrolusite.

M-201 Mathematics-II 3-1-0-4-4:

Module I

***Ordinary differential equations (ODE)- First order and first degree*:** Exact equations, Necessary and sufficient condition of exactness of a first order and first degree ODE (statement only), Rules for finding Integrating factors, Linear equation, Bernoulli's equation. General solution of ODE of first order and higher degree (different forms with special reference to Clairaut's equation). **6L**

Module II

***ODE- Higher order and first degree*:** General linear ODE of order two with constant coefficients, C.F. & P.I., D-operator methods for finding P.I., Method of variation of parameters, Cauchy-Euler equations, Solution of simultaneous linear differential equations. **7L**

Module III

Partial Differential Equations: Origin of PDE, its order and degree, concept of solution in PDE. Solution of First Order Partial differential equation by Lagrange's Method, Integral Surfaces passing through a given curve, Solution of non-linear first order partial differential equations by Charpit's method, Solution of Second order Linear partial Differential equations with constant coefficients and with variable coefficients. **14L**

Module IV

***Improper Integral*:** Basic ideas of improper integrals, working knowledge of Beta and Gamma functions (convergence to be assumed) and their interrelations. **3L**

Laplace Transform (LT): Definition and existence of LT, LT of elementary functions, First and second shifting properties, Change of scale property; LT of $\frac{f(t)}{t}, t^n f(t), f^{(n)}(t)$ and $\int f(u)du$. Evaluation of improper integrals using LT, LT of periodic and step functions, Inverse LT**:** Definition and its properties; Convolution Theorem (statement only) and its application to the evaluation of inverse LT, Solution of linear ODE with constant coefficients (initial value problem) using LT. **10L**

Total 40 Lectures

Suggested Reference Books:

1**. Advanced Engineering Mathematics**, Erwin Kreyszig, (Wiley Eastern)
2. **Engineering Mathematics:** B.S. Grewal (S. Chand & Co.)
3. **Engineering Mathematics (Volume 2):** S. S. Sastry (Prentice-Hall of India)
4. **Advanced Engineering Mathematics, 3E**: M.C. Potter, J.L. Goldberg and E.F. Abonfadel (OUP), Indian Edition
5. **An Introduction to Differential Equations**, R.K. Ghosh and K.C.Maity (New Central Book Agency)
6. **Elements of Partial Differential Equations**, I. N. Sneddon, (McGraw-Hill International)
7. **Laplace Transforms**, M. R. Spiegel(MGH)

EC-201 Basic Electronics Engineering 3-1-0-4-4:

Pre-requisite: Knowledge of class XII level Physics and Mathematics

Introduction: Basic ideas on different circuit components (Resistor, Inductor, Capacitor) 1L

Module – 1: Semiconductors: **4L**

Crystalline material: Mechanical properties, Conductors, Semiconductors and Insulators: electrical properties. Energy band theory, Fermi levels; Semiconductors: intrinsic and extrinsic, energy band diagram, electrical conduction phenomenon, P-type and N-type semiconductors, drift and diffusion carriers.

Module – 2: Diodes and Diode Circuits: 3L+3L = 6L

Formation of P-N junction, energy band diagram, built-in-potential, forward and reverse biased P-N junction, formation of depletion region, Junction capacitance, V-I characteristics of diode, Simple diode circuits, load line, linear piecewise model; Rectifier circuits: half wave, full wave, (PIV, DC voltage and current, ripple factor, efficiency), idea of regulation, rectifier filter circuits, clipper, clamper, voltage multiplier circuits, breakdown mechanism of diodes, Zener diode,Varactor diode.

Module – 3: Bipolar Junction Transistors : **5L+2L=7L**

Formation of PNP / NPN junctions, energy band diagram; current flow diagram, transistor mechanism and transistor principles, CE, CB, CC configuration, transistor input output characteristics: amplification factors for CB,CC and CE modes. Biasing and Bias stability: calculation of stability factor; small signal analysis, h-parameter model.

Module – 4: Field Effect Transistors: **5L**

Concept of Field Effect Transistors (channel width modulation), Gate isolation types, JFET Structure and characteristics, MOSFET Structure and characteristics, depletion and enhancement type; CS, CG, CD amplifier configurations, FET parameters, small signal equivalent circuits for different configurations; CMOS: Basic Principles.

Module – 5: Feed Back Amplifier and Operational Amplifiers: **4L+4L = 8L**

Positive and negative feed back, close loop gain, open loop gain, topologies of feed back amplifier,:output impedance, input impedance, sensitivities (qualitative), bandwidth stability; effect of positive feed back: instability and oscillation, condition of oscillation, Barkhausen criteria. Introduction to integrated circuits, open loop characteristics of operational amplifier; Application of operational amplifier; inverting and non-inverting mode of operation, Adders, Subtractors, Constant gain multiplier, Voltage follower, Comparator, Integrator, Differentiator. OPAMP parameters: CMRR, OFFSET parameters, slew rate.

Module – 6: Special Semiconductor devices: **3L**

SCR, DIAC, TRIAC, UJT, IGBT- structure, characterization, principle of operation and applications.

Module – 7: Cathode Ray Oscilloscope (CRO) **4L**

CRT structure**,** block diagram, operation, Deflection systems, sweep circuit operation, basic block of CRO, applications of CRO, Frequency,phase and amplitude measurement using CRO, Lissajous figure.

Module – 8:Digital Electronics: **2L**

Introduction to binary number; Basic Boolean algebra;,De Morgan's Theorem, Logic gates.

Outcome: The students will be able to select proper electronics component and device depending on the requirement.The student should be able to use required rectifier circuit and to calculate it's different parameters. The students must be able to design a transistor amplifier.

Recommended Books:

Text.

1. Chattopadhyay & Rakshit:Electronics Fundamentals & Applications
2. Millman & Halkias: Integrated Electronics References:
1. Boylestad & Nashelsky: Electronic Devices & Circuit Theory
2. Sanjeev Gupta: Electrinics Devices Circuits
3. Malvino: Electronic Principle

EC-291 Basic Electronics Engineering Lab. 0-0-3-3-2:

There will be a couple of familiarization lectures before the practical classes are undertaken where basic concept of the instruments handled Eg: CRO, Multimeters etc will be given.

List of Experiments:

1. Familiarisation with passive and active electronic components such as Resistors, Inductors, Capacitors, Diodes, Transistors (BJT) and electronic equipment like DC power supplies, multimeters etc.
2. Familiarisation with measuring and testing equipment like CRO, Signal generators etc.
3. Study of I-V characteristics of Junction diodes.
4. Study of I-V characteristics of Zener diodes.
5. Study of Half and Full wave rectifiers with Regulation and Ripple factors.
6. Study of I-V characteristics of BJTs.
7. Study of Characteristic curves for CB, CE and CC mode transistors
8. Study of I-V characteristics of Field Effect Transistors.
9. Determination of input-offset voltage, input bias current and Slew rate of OPAMPs.
10. Determination of Common-mode Rejection ratio, Bandwidth and Off-set null of OPAMPs.
11. Study of OPAMP circuits: Inverting and Non-inverting amplifiers, Adders, Integrators and Differentiators.

ME-292 Workshop Practice 0-0-3-3-2:

Jobs:

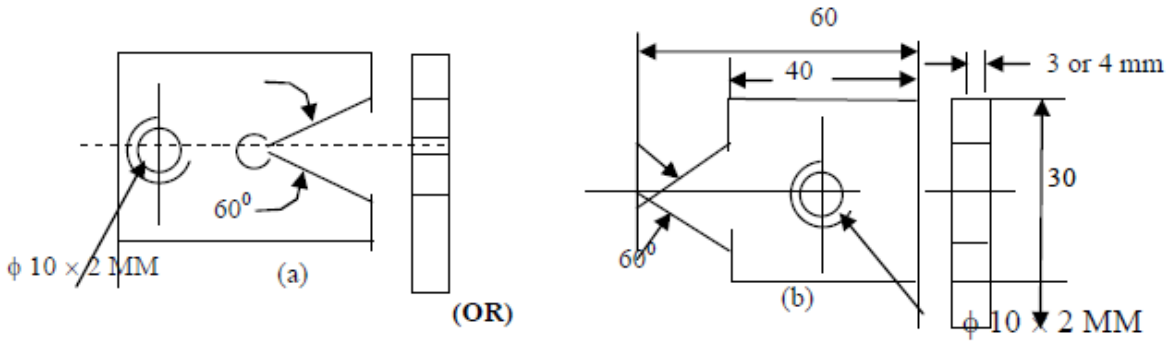

Fig.1: Job for fitting practice

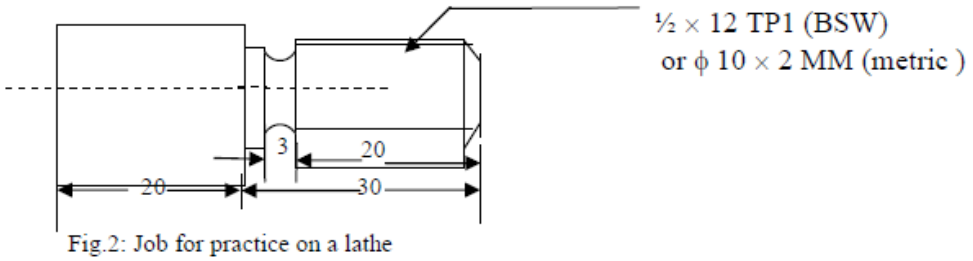

Fig.2: Job for practice on a lathe

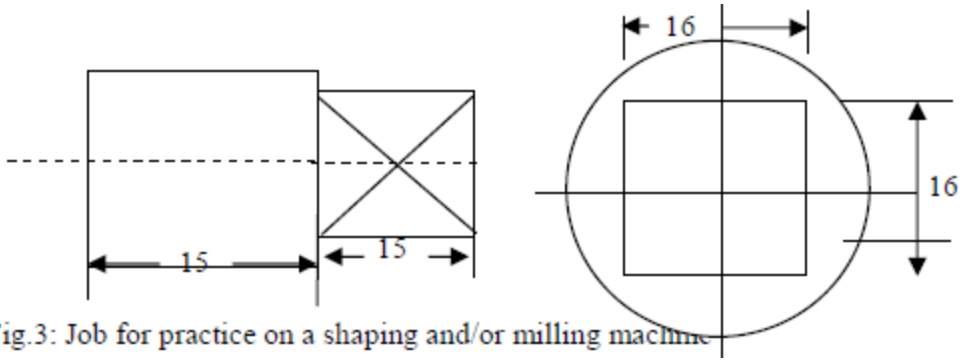

Fig.3: Job for practice on a shaping and/or milling machine

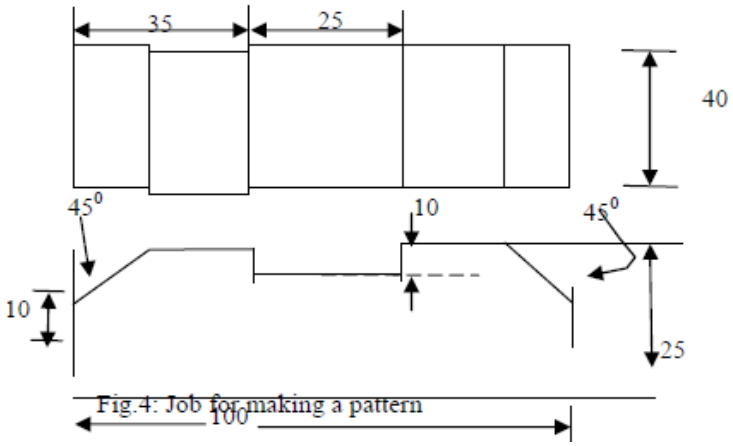

Fig.4: Job for making a pattern

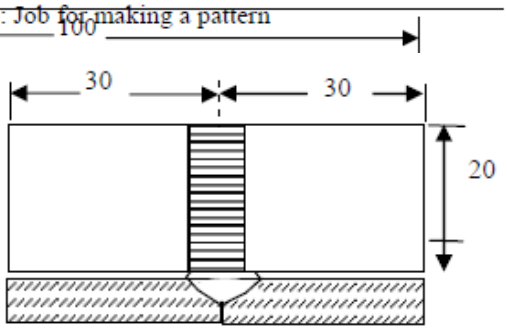

Fig.5: Welding specimen for practice

1. FITTING : Making a gauge from MS plate as shown in Fig.1.

Operations required:

a. Squaring and finishing of the blank by filing
b. Making the Vee-portion by sawing and filing
c. Drilling (in machine) and tapping (hand)

2. MACHINING : To make a pin as shown in Fig.2 from a □20mm mild steel rod in a lathe.
3. MACHINING : To make a MS prism as shown in Fig.3 from a □20mm mild steel rod in a shaping and / or milling machine.
4. PATTERN MAKING, SAND MOULDING AND CASTING: To make a wooden pattern and a sand mould with that pattern for casting a cast iron block as shown in Fig.4.
5. WELDING (GAS WELDING): To join two thin mild steel plates or sheets (1 to 3mm thick) as shown in Fig. 5 by gas welding.
6. WELDING (ARC WELDING) : To join two thick (6mm) MS plate as shown in Fig. 5 by arc welding.
7. SHEET METAL WORK (in 1 day or 3 hours); Forming a cone, for example.

SEMESTER – III

HU-301 VALUES & ETHICS IN PROFESSION 3-0-0-3-3:

Science, Technology and Engineering as knowledge and as Social and Professional Activities.
Effects of Technological Growth: Rapid Technological growth and depletion of resources, Reports of the Club of Rome. Limits of growth: sustainable development
Energy Crisis: Renewable Energy Resources, Environmental degradation and pollution. Eco-friendly Technologies. Environmental Regulations, Environmental Ethics,
Appropriate Technology Movement of Schumacher; later developments Technology and developing notions. Problems of Technology transfer, Technology assessment impact analysis.
Human Operator in Engineering projects and industries. Problems of man, machine, interaction, Impact of assembly line and automation. Human centered Technology.
Ethics of Profession: Engineering profession: Ethical issues in Engineering practice, Conflicts between business demands andprofessional ideals. Social and ethical responsibilities of Technologists.Codes of professional ethics. Whistle blowing and beyond, Case studies.
Profession and Human Values: Values Crisis in contemporary society
Nature of values: Value Spectrum of a good life
Psychological values: Integrated personality; mental health
Societal values: The modern search for a good society, justice, democracy, secularism, rule of law, values in Indian Constitution.
Aesthetic values: Perception and enjoyment of beauty, simplicity, clarity
Moral and ethical values: Nature of moral judgements; canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility.
Books:

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

PH301 : :Physics-II Contacts : 3L + 1T Credits : 4

Module 1:Vector Calculus:

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

Module 2 :Electricity

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

2.2 Dielectrics-concept of polarization, the relation $D=\varepsilon 0E+P$, Polarizability. Electronic polarization and polarization in monoatomic and polyatomic gases.

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

Module 4: Electromagnetic Theory:

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

5:Quantum Mechanics: 5.1 Generalised coordinates, Lagrange's Equation of motion and Lagrangian, generalised force potential, momenta and energy. Hamilton'sEquation of motion and Hamiltonian. Properties of Hamilton and Hamilton's equation of motion.

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

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

Module 6: Statistical Mechanics:

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

Electrical Machines, EE(ME) 301, Contacts: 3L , Credits- 3

Topic	Periods
Module-I: DC Machines:	
• EMF generated in the armature. Methods of Excitation, Armature reaction & its effect in the performance, Methods of decreasing the effects of Armature reaction, Effect of Brush shift. Commutation process.	3
• Operating Characteristics of DC Generators: Separately Excited generators, Shunt Generators, Series Generators and Compound Generators.	2
• Torque equation of D.C motor, Operating Characteristics of Shunt, Series & Compound motors.	2

• Losses and efficiency of DC machines, Hopkinson's and Swinburne's test	2
• D.C Machine application: Generator application, Motor application	1
Module-II: 3-Phase Induction machine:	
• Induction motor as a Transformer, Flux and MMF phasors in Induction motors,	1
• Equivalent circuit, Performance equations, Induction motor phasor diagram	2
• Toque-slip characteristic, Power slip characteristic.	1
• Speed control of Induction motor	2
• Polarity Test, Application of Polyphase Induction motor.	1
Module-III: Synchronous Machines:	
• Construction, Types, Excitation system, Generator & motor modes	2
• Armature reaction, Theory of salient pole machine, Two reaction theory, Voltage regulation	3
• Parallel operation of alternators, Synchronous machine connected to infinite bus, effect of change of excitation and speed of prime mover.	3
• Starting of Synchronous motor, V-Curve, Damper winding, Hunting.	2
Module-IV: Fractional Kilowatt motors:	
• Single phase Induction motor: Construction, Double revolving field theory. Starting methods, Speed - torque characteristics, Phasor diagram, Application	3
• Principle of operation of AC servo motors, Stepper motors, Tacho generators, BL DC	3

Text Books:

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

Reference Books:

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

ME301 : Thermodynamics
Contacts : 4 (3 L + 1 T)
Credits : 4

Module No.	Syllabus Details	Hours
1.	01. Review of fundamentals; Concept of Thermodynamic Systems, Properties, Heat and Work, Zeroth Law, Equilibrium concepts, First Law of Thermodynamics, First Law analysis for steady and unsteady flow systems, Limitations of First Law.	03
2.	02. Second Law of Thermodynamics; Statements, Equivalence of Statements; Carnot's Theorem, the corollaries & proof; The concept of Entropy; Clausius' Theorem, The Inequality of Clausius, Tds equations and calculation of entropy change; Principle of Increase of Entropy, the Entropy Generation concepts, Entropy balance for closed and open systems. 03. Exergy; Concepts, Reversible work and Irreversibility, Exergy of a system, The decrease of Exergy principle and Exergy destruction, Exergy balance for closed and open systems, Second Law efficiency.	07 04
3.	04. Pure Substance, Properties of pure substance; Phases of pure substances – Phase rule; Phase Change Processes of Pure Substances – Triple point, Critical point; Property diagrams for Phase change Processes; Quality of steam, Property Tables for compressed liquid, saturated, wet &	04

	superheated vapour.	
4.	05. Thermodynamic Relations : Important mathematical relations, Cyclic rule, Maxwell relations; Thermodynamic relations involving entropy, enthalpy and other properties; Clapeyron equation, Joule Thompson co-efficient, Compressibility and expansion co-efficients.	04
5.	06. Air Standard Cycles : Otto, Diesel, Dual, Stirling and Brayton cycles. Comparison among Otto, Diesel & Dual cycles. 07. Reciprocating air compressors; the compressor cycle with and without clearance, efficiencies; volumetric efficiency & its effect on performance; Multistaging.	03 03
6.	08. Vapour power cycles & its modifications, Reheat & Regenerative cycles, Super Critical Rankine cycle, Binary cycle and Cogeneration.	05
7.	09. Refrigeration cycles, Reversed Carnot cycle; Components and analysis of simple Vapour Compression Refrigeration cycle, Actual Refrigeration cycles, Vapour Absorption Refrigeration cycle, Gas Refrigeration cycle. 10. Use of psychometric charts & concepts of related parameters. Processes for Air Conditioning.	04 03

Total = 40

Books recommended : (Latest editions of Books)

1. Thermodynamics - an Engineering approach by Y. A. Cengel & M. A. Boles, TMH
2. Fundamentals of Engineering Thermodynamics by M. J. Moran & H. N. Shapiro, John Wiley
3. Fundamentals of Thermodynamics by R. E. Sonntag, C. Borgnakke & G. J. Van Wylen, Wiley - India
4. Engineering Thermodynamics by P. K . Nag, TMH
5. Thermodynamics by C. P. Arora , TMH
6. Thermodynamics by Kenneth Wark , McGraw Hill
7. Statistical Thermodynamics by John Lee, Francis Sears and Donald Turcotte, Addison-Wesley Pub.

Strength of Materials
ME 302
Contacts: 3L + 1T
Credits- 4

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

	theorem, superposition method.	
6.	Theory of columns; eccentric loading of short strut; column buckling: Euler load for columns with pinned ends and other end restraints; Euler's curve; emperical column formulae – (i) straight line, (ii) parabolic and (iii) Rankine Gordon.	6L

Books Recommended:

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

ME303
Engineering Materials
Contacts: 3L
Credits: 3

Introduction : Material Science — its importance in engineering Classification of Materials — metals, polymers , ceramics, composites; Advanced materials—semiconductors, smart materials, nano –materials.

Crystal Structure : Fundamental concepts ; Unit cells ; seven crystal systems ; single crystal , polycrystalline and non - crystalline materials ; Metallic crystal structures—FCC , BCC & HCP structures , Co - ordination number , Atomic Packing Factor, Planar Atomic Density,Miller Indices.

Imperfections in Metals : Point defect, Line Defect, Surface Defect .

Phase Diagrams : Alloys and solid solutions, Definition and basic concepts ; solubility limit ; Phase equilibrium, Onediagram,binary phase diagram , interpretation of phase diagrams. Gibb's phase rule, Type I, II & III Equilibrium Phase Diagram, Lever Rule, Nucleation and grain growth.

Iron-carbon System: Allotropy of iron, iron-carbon modified phase diagram, properties and uses of plain carbon steel, Isothermal Transformation-TTT diagram, CCT diagram.

Heat Treatment : Definition and purposes; Heat treatment processes for steels-Annealing, Normalising, Hardening & Harden ability, Tempering , Martempering , Austempering , Surface Hardening - Carburising , Nitriding , Flame Hardening , Induction Hardening ; Precipitation or Age Hardening of non-ferrous alloys , Major defects in faulty Heat treatment., Heat Treatment Furnaces.

Classification of Metals and Alloys- compositions, general properties and uses:

Ferrous alloys : Classification – low carbon steels , medium carbon steels , high carbon steels , stainless steels, alloy steels, tool and die steel, cast irons.

Non-ferrous alloys : Copper & Copper alloys ; Aluminium alloys ; Zinc alloys ; Nickel alloys ; Lead & Tin alloys.

Mechanical Properties of Materials : Elastic properties of materials — tensile and compressive stress and strain , tress-strain behaviour, modulus of elasticity (Young's modulus), yield strength, tensile strength, plastic deformation, true stress and strain ; Ductility ; Resilience ; Toughness , impact tests ; Hardness - Brinell , Rockwell and Vickers hardness and their testing procedures , correlation between hardness and tensile strength ; Fatigue strength ; Effect of temperature on tensile strength & impact properties , creep failure.

Thermal, Electrical ,Optical and Magnetic properties of material : Basic properties and application.

Polymers & Elastomers : Definition ; How polymers are made - polymerization ; Polymer molecular structures ; Thermoplastics & Thermosetting ,; Special characteristics like low sp. gravity, optical, electrical & thermal property, decorative colour, easy formability ,low corrosion etc; Uses of polymers and elastomers.

Ceramic Materials: What is ceramics; common ceramic materials and their characteristics; How ceramics are made— sintering process; Ceramic structures; Properties and applications.

Composite materials: What is composites ; Polymers matrix and their applications ; Metal matri and ceramic matrix composites and their applications; How composites are made.

Corrosion and Degradation of Engineering Materials : Definition ; Types of corrosion —uniform, pitting, crevice, Galvanic , stress corrosion cracking and erosion ; Corrosion control — material selection , environment control , proper design .

Materials Selection Methodology : Selection of material based on required properties , availability and cost of material, environmental issues.

Recommended Books :

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

ME 391: Machine Drawing –I
Contact Period: 3P
Credits: 2

Schematic product symbols for standard components in mechanical, electrical and electronic systems, welding symbols and pipe joints;

Orthographic projections of machine elements, different sectional views- full, auxiliary sections;

Isometric projection of components;

Assembly and detailed drawings of a mechanical assembly, such as a plummer block, tool head of a shaping machine, tailstock of a lathe, welded pipe joints indicating work parts before welding, etc.

Practice of AutoCAD or similar graphic software for drawing 2-D orthographic and isometric views of a component.

(At Least Six Sheets must be drawn)

1. Machine Drawing by K. L. Narayana, P. Kannaiah, K. Vnkata Reddy, New Age International Publishers
2. Machine Drawing by N.D. Bhatt, V. M. Panchal, Chrotar Publishing House Pvt. Ltd.
3. Machine Drawing by P.S. Gill, S. K. Kataria & Sons
4. Machine Drawing with AutoCAD by G. Pohit & G. Ghosh, Pearson Education

CE(ME)-392 : Strength of Materials Lab
Contacts: 3P
Credits: 2

Verification of Varignon's theorem

Determining spring stiffness under tension and compressive loads; Strain gauge based strain/ deflection/ force measurement of a cantilever beam; Tension Test and Compression Test of ductile and brittle materials: stress-strain diagram, determination of yield strength, ultimate strength, modulus of elasticity, percentage elongation and percentage reduction in areas, observation of fractured surfaces; Bend and rebend test of flat test pieces, determination of bending stresses; Torsion Test;

Hardness Tests: Brinnel/ Vickers and Rockwell tests, Shore hardness test;

Experiments on friction: determination of coefficient of friction;

Experiments to observe speed ratios obtained using belt pulley and gears, and to evaluate torque and energy required.

Electrical Machines Lab
EE(ME) 391
Contacts: 3P
Credits- 2

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

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

Reference Books:

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

ME-392 : Workshop Practice
Contacts : 3P
Credits : 2

Pattern Making; pattern material, pattern allowances and types of patterns.
1. Make a single piece pattern mould.
2. To make spilt pattern mould.
Mould making Practice: Introduction to moulding materials, moulds, Uses of moulding tools: green sand moulding, gating system, risering system, core making.
1. To make mould and core and assemble it
Introduction to forging tools, equipments and operations, Forgability of metals.
Basic Forging processes like upsetting, drawing down and forge welding;
1. To make a ring of mild steel by cold forging process.
2. To make S-hook by hot forging process.
Practicing Resistance Butt Welding, Shielded Metal Arc Welding and Gas Welding.

Books: -

1. Workshop Technology by Chapman.
2. Manufacturing Processes by Begman.
3. Manufacturing Materials and processes by JS Campbell

SEMESTER – IV

M-402 Mathematics-III 3-1-0-4-4:

Fourier Series: Introduction, Periodic functions: Properties, Even & Odd functions: Properties, Special wave forms: Square wave, Half wave Rectifier, Full wave Rectifier, Saw-toothed wave, Triangular wave.
Euler's Formulae for Fourier Series, Fourier Series for functions of period 2π, Fourier Series for functions

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

Fourier Transform: Fourier Integral Theorem (statement only), Fourier Transform of a function, Fourier Sine and Cosine Integral Theorem (statement only), Fourier Cosine & Sine Transforms. Fourier, Fourier Cosine & Sine Transforms of elementary functions. Properties of Fourier Transform: Linearity, Shifting, Change of scale, Modulation. Examples. Fourier Transform of Derivatives. Examples. Convolution Theorem (statement only), Inverse of Fourier Transform, Examples.

Calculus of Complex Variable : Complex functions, Concept of Limit, Continuity and Differentiability. Analytic functions, Cauchy-Riemann Equations (statement only). Sufficient condition for a function to be
analytic. Harmonic function and Conjugate Harmonic function, related problems. Construction of Analytic functions: Milne Thomson method, related problems**.**

Concept of simple curve, closed curve, smooth curve & contour. Some elementary properties of complex Integrals. Line integrals along a piecewise smooth curve. Examples. Cauchy's theorem (statement only). Cauchy-Goursat theorem (statement only). Examples. Cauchy's integral formula, Cauchy's integral formula for the derivative of an analytic function, Cauchy's integral formula for the successive derivatives of an analytic function. Examples. Taylor's series, Laurent's series. Examples.

Zero of an Analytic function, order of zero, Singularities of an analytic function. Isolated and non-isolated singularity, essential singularities. Poles: simple pole, pole of order m. Examples on determination of singularities and their nature. Residue, Cauchy's Residue theorem (statement only), problems on finding the residue of a given function, evaluation of definite integrals:

$$\int_0^{\infty} \frac{\sin x}{x}\,dx, \quad \int_0^{2\pi} \frac{d\theta}{a+b\cos\theta+c\sin\theta}, \quad \oint_C \frac{P(z)}{Q(z)}\,dz$$

(elementary cases, P(z) & Q(z) are polynomials of 2nd order or less).

Concept of transformation from z-plane to w-plane. Concept of Conformal Mapping. Idea of some standard transformations. Bilinear Transformation and determination of its fixed point.

Probability: Classical definition of probability and its limitation. Axiomatic definition of probability. Conditional probability. Independent events and related problems. Baye's theorem (Statement only) & related problems. One dimensional random variable. Probability distributions-discrete and continuous. Expectation and Varience. Binomial, Poisson, Uniform, Exponential, Normal distributions and related problems.

Partial Differential Equation (PDE): Solution by Separation of variables and Integral Transform(Laplace & Fourier transform) methods:(i) One dimensional Wave equation (ii) One dimensional Heat equation, (iii) Two dimensional Laplace equation.

Series solution of Ordinary Differential Equation (ODE): Validity of the series solution of an ordinary differential equation. General method to solve $a_0(x)\,y'' + a_1(x)y' + a_2(x)\,y = 0$ and related problems. Series solution, Bessel function, recurrence relations of Bessel's Function of first kind. Legendre's equation: Series solution, Legendre function, recurrence relations and orthogonality relation.

Text Books:

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

References:

1. Sneddon, I. N..: Elements of Partial Differential Equations, McGraw-Hill International
2. Kreyzig E.: Advanced Engineering Mathematics, John Wiley and Sons.
3. Potter M.C, Goldberg J.L and Aboufadel E.F.: Advanced Engineering Mathematics, OUP.

4. Ramana B.V.: Higher Engineering Mathematics, TMH.
5. Spiegel M.R. , Lipschutz S., John J.S., and Spellman D., : Complex Variables, TMH.
6. Sneddon, I. N..: Fourier Transforms, Dover
7. Sneddon, I. N..: Use of Integral Transforms, MGH
8. Bhatia, R, Fourier Series, MAA

CH-401: Basic Environmental Engineering & Elementary Biology **3-0-0-3-3:**

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

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

Materials balance: Steady state conservation system, steady state system with non conservative pollutants, step function. Environmental degradation: Natural environmental Hazards like Flood, earthquake, Landslide-causes, effects and control/management; Anthropogenic degradation like Acid rain-cause, effects and control. Nature and scope of Environmental Science and Engineering.

Ecology: Elements of ecology: System, open system, closed system, definition of ecology, species, population,community, definition of ecosystem- components types and function. Structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems, Mangrove ecosystem (special reference to Sundar ban); Food chain ,Food web. Biogeochemical Cycle- definition, significance, flow chart of different cycles with only elementary reaction [Oxygen, carbon, Nitrogen, Phosphate, Sulphur]. Biodiversity- types, importance, Endemic species, Biodiversity Hot-spot, Threats to biodiversity, Conservation of biodiversity.

Air pollution and control :Atmospheric Composition: Troposphere, Stratosphere,Mesosphere, Thermosphere, Tropopause and Mesopause.

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

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

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

Atmospheric dispersion: Maximum mixing depth, ventilation coefficient, effective stack height, smokestack plumes and Gaussian plume model. Definition of pollutants and contaminants, Primary and secondary pollutants: emission standard, criteria pollutant. Sources and effect of different air pollutants- Suspended particulate matter, oxides of carbon, oxides of nitrogen, oxides of sulphur, particulate, PAN. Smog, Photochemical smog and London smog.

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

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

Water Pollution and Control :Hydrosphere, Hydrological cycle and Natural water. Pollutants of water, their origin and effects: Oxygen demanding wastes, pathogens, nutrients, Salts, thermal application, heavy metals, pesticides, volatile organic compounds. River/Lake/ground water pollution: River: DO, 5 dayBOD test, Seeded BOD test, BOD reaction rate constants, Effect of oxygen demanding wastes on river[deoxygenation, reaeration], COD, Oil, Greases, pH. Lake: Eutrophication. Ground water: Aquifers, hydraulic gradient, ground water flow.

Standard and control: Waste water standard [BOD, COD, Oil, Grease], Water Treatment system [coagulation and flocculation, sedimentation and filtration, disinfection, hardness and alkalinity, softening] ,Waste water treatment system,

primary and secondarytreatments [Trickling filters, rotating biologicalcontractor, Activated sludge, sludge treatment, oxidation ponds] tertiary treatment definition. Water pollution due to the toxic elements and theirbiochemical effects: Lead, Mercury, Cadmium, and Arsenic.

Land Pollution: Lithosphere; Internal structure of earth, rock and soil Solid Waste: Municipal, industrial, commercial, agricultural, domestic, pathological and hazardous solid wastes; Recovery and disposal method- Open dumping,Land filling, incineration, composting, recycling.Solid waste management and control (hazardous and biomedical waste). Noise Pollution :Definition of noise, effect of noise pollution, noise classification [Transport noise, occupational noise, neighbourhood noise], Definition of noise frequency, noise pressure, noise intensity, noise threshold limit value, equivalent noise level, Noise pollution control. L

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

References/Books

1. Masters, G. M., “Introduction to Environmental Engineering and Science”, PHI, 1991.
2. De, A. K., “Environmental Chemistry”, New Age International.

M(CS)-401 NUMERICAL METHODS 2-0-0-2-2:

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

Interpolation: Newton forward/backward interpolation, Lagrange’s and Newton’s divided difference Interpolation.

Numerical integration: Trapezoidal rule, Simpson’s1/3 rule, Expression for corresponding error terms.

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

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

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

Text Books:

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

References:

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

ME401
Kinematics of Machines
Contacts : 3L+1T
Credits: 4
Basic Concepts :

Kinematics and Dynamics, Mechanisms, machines, terminology, links, kinematic Pairs & classifications, kinematic chains, mobility and degree of freedom – Kutzbach and Grubler’s criterion, kinematic inversion, Grashof’s law, Mechanical Advantages.

Miscellaneous Mechanism and Intermittent Motion Mechanisms : Reciprocating mechanism, Swing or Rocking mechanism, Quick Return mechanism, Indexing mechanism, Ratchet and Escapement, Feed mechanism.
Straight Line and Curve Generating Mechanism : Path generation - exact straight line mechanism, approximate straight line mechanism, Peaucillier mechanism, Hart's mechanism, Scott – Russel mechanism, Watt's mechanism, Grasshopper mechanism, chebychev mechanism, Robert's mechanism, Steering gear mechanism, Hooke's joint.
Analysis of Velocity : Analytical method for reciprocating parts, Vector method, Instantaneous center of velocity, Aronhold – Kennedy theorem of three centers, Velocity analysis with instantaneous centers, angular velocity ratio theorem, Displacement, velocity and acceleration of the piston, velocity & acceleration of the connecting rod.
Analysis of Acceleration : Angular acceleration, Acceleration of slider crank mechanism, four bar mechanism, crank and slotted lever mechanism, Klein's Construtions, Coriolis component of Acceleration.
Gear Tooth Profile : Terminology, laws of gearing, velocity of sliding, involute profile, contact ratio, interference, types of gears, minimum number of teeth.
Gear Trains : Simple gear trains, Compound gear trains, Epicyclic gear trains.
Cam Profile Analysis : Terminology, Classification of cams and follower, Follower displacement diagram, Analysis of follower motion – constant velocity motion, simple harmonic motion, constant acceleration & deceleration, cycloidal motion, Graphical layout of cam profile.
Belt Drive : Length of belts, Ratio of tension, Power Transmission, Maximum power transmission, Centrifugal tension, Initial tension, V-belt pulley.
Reference Text Books :
1. Theory of Mechanisms & Machines - A. Ghosh & A.K. Mallik
Publ: AEWP
2. Theory of Machines - Thomas Bevan, Publ: CBS
3. Mechanism & Machines Theory - Rao, R.V. Dukkipati Wiley
4. Theory of Machines – S. S. Ratan

ME402
Primary Manufacturing Processes
Contacts: 3P
Credits: 3
Introduction : Definition of Manufacturing and broad grouping
Casting : Introduction , History, Definition , Major Classification and Casting Material ; Sand Mould Casting : Moulding sands- composition, properties & testing; steps in making a casting, Pattern-types, material, design &allowances, use of a core, Design of gating system :sprue, runner, gate & riser, Foundry equipments, Furnaces, Melting, pouring and solidification, Different type of mould Casting : Floor mould casting , Centrifugal casting , Continuous casting , Shell mould & CO_2 Casting , Investment casting, Permanent mould casting : Die casting -types, methods, advantages & applications , Slush casting, Casting defects : types, causes & remedy .
Welding : Introduction , Broad classification of welding processes , Fusion welding : types, principles , equipment , characteristics & applications **,** Gas welding & thermit welding, Electric arc welding – theory of heat generation ,power source selection, arc structure & characteristics, metal transfer in arc welding, fluxes &coatings, different arc welding processes : - Carbon arc welding, Submerged arc welding ,GMAW,TIG, Plasma arc welding, Electroslag welding, Resistance welding- Spot & butt welding, Solid state welding: Principles, advantages & applications of: Hot forge welding, Friction welding, Pressure & Percussion Welding , Precision welding processes : Ultrasonic welding , Laser beam welding , Electron beam welding , Explosion welding, Weldability and welding of different ferrous & non-ferrous metals and alloys, Welding defects, types, causes & remedy. Welding inspection and testing , Design considerations in welding , Brazing and Soldering : principle, types, processes and application.
Forming Processes : i) Forging : Introduction , definition, classification , hot forging & cold forging , characteristics & applications , Forging operations, equipment& tools: Smith forging, Drop forging, Press forging, Upset forging, Forging dies, materials & design, forging defects and remedy; ii) Rolling : Introduction , basic principles, hot rolling &

cold rolling , characteristics & applications Rolling processes & applications, equipment& roll stands, defects and remedy. iii) Wire drawing & Extrusion : Basic principle ,Classification, methods & applications, defects and remedy. iv) Press tool works: Basic principles , tools , operations & applications ,Shearing, Parting , Blanking , Piercing , Notching, Cupping, (drawing), Spinning & Deep Drawing , Bending, Coining & Embossing, Blanks & forces needed for drawing and bending operations, Coining & Embossing, Bending, HERF, defects & remedy.

Text Books:

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

Reference Books:

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

ME 403: Fluid Mechanics & Machinery
Contact Period: 3L+1T
Credit: 4

Properties & Classification of Fluids; Newton's law of viscosity;

Fluid Statics: Pressure at a point in fluid, Pressure measurement and Manometers; Hydraulic forces on submerged surfaces (horizontal, vertical, inclined and curved surfaces), Centre of Pressure.

Centre of Buoyancy, meta-centric height; Condition of equilibrium of floating and submerged bodies.

Fluid Kinematics: Classification of flow, Continuity equation in 1D and 3D. Acceleration of fluid; Stream Line, Streak Line, Path Line. Translation, Deformation, Rotation and Vorticity. Sink, Source and Doublet.

Dynamics of Fluid Flow: Euler's Equation of Motion, Bernoulli's Equation of Motion, Venturimeter, Orifice meter and Pitot- Tube.

Viscous Flow: Flow through pipes; Darcy – Weisbach equation of friction loss; hydraulic grade line and total energy line. Boundary layer – definition; Boundary layer separation – basic concept.

Basic principle for flow through orifice, mouthpiece, notches and weirs). Flow through open channels; use of Chezy's formula.

Dimensional Analysis– Buckingham Pi theorem. Dimensionless numbers in fluid flow.

Flow of fluid around submerged bodies; basic concepts of drag and lift.

Hydraulic Machines- Hydraulic Turbines; Impulse and Reaction Principle. Pelton wheel- efficiency and performance curves. Francis Turbine Kaplan Turbine; Function of Draft Tube. Specific speed, unit quantities.

Centrifugal Pump- Component, working principle, Multistage Pump Characteristics, NPSH , Cavitation. Specific speed

Reciprocating Pumps- component, working principles, discharge, work done, power; air vessels.

Recommended books:

1. Introduction to Fluid Mechanics & Fluid Machines – Som & Biswas, TMH.
2. Fluid Mechanics & Machinery – R.K.Bansal, Laxmi Publications.
3. Hydraulics & Fluid Mechanics including Hydraulic Machines – Modi & Seth, Standard Book House

ME 491: Machine Drawing-II
Contacts: 3L
Credit: 2

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

Practicing of solid modeling software like AutoCAD, Inventor/ Pro-E/ Catia/ Solidworks or similar graphics software and making 3D modela and drawing orthographic and isometric projections of that component.

(At least six assignments must be conducted)

References:

1. Machine Drawing by K. L. Narayana, P. Kannaiah, K. Vnkata Reddy, New Age International Publishers
2. Machine Drawing by N.D. Bhatt, V. M. Panchal, Chrotar Publishing House Pvt. Ltd.
3. Machine Drawing by P.S. Gill, S. K. Kataria & Sons
4. Machine Drawing with AutoCAD by G. Pohit & G. Ghosh, Pearson Education

M(CS)491 NUMERICAL METHODS 0-0-3-3-2:

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

ME-492: Manufacturing Process Lab

Contacts : 3P

Credits : 2

Sand preparation and testing: specimen preparation for testing permeability, clay content, grain fineness number, moisture content, green compression strength, green shear strength, splitting strength, hardness, etc.;

Casting of metals after preparation of suitable moulds; Experiments on properties of post casting, fettling, cleaning, deburring, and polishing operations;

1. To make a standard test specimen for permeability testing.
2. To make a mould and perform casting operation.
3. Study of casting defects and remedies.
4. To determine the GFN of moulding sand.

Practicing smithy or forging of carbon steels and testing for its property changes;

1. To make chisel by hot forging process.

Laboratory experiments in Fabrication processes to observe effects of varying process parameters in GMAW and SMAW and Testing for Joint defects.

1.To make a butt joint on a test specimen by GMAW and record the varying operating parameter.

ME 493 : Fluid Mechanics & Machinery Laboratory

Contacts: 3P

Credit: 2

Experiments to determine coefficient of discharge for venturimeter, orificemeter, weirs ; Experiment to verify Bernouli's theorem ; Experiment to determine Chezy's constant ; Experiment to determine metacentric height of a floating body ; Experiments to determine Viscosities of different liquids ; Verification of Stokes law; Reynolds experiment for flow through pipes ; Experiment on Pipe friction in laminar and turbulent flow regimes; Pitot tube experiments on viscous flow and boundary layer theory; Study on subsonic wind tunnel.

Experiments on Pumps, Blowers, Compressors;

Experiments on Pelton, Francis and Kaplan turbines.
(At least eight experiments must be conducted)

SEMESTER – V

HU-501 PRINCIPLE OF MANAGEMENT 3-0-0-3-3:

Basic concepts of management: Definition – Essence, Functions, Roles, Level.
Functions of Management: Planning – Concept, Nature, Types, Analysis, Management by objectives; Organization Structure – Concept, Structure, Principles, Centralization, Decentralization, Span of Management; Organizational Effectiveness.
Management and Society– Concept, External Environment, CSR, Corporate Governance, Ethical Standards.
People Management– Overview, Job design, Recruitment & Selection, Training & Development, Stress Management.
Managerial Competencies– Communication, Motivation, Team Effectiveness, Conflict Management, Creativity, Entrepreneurship
Leadership:Concept, Nature, Styles.
Decision making: Concept, Nature, Process, Tools & techniques.
Economic, Financial & Quantitative Analysis– Production, Markets, National Income, Accounting, Financial Function & Goals, Financial Statement & Ratio Analysis, Quantitative Methods – Statistical Interference, Forecasting, Regression Analysis, Statistical Quality Control.
Customer Management– Market Planning & Research, Marketing Mix, Advertising & Brand Management.
Operations & Technology Management– Production & Operations Management, Logistics & Supply Chain Management, TQM, Kaizen & Six Sigma, MIS.
Text Books:
1. Management: Principles, Processes & Practices – Bhat, A & Kumar, A (OUP).
2. Essentials for Management – Koontz, Revised edition, Tata McGraw Hill (TMH)
3. Management – Stoner, James A. F. (Pearson)
4. Management - Ghuman, Tata McGraw Hill(TMH)

ME 501 : HEAT TRANSFER , Contacts: 3L + 1T , Credit: 4

1. Introduction : Modes of heat transfer
2. Conduction: Fourier law of heat conduction. Thermal conductivity. Derivation of general heat conduction equation in three dimensions. Thermal diffusivity and Fourier number. Types of boundary conditions. Solution of steady one dimensional heat conduction problem with and without heat generation. Analogy with electrical circuits. Critical thickness of insulation. Fins - rectangular and pin fins. Heat transfer from fins. Fin effectiveness and efficiency. Practical considerations for using fins. Lumped parameter approach and significance of time constant. Biot number. Solution of steady two-dimensional conduction equation without internal heat generation using product solution. Introduction to computational methods in heat conduction.
3. Radiation: Physical mechanism of thermal radiation. Absorptivity, reflectivity, transmissivity. Definitions of Black body, Gray body, Solid angle, Emissive power, Intensity of radiation, Irradiation, Radiosity. Laws of radiation. View factors : Definition and relations, Radiation exchange between black bodies. Concept of grey-diffuse-isotropic (GDI) surface. Radiation exchange between GDI surfaces by radiation network and radiosity matrix method. Radiation shield.
4. Convection: Introduction. Newton's law of cooling and significance of heat transfer coefficient. Velocity and thermal boundary layer. Laminar and Turbulent flows. Momentum and energy equation in two-dimensions. Non-

dimensionalisation and significance of non-dimensional quantities. External Forced Convection : Drag and heat transfer coefficient, parallel flow over flat plates, flow across cylinders. Reynolds-Colburn analogy. Internal Forced Convection : Mean velocity and mean temperature, entrance region , constant heat flux and constant temperature conditions in pipe flow, Hagen-Poiseuille flow, Turbulent flow and heat transfer. Natural convection : Natural convection over a flat plat and related correlations and applications. Introduction to Boiling and Condensation heat transfer.
5. Heat exchangers : Types of heat exchangers. Overall heat transfer coefficient. Fouling factors and its influence in heat transfer process. Introduction to LMTD. Correction factor. Effectiveness-NTU method for heat exchangers. Selection criteria of heat exchangers.
6. Introduction to Mass transfer. Fick's law. Analogy between heat and mass transfer.
Text / References : (Latest editions)
1) F. P. Incropera and D. P. Dewitt ; Fundamentals of Heat and Mass Transfer, John Wiley & Sons.
2) M. N. Ozisik ; Heat Transfer – A Basic Approach, McGraw-Hill.
3) Y. A. Cengel ; Heat Transfer – A Practical Approach, Tata McGraw-Hill.
4) V. Ganapathy ; Applied Heat Transfer , Pennwel Publishing Company.

ME-502 : Dynamics of Machines, Contacts: 3L + 1T, Credits- 4

Module	Syllabus
1.	Inertia force and inertia torque in reciprocating engine; Equivalent dynamical system; correction couple (torque); Turning moment diagram and flywheel design.
2.	Balancing: Static balancing; Dynamic balancing of rotating masses -graphical and analytical methods; Balancing of inline single cylinder and four cylinder engine; Balancing of symmetric two cylinder V-engine; Swaying couple; Hammer blow.
3.	Governors: Use and classification; Study and analysis of Porter, Proell and Wilson-Hartnell governors; Sensitiveness, stability, isochronism, hunting, effort and power of governors; Controlling force diagram and stability criteria analysis; coefficient of insensitiveness
4.	Gyroscope: Gyroscopic couple and precessional motion; Effect of gyroscopic couple on aeroplane and ship; Stability of two wheel and four wheel vehicles taking turn.
5.	Vibration: Definition & types of vibration; Differential equations of vibratory motions (longitudinal & torsional); Natural frequency of free longitudinal vibration-Equilibrium method, Energy method(Rayleigh's maximum energy principle); Effect of inertia in longitudinal vibration; Natural frequency of free transverse vibration of a beam due to point loads -Rayleigh's method. Whirling of shaft, synchronous whirling; critical speed -Dunkerley's method.
6.	Free damped vibration; Damping factor; Logarithmic decrement.
7.	Forced vibration, concept of under damped, critically damped and over damped system; Dynamic magnifier (magnification factor); Vibration isolation and transmissibility.

Recommended Books:

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

Machining Principles & Machine Tools
ME-503

Contacts: 3L
Credits: 3

Introduction : Machining: Basic principle, purpose, definition and requirements.

Geometry of cutting tools : Geometry of single point turning(shaping, planning and boring) tools in ASA, ORS and NRS systems.

Mechanism of machining :

i) Chip formation mechanism, yielding and brittle fracture, chip reduction coefficient, cutting ratio, shear angle and cutting strain. ii) Orthogonal cutting and Oblique cutting.

Machining chips : types and conditions,Built-up edge formation, cause, type and effects, chip formation in drilling and milling.

Mechanics of machining :

i) Purposes of determination of cutting forces, Cutting force analysis for machining by single point tools, ,Analysis of forces under Orthogonalcutting and use of Merchant's circle diagram ORS and Merchant's circle diagram.

ii)Determination of cutting forces by analytical methods.

iii)Measurement of cutting forces, Dynamometers - construction and working principles of strain gauge type and piezoelectric crystals type turning, drilling, milling and grinding dynamometers.

Cutting temperature :

i) Heat generators and cutting zone temperature, sources, causes and effects on job and cutting tools, role of variation of the machining parameters on cutting temperature .

ii) Control of cutting temperature and application of cutting fluids (purpose, essential properties, selection and methods of application).

Cutting tools-failure, life and materials :

i)Major causes & Modes of failure of cutting tools, Mechanism of cutting tool wear,Measurement of tool wear

ii) Tool life, definition, assessment and measurement, Taylor's tool life equation and its use

iii) Cutting tool materials - essential properties, characteristics and applications of HSS, carbide(uncoated/coated), ceramic, diamond , CBN and newly developed cutting tools.

Broaching and grinding :

i) Modes and mechanisms of chip formation, selection and application.

ii) Grinding wheel ,effect on surface roughness and types.

Machinabilityand machining economics :

1. Machinability(and grindability) : definition, assessment, improvement and evaluation of optimum cutting velocity and tool life.

Machine tools – Introduction :

i) Purpose of use, definition ,classificationand general features of machine tools.

ii)Generatrix and Directrix and tool – work motions in different operations of conventional machine tools.

General constructions and function of machine tools and drives :

i) Major components and their functions in lathes; shaping , planning and slotting machines ; drilling machine , milling and grinding machines.

ii) Machining operations and application of the common machine tools and their way of specification.

Role & Forms of Kinematic structure in machine tools :

Role and constituents of kinematic structure, different forms of machine tool kinematic structure, Mechanism commonly used in machine tool kinematic systems.

Control of speed and feed of machine tools :

i) Need of wide ranges of speeds and feeds in machine tool drive.

ii)Design of speed gear box, speed layout, gear layout, ray diagrams .

iii)Control (selection and change) of feed in centre lathes and in hydraulically driven machine tools.

Machining time :

Estimation of time required for various operations like turning , drilling , shaping , milling .

Methods of mounting blanks and cutting tools in machine tools, application of jigs and fixtures.

Inspection and testing of machine tools.

Books recommended:

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

Design of Machine Elements
ME-504
Contacts: 4L (3+1)
Credits- 4

1. Introduction to design, Review of common engineering materials and their properties, Stress – strain diagram, Improvement of properties through heat treatment and alloying ; codes and standards;
2. Modes of failure; Design/allowable stress; Factor of safety (FoS); Stress Concentration ; Theories of failure – maximum normal stress theory, maximum shear stress theory, Distortion energy theory.
3. Design of
   (i) Cotter joint; (ii) Knuckle joint and (iii) Fillet Welded joint of brackets under different types of loading.
4. Bolted joints : Metric thread, standard sizes, use of lock nuts and washers; Applications in structures including brackets, turn buckle; Pre-stressed bolts;
   Riveted joints : Unwin's formula; Brief discussion on single, double and triple row lap joints, butt joints with single or double strap / cover plate; simple strength design; joint efficiencies, boiler joint, Lozenge Riveting, Ecentric Loading of Rivets.
5. Design of :
   (i) shafts - design based on strength and torsional rigidity;
   (ii) Shaft coupling-rigid, pin-bush and geared flexible type, alignment of coupling;
   (iii) Keys – Sunk key and Feather Key
6. Fatigue in metals; S-N curve; Endurance limit and fatigue strength; Stress concentration factors – effect of discontinuity, fillets and notches; Effect of size, surface finish, stress concentration and degree of reliability on endurance limit; Design for finite and infinite life; Goodman, modified Goodman and Soderberg diagrams with respect to fatigue failure under variable stresses; Cumulative fatigue damage – Miner's equation.
7. Design of:
   (i) Transmission screw, Screw jack
   (ii) Belt drives-geometrical relations, derivation of torque and power transmission by flat and V-belt drives,selection of belt from manufacturers' catalogues, pulley
8. Design of
   (i) Helical compression spring - stress and deflection equations, stiffness, curvature effect : Wahl's factor, springs in parallel and series;
   (ii) Multi-leaf springs : load-stress and load-deflection equations, Nipping

Books Recommended :

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

Refrigeration & Air Conditioning

ME-505A

Contacts: 4L

Credits- 4

1. Introduction: Concepts of Refrigeration and Air-conditioning; Necessity; Methods of refrigeration; Unit of refrigeration; Coefficient of performance (COP);Fundamentals of air-conditioning system; Refrigerants- Definition, Classification, Nomenclature, Desirable properties, Comparative study, secondary refrigerants, Introduction to eco-friendly Refrigerants; Introduction to Cryogenics.

2. Air Refrigeration System (ARS): Carnot refrigeration cycle. Limitations; Brayton refrigeration or the Bell-Coleman refrigerator. COP determination, actual air-refrigeration cycle. Necessity of cooling the aero plane; Air craft refrigeration systems.

3. Simple Vapour Compression Refrigeration System (Simple VCRS):Simple Vapour Compression (VC) Refrigeration systems-Limitations of Reversed Carnot cycle with vapour as the refrigerant; Analysis of VC cycle considering degrees of sub cooling and superheating; VC cycle on p-v, t-s and p-h diagrams; Effects of operating conditions on COP; dry compression and wet compression of refrigerant; actual Vapour Compression Cycle. Comparison of VC cycle with Air Refrigeration cycle.

4. Other Refrigeration Systems: (A) Vapour Absorption Refrigeration Systems(VARS) – Working principle of simple VARS, practical VARS. Limitations of VARS, actual and maximum COP of a VARS, Performance, Relative merits and demerits; Properties of aqua ammonia; Advantages of VARS over VCRS, Electrolux Refrigeration; Aqua-ammonia systems, Problems.

(B) Steam Jet Refrigerating System- Introduction, Analysis, Relative merits and demerits, Performance Applications, Problems.

5. Psychrometry of Air & Air Conditioning Processes: Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temp, Dry bulb temperature, Thermodynamics wet bulb temp., Psychrometric Charts & Their Uses; Psychrometry of air conditioning processes, Mixing Process, Heating, Cooling, Heating & Humidification & Cooling & Dehumidification processes. Adiabatic Saturation, Cooling Coils, By-pass Factor; Sensible Heat Factors, Heat Load estimation: Simple cases of Cooling and Dehumidification, Basic processes in conditioning of air; Psychrometric processes in air washer, Problems.

6. Refrigeration and Air Conditioning Equipments and control: Type of compressors and their performance curves; volumetric efficiency, Types of Condensers, Heat transfer in condensers; Types of expansion devices; capillary tubes and thermostatic expansion valves, types of evaporators, Cooling and Dehumidifying coils, Problems.

7. Ventilation – Definition & Requirement, Natural & Mechanical Ventilation, Ventilation Load Calculation- Air-Conditioning Load Calculations: Outside and inside design conditions; Sources of heating load; Sources of cooling load; Heat transfer through structure, Solar radiation, Electrical applications, Infiltration and ventilation, Heat generation inside conditioned space; Apparatus selection; Comfort chart, Problems. 06

8. Air Conditioning Systems with Controls & Accessories: Classifications, Layout of plants; Equipment selection; Air distribution system; Duct systems sizing and Design; Filters; Refrigerant piping; Design of summer air-conditioning and Winter air conditioning systems; Temperature sensors, Pressure sensors, Humidity sensors, Actuators, Safety controls; Accessories; Problems.

Texts & References:

1. R.C. Jordan and G.B. Priester, Prentice Hall of India- Refrigeration & Air conditioning
2. C.P. Arora, Refrigeration and Air Conditioning.
3. P.L. Ballaney, Refrigeration and Air Conditioning.
4. R.C.Arora, Refrigeration and Air Conditioning, TMH.
5. Arora and Domkundwar, Refrigeration and Air Conditioning, Dhanpat Rai Pub
6. Stocker & Jones, Refrigeration and Air Conditioning, McGraw Hill

7. Manohar Prasad Wiley Estern limited, New Delhi- Refrigeration & Air conditioning.

ME 505B : COMPUTATIONAL FLUID DYNAMICS

Contacts : 4L

Credit: 4

1. Fundamental Concepts : Introduction - Basic Equations of Fluid Dynamics - Incompressible In viscid Flows: Source, vortex and doublet panel, methods - lifting flows over arbitrary bodies. Mathematical properties of Fluid Dynamics Equations -_ Elliptic, Parabolic and Hyperbolic equations - Well posed problems - discretization of partial Differential Equations. Explicit finite difference methods of subsonic, supersonic and viscous flows.

2. Grid Generation : Structured grids. Types and transformations. Generation of structured grids. Unstructured grids. Delany triangulation.

3. Discretization : Boundary layer Equations and methods of solution -Implicit time dependent methods for inviscid and viscous compressible flows - Concept of numerical dissipation –Stability properties of explicit and implicit methods - Conservative upwind discretization for Hyperbolic systems - Further advantages of upwind differencing.

4. Finite Element Techniques : Overview of Finite Element Techniques in Computational Fluid Dynamics. Strong and Weak Formulations of a Boundary Value Problem.

5. Finite Volume Techniques : Finite Volume Techniques - Cell Centered Formulation - Lax – Vendoroff Time Stepping - Runge - Kutta Time Stepping - Multi - stage Time Stepping - Accuracy -. Cell Vertex Formulation – Multistage Time Stepping - FDM - like Finite Volume Techniques – Central and Up-wind Type Discretizations - Treatment of Derivatives. Flux – splitting schemes. Pressure correction solvers – SIMPLE, PESO. Vorticity transport formulation. Implicit/semi-implicit schemes.

Text / References : (Latest editions)

1. J. C. Tannehill, D. A. Anderson and R. H. Pletcher, Computational Fluid Mechanics and Heat Transfer, Taylor & Francis.
2. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press.
3. A.W. Date, Introduction to Computational Fluid Dynamics, Cambridge University Press.
4. S. V. Patankar, Computational Fluid Mechanics and Heat Transfer, Hemisphere.
5. P. Niyogi, S. K. Chakrabarty and M.K. Laha, Introduction to Computational Fluid Dynamics, Pearson Education.
6. K. Muralidhar and T. Sundararajan, Computational Fluid Flow and Heat Transfer, Narosa Publishing House, 7. P. S. Ghoshdastidar, Computer Simulation of Flow and Heat Transfer, Tata-McGrawhill.

Mechatronics
ME-505C
Contacts: 3L
Credits: 3

Introduction to Mechatronics : Definition, Mechatronics in design and manufacturing, Comparison between Traditional and Mechatronic approach; Concurrent engineering.

Review of fundamentals of electronics, Logic gates and their operations, Signal processing devices, Data conversion devices, Input and output devices. Sensors and Transducers, Actuators, Limit switches, Relays.

Control Systems: Open loop and closed loop control, block diagrams, transfer functions, Laplace transforms.

Electrical Drives : Stepper motors, servo drives.

Mechanical Drives : Different mechanisms, Ball screws, Linear motion bearings, Transfer systems. Pneumatic and Hydraulic Drives: Elements of pneumatic and hydraulic drives, comparison between them. Design of pneumatic and

hydraulic circuits, symbolic representations of such circuits indicating different valves, actuators, etc., Basics of 8085 microprocessor, programmable register architecture, buses, memory mapping, clock pulse and data transfer operations, and simple assembly and mnemonic programming on 8085 microprocessor. Use of On-Off, PI and PID controllers to control different drives, Programming in PLC controller using Ladder diagram. Mathematical modeling of physical systems, such as spring-mass vibration system, linear and rotory motion and its Laplace Transform. Basics of time domain analysis, Introduction to discrete-time systems and Z-transform. Introduction to Mechatronic systems, such as automatic brake, door closing and opening, robot, CNC machine, AGV, etc.

References:

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

ME 505D
Quality & Reliability Engineering
Contact Hours: 4L
Credit: 4

Management of Product Quality

Evolution of Quality Control; Changing Quality Concepts; Modern Concept of Total Quality Management; Contribution of Quality masters (Deming, Juran, Crosby, Ishikawa, Taguchi);

Creating Quality by Design

Assessment of Customer's needs; Formulation of Design Specifications; Standardization; Costs of Quality; Quality Circles; 5-S concept.

Total Quality Management

Concept of Total Quality, Difference between "Quality" Management and "Total Quality" Management, total quality maintenance, total quality in service sector; Role of Customer and People in Total Quality Management; Steps for Quality Improvement, Kaizen; Organizing for effective Quality Management;

Process Control

Control Charts; Statistical Quality Control Tools; Statistical Process Control and Process Capability, Zero defect programme; Six – Sigma approach;

Quality Management Systems

ISO 9000 Series of Standard; ISO 14000 Series of Standards;

Strategic tools and Techniques for TQM

Need for Tools and Techniques in TQM; Commonly used Tools for TQM; Approaches and Deployment of Tools for Quality Planning – Quality Function Deployment (QFD), concurrent engineering; Tools for continuous Improvement – Deming's Plan – Do – Check – Act (PDCA) cycle, Poka – Yoke (Mistake – Proofing), Taguchi's Quality Loss Function.

Reliability

Concept and definition of reliability; Reliability Parameters: Reliability as a function of time, failure rate as a function of time, constant failure rate, mean time to failure (MTTF), MTTF as a function of failure rate, mean time between failure (MTBF), mean down time (MDT), maintainability & availability, increasing failure rate, bath-tub curve; Brief discussion on hazard models: constant hazard model, linearly increasing hazard model, nonlinear hazard model and weilbull distribution, Advantages of weibull distribution; System reliability models: series system, parallel system, series-parallel system.

Risk Assessment & Reliability in Design

Causes of failures, Failure modes & Effects Analysis (FMEA), faulty tree analysis (FTA); Tribological failure and monitoring techniques; Design based on reliability, redundancy in design.

Recommended Books

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

ME 591 : Heat Transfer Laboratory

Contacts: 3P

Credit: 2

1) To determine thermal conductivity of a metal rod.

2) To determine thermal conductivity of an insulating power / or of an insulating plate.

3) To determine heat transfer coefficient, rate of heat transfer and effectiveness of a pin fin under steady state condition for forced convection and plot temperature distribution along its length.

4) To determine heat transfer coefficient, rate of heat transfer and effectiveness of a pin fin under steady state condition for natural convection and plot temperature distribution along its length.

5) To determine local and overall heat transfer coefficients, Nusselt numbers along the length of a heated vertical tube/plate under natural convection situation.

6) To determine average heat transfer coefficient, Nusselt number in forced convection for flow through a heated pipe / duct.

7) To determine emissivity of a material.

8) To verify Stefan-Boltzmann constant for radiation.

9) To determine dryness fraction of steam by throttling calorimeter.

10) To determine LMTD, overall heat transfer coefficient and heat transfer rate of a heat exchange under parallel and counter flow conditions.

11) Study of a shell and tube heat exchanger and determination of LMTD.

(At least eight experiments must be conducted)

ME-592 : Dynamics of Machines Laboratory, Contacts: 3P, Credits- 2

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

Experiments to be conducted on

1. Studying vibratory systems of single and more than one degree of freedom in linear and rotory systems;
2. Static and dynamic balancing of rotating masses;
3. Balancing of reciprocating masses;
4. Experiments on working of governor, operation and analysis.
5. Experiments on working of gyroscope, operation and analysis.
6. Designing of cam.
7. Studying operation of cams and its analysis.

ME-593 : Machine Tools Lab
Contacts : 3P
Credits: 2
1. Measurement of cutting forces (Pz and Px or Py) in straight turning at different feeds and velocities 3 (1)
2. Measurement of average cutting temperature in turning under different speed – feed combinations 3 (1)
3. Measurement of surface roughness in turning under different conditions 3 (1)
4. Study of chip formation (type, color & thickness) in turning mild steel and evaluation of role of variation of cutting velocity and feed on chip reduction coefficient /cutting ratio and shear angle 3 (1)
5. Measurement of tool – wear and evaluation of tool life in turning mild steel by HSS or carbide tool 3 (1)
6. Geometrical and kinematic test of a centre lathe or a drilling machine 3 (1)
7. Producing a cast iron vee – block by machining 9 (3)
8. Production of a straight toothed spur gear from a cast or forged disc 9 (3)

Design Practice-1
ME-594
Contacts: 3P
Credits: 2
Drawing board exercises compatible to theory course on ME 504: Design of Machine Elements.
At least six assignments are to be completed from the following list:
1. Knuckle
2. Cotter joint
3. Shaft design
4. Bolted bracket/ turn buckle
5. Screw jack
6. Riveted joints
7. Welded joints
8. Shaft Couplings
9. Belt pulley drive
10. Helical compression spring/ Leaf spring.

SEMESTER – VI

I.C.ENGINE & GAS TURBINE
ME601
Contact Periods: 3L+1T
Credits: 4
Classification and working of basic engine types: 2-stroke, 4- stroke, C.I., S.I., etc.
Analysis of air standard cycles: fuel- air cycles and actual cycles.
Fuels: classification and desirable characteristics of I.C. engine fuels, Rating of S.I. and C.I. engine fuels, Alternative fuels (liquid, gaseous, etc.), Analysis of combustion product, HCV and LCV of the fuels .Alternative fuel development program.
Combustion of fuels in I.C. engines, Combustion in S.I and C.I engines, Parameter influencing combustion, Detonation and knocking in S.I. and C.I. engines and their preventions, Combustion chamber types, Basic principles of combustion chamber in I.C. engines. Premixed combustion, diffused combustion, laminar and turbulent combustion of fuels in engines. Droplet combustion, Flame travel. Knocking of engines
Fuel- air mixing in S.I. engines, working principle of a carburetor, Analysis of simple carburetor, Mechanical and electronic fuel injection system and their control in S.I. engines. Basic principles of MPFI in SI engines. Advantages of electronic ignition systems. Contactless electronic ignition system, Electronic spark timing control.

Fuel-oil injection in C.I. engines, Fuel injection systems, Working principles, Injection pumps and nozzles. CI Engine Fuel injection system, parameters affecting combustion, noise and emissions in CI engines.. Electronically controlled Unit Injection system. Layout of the common rail fuel injection system. Working of components like fuel injector, fuel pump, rail pressure limiter, flow limiter. Governors of IC engine

Ignition: ignition systems in I.C. engines (Battery, magneto and electronic), ignition timing and spark advance.

Air induction: Air filter, Manifolds, EGR, Supercharging **of I.C. engines**, supercharging limits, Turbo charging,

Scavenging - ideal and actual, scavenging parameters, and scavenging pumps.

Engine Friction and Lubrication: Principles of lubrication in I.C. engines, Properties of lubricating oil. Friction estimates and Lubrication requirements, theory of lubrication, types of lubrication, splash lubrication system, forced feed lubrication system. Hydrodynamic lubrication. Engine Tribology basics.

Cooling System: Air cooling and liquid cooling, Principles and systems, forced cooling systems. Fins and radiator, Basics of heat and mass transfer through IC Engine.

Performance and testing of I.C. engines; Measurement of speed, torque, fuel consumption, determination of IHP, BHP and FHP, specific fuel consumption, determination of indicated thermal efficiency, brake thermal efficiency and mechanical efficiency, plot of efficiency vs. speed curves. Total heat balance equation study of IC Engine, Morse test, dynamometers.

Design of Engine Components: Overall engine system parameter, configuration finalization, Design of Piston, cylinder block & head, Connecting rod, Crankshaft, camshaft, valve train,

Pollution control of emissions of I.C. engines: Petrol engine emission, Diesel engine emission, Catalytic converter, Euro norms, particulate emission, emission control technologies.DPF

New Engine Technology Lean Burn engine, Different approaches to lean bum, LHR engine, Surface ignition concept, catalytic ignition, homogenous charge compression ignition (HCCI) in diesel engines, variable valve timing, stratified charge engine, Wankel rotary combustion engine, Stirling engine, VCR engine, Free piston engine, MAN engine, CFR engine, DTSI engine, CRDI engine, MPFI Engine, CCVTi engine,

IC ENGINE MODELING: Thermodynamic Combustion Models of Engines, Mathematical Models of CI and SI Engines.

Introduction to Gas Turbine Cycles & Performance analysis

Recommended Books:

1. J.B.Heywood, 'Internal Combustion Engine Fundamentals', McGraw Hill Book Co, 1988.
2. V. Ganesan, 'Internal Combustion Engines', Tata McGraw Hill Book Co, Eighth Reprint, 2005.
3. Edward F.Obert, 'Internal combustion engines and air pollution' Harber and Row Publishers, 1973.
4. Internal combustion Engine – applied Thermoscience- Colin R. Ferguson, Allan T. Kirkpatrick- Johnwilly. I.C.Engine by Ferguson , Johnwilly
5. W.H.Crouse and A.L.Anglin, 'Automotive Emission Control', McGraw Hill Book Co, 1995.
6. G.S.Springer and A.J.Patterson, 'Engine emissions and pollutant formation', plenum press, Newyork,1985.
7. The Internal Combustion Engine – Theory and Practice Vols. I & II by C.F.Taylor, MIT Press
8. Gas Turbine Theory , Cohen, Pearson Education
9. V. Ganesan, 'Gas Turbine', Tata McGraw Hill Book Co, 3rd Edition, 2010.
10. Taylor.E.F. "The Internal Combustion Engines ", International Text Book Co., Pennsylvania, 1982.
11. Ganesan.V. "Computer Simulation of Spark Ignition Engine Process", Wiley eastern India Ltd,1996.
12. Ganesan.V. "Computer Simulation of Compression Ignition Engine Process", Wiley eastern India Ltd,1996

Machine Design
ME-602
Contacts : 4 (3L+1T)
Credits- 4

Brakes: Function, types; pivoted block brake (single and double block brakes), internal expanding shoe brake,self energizing and self locking; Pivoted block brake; Band brake-simple and differential; Block and band brake; Brake lining materials; Thermal considerations during braking.
Clutches: Function, types; Friction clutches – torque capacity based on uniform pressure and uniform wear theory for disc and cone clutch; Centrifugal clutch; Friction materials; Considerations for heat dissipation.
Rolling contact bearings: Bearing types, nature of load; Static and dynamic load capacity, Stribeck equation, Load - Life relation; Bearing selection from manufacturers' catalogues; Methods of lubrication; Bearing mounting on journal and bearing block
Sliding contact bearings: Bearing types and materials; Stribeck Curve, Petroff equation, Hydrodynamic lubrication theory - pressure development; Reynolds equation, Finite bearings – Raimondi-Boyd charts, Heat generation & dissipation; Hydrostatic bearing; Plummer block.
Gears: Design objectives, types, terminologies, conjugate action and involute tooth profile, tooth systems, standard modules; Gear materials.
Spur Gear : Strength design, static and dynamic considerations in strength design, Lewis formula, Lewis form factor, beam strength, Buckingham equation for dynamic tooth load; Endurance strength and wear strength; Designing a pinion based on above considerations;
Helical Gear: Helix angle, minimum face width, virtual number of teeth; Strength design, Buckingham formulae for checking dynamic load and wear load.
Bevel Gear: Terminologies, formative number of teeth; Lewis equation, dynamic load, endurance strength and wear strength checking.
Worm- worm wheel: Terminologies and their inter-relation; Preferred combination of various parameters;Efficiency; Materials.
Pressure vessels– thin cylinder, thick cylinder, Lame's equation, Clavarino's equation, Birnie's equation, Autofrettage– compound cylinders, End Covers, Opening in pressure vessel – area compensation method,Fired and unfired vessels – category, Industrial Code.
Flywheel design for application to: (i) Punching press; (ii) 2-stroke engine; (iii) 4-stroke engine, Torque analysis, Solid disc and rimmed flywheel
Books Recommended :
1. V. B. Bhandari, Design of Machine Elements, TMH.
2. Shigley and Mischke, Mechanical Engineering Design, TMH.
3. Hall, Holowenko and Laughlin, Theory and Problems of Machine Design, TMH.
4. Hamrock, Schmid, Jacobson, Fundamentals of Machine Elements, Mcgraw Hill.
5. Burr and Cheatham, Mechanical Analysis and Design, Prentice Hall.
6. P. Kannaiah, Machine Design, Scitech Publications.
7. P.C. Gope, Fundamentals of Machine Design, PHI.

ME 603
Power Plant Engineering
Contact Hours: 3L+1T
Credit: 4
Classification of power plant: classification based on working fluid, primary fuel, cycle. Combined cycle and co-generation plant.
Steam power plant:
Fuel and combustion- Coal analysis and properties, combustion reactions. Draught system- Natural Mechanical and Balanced draught. Pulverized coal firing system, fluidized bed combustion.
Analysis of steam cycle- Rankine cycle, Reheating, Regeneration, Feed water heaters, Deaerator.
Steam Generator- Differences between fire tube and water tube boiler. Commonly used water tube boilers. Economizer, Superheater, Reheater, Air preheater. Mountings and accessories; Circulation; Dust Collectors.

Steam Turbine: Flow through nozzle, nozzle efficiency. Impulse turbine- Velocity diagram, work done,power and efficiency. Pressure compounding and velocity compounding. Impulse reaction turbine. Velocity diagram, degree of reaction, Parsons turbine. Governing of steam turbine
Condenser-function, effect of air leakage, cooling towers.
Power Plant economics- load curve, various factors.
Introduction to Nuclear power plant, Diesel power plant, Gas turbine power plant, Hydro-electric power plant and Renewable power plants.
Recommended books
1. Power Plant Engg- by P.K. Nag, Tata-McGrawhill
2. A textbook of Power Plant Engg- by R.K. Rajput, Laxmi publications Pvt. Ltd.
3. Power Plant Engineering- by Arora & Domkundwar, Dhanpat Rai & Co.(P) Ltd.
4. Power Plant Engineering- by Dr. P. C. Sharma, S. K. Kataria & Sons.
5. A text book on Power Plant Engg- by K.K. Ramalingam, Scitech Publication (India) Pvt. Ltd.

ME-604 Advanced Machine Tools

Contacts: 3L + 1T

Credits: 4

Automation Machine Tools: Introduction; Purpose,degree,type and economy of machine tool automation; examples of semi-automatic & automatic machine tools; transfer machine; Thread Manufacturing systems, Gear Manufacturing Systems

CNC machine tools and systems

i) Basic Principles of NC system,Components and their functions in NC machines
ii)Control : MCU, DPU and CLU
iii)Feed drives : special motors and screw-nut system
Advantages of CNC over NC machines
Basic systems of NC and CNC machines
(i) coordinate system
(ii) control – open loop and closed loop
(iii) dimensioning – absolute and incremental
CNC machine tools ;
(i) structure and working principle
(ii) examples and use of CNC machines
Control of tool – work travel ;
(i) point – to – point and contouring
(ii) interpolation – linear and circular

Part programming for NC, CNC and MC systems

Manual part programming :
(i) definition and codes used
(ii) sequential steps
(iii) examples of part programming for machining in CNC lathes, drilling and milling machine
Computer aided part programming :
(i) definition and advantages
(ii) programming languages
(iii) statements in APT
(iv) examples of part programming in APT

ME-605A : Finite Element Methods

Contacts: 4L
Credits- 4

Module	Syllabus
1.	**Introduction**: Historical background, Relevance of FEM to design problems, Application to the continuum–Discretisation, Matrix approach, Matrix algebra– Gaussian elimination, Governing equations for continuum,Classical Techniques in FEM, Weighted residual method, Ritz method, Galerkin method.
2.	**One dimensional problems:** Finite element modeling– Coordinates and shape functions, Potential energy approach– Element matrices and vectors, Assembly for global equations, Boundary conditions, Higher order elements- Shapes functions, Applications to axial loadings of rods– Extension to plane trusses, Bending of beams– Finite element formulation of stiffness matrix and load vectors, Assembly to Global equations, boundary conditions, Solutions and Post processing, Example Problems.
3.	**Two dimensional problems– scalar variable problems:** Finite element modeling– CST element, Element equations, Load vectors and boundary conditions, Assembly, Application to heat transfer, Examples.
4.	**Two dimensional problems– vector variable problems:** Vector Variable problems, Elasticity equations– Plane Stress, Plane Strain and Axisymmetric problems, Formulation, element matrices, Assembly, boundary conditions and solutions Examples.
5.	**Isoparametric elements for two dimensional problems:** Natural coordinates, Iso parametric elements, Four node quadrilateral element, Shape functions, Element stiffness matrix and force vector, Numerical integration, Stiffness integration, Displacement and Stress calculations, Examples.
6.	**Computer implementation**: Pre-processor, Processor, Post-processor. Discussion about finite element packages.

REFERENCES:

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

ME-605B : Materials Handling
Contacts : 4L
Credits: 4

UNIT – I: Types of intraplant transporting facility, principal groups of material handling equipments, choice of material handling equipment, hoisting equipment, screw type, hydraulic and pneumatic conveyors, general characteristics of hoisting machines, surface and overhead equipments, general characteristics of surface and overhead equipments and their applications. Introduction to control of hoisting equipments. [8 Hrs]

UNIT – II: Flexible hoisting appliances like ropes and chains, welded load chains, roller chains, selection of chains hemp rope and steel wire rope, selection of ropes, fastening of chains and ropes , different types of load suspension appliances, fixed and movable pulleys, different types of pulley systems, multiple pulley systems . Chain and rope sheaves and sprockets. [10 Hrs]

UNIT – III: Load handling attachments, standard forged hook, hook weights, hook bearings, cross piece and casing of hook, crane grab for unit and piece loads, carrier beams and clamps, load platforms and side dump buckets, electric lifting magnets, grabbing attachments for loose materials, crane attachments for handling liquid materials. [7 Hrs]

UNIT – IV: Arresting gear, ratchet type arresting gear, roller ratchet, shoe brakes and its different types like electromagnetic, double shoe type, thruster operated, controller brakes, shoe brakes, thermal calculations of shoe brakes and life of linings, safety handles, load operated constant force and variable force brakes general theory of band brakes, its types and construction. [10 Hrs]

UNIT – V; Different drives of hosting gears like individual and common motor drive for several mechanisms, traveling gear, traveling mechanisms for moving trolleys and cranes on runway rails, mechanisms for trackless, rubber-tyred and crawler cranes motor propelled trolley hoists and trolleys, rails and traveling wheels, slewing, jib and luffing gears.

Operation of hoisting gear during transient motion, selecting the motor rating and determining braking torque for hoisting mechanisms, drive efficiency calculations, selecting the motor rating and determining braking torque for traveling mechanisms, slewing mechanisms, jib and luffing mechanisms . (Elementary treatment is expected) [8 Hrs]

UNIT – VI: Cranes with rotary pillar, cranes with a fixed post, jib cranes with trolley, cranes with luffing boom cantilever cranes, cage elevators safety devices of elevators belt and chain conveyors and their power calculations, vibrating and oscillating conveyors pneumatic and hydraulic conveyors, screw conveyors hoppers, gates and feeders. Introduction to AGV s as new material handling device, use of robot for material handling. [7 Hrs]

TEXT BOOK

1. Materials Handling Equipment – N. Rudenko , Envee Publishers, New Delhi
2. Materials Handling Equipment – M.P. Alexandrov. Mie publications, Maskow

Fluid Power Control
ME-605C
Contacts: 4L
Credits- 4

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

(ii) Operation and graphical symbols of check valves, pressure relief valve pressure reducing valve, unloading valve and flow control valve.

ANSI symbols for different hydraulic components. Analysis of hydraulic circuits for :

i) single acting cylinder control,
ii) double acting cylinder control,
iii) regenerative circuit,
iv) pump unloading circuit
v) double pump hydraulic system,
vi) cylinder synchronization circuit
vii) speed control of a hydraulic motor
viii) circuit to lift and hold heavy load,
ix) automatic sequencing of two cylinders.

Advantages & disadvantages of pneumatic system compared to hydraulic system; constructional details and operation of a reciprocating compressor; working principle and use of filter, pressure regulator, lubricator and silencer; symbols of different pneumatic components; compressed air distribution system in a plant; drawing pneumatic circuits for different operations.

Use of electrical devices for controlling fluid circuits; function of electrical devices like push-button switches, limit switches, pressure switches, solenoids, relays and timers and their symbols; concept of ladder diagram; study of following circuits using electrical control devices :
i) control of a solenoid actuated cylinder using one limit switch;
ii) reciprocation of a cylinder using pressure or limit switches,
iii) two cylinder sequencing circuit using two limit switches.

ME605D
Industrial Robotics
Contact Hours: 3L
Credit: 3

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

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

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

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

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

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

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

TEXT AND REFERENCE BOOKS:

1. Klafter, Richard D. Chmielewski, Thomas A. and Negin, Michael (2001) - Robotic Engineering:An Integrated Approach, Prentice-Hall of India Pvt. Limited.
2. Mikell P. Groover, Mitchell.Weiss, Roger N. Nagel, Nicholas G. Odrey, Industrial Robotics: Technology. Programming and Applications, McGraw-Hill International Edition.
3. S.R. Deb, Robotics Technology and Flexible Automation, Tata McGraw-Hill Publication.
4. S.K. Saha, Introduction to Robotics, The McGraw-Hill Publication.
5. Niku, Saeed B., Introduction to Robotics Analysis, Systems, Applications, Prentice Hall of India Private Limited.
6. Koren, Yoram, Robotics for Engineers, McGraw-Hill Book Company, Singapore
7. Hegde, Ganesh S., A Textbook on Industrial Robotics, Laxmi Publications (P) Ltd.

ME 605E : Mechanics of Composite Materials
Contact per week: 4L

Credit: 4

Basic concepts and characteristics: Definition and characteristics of composite materials, overview of advantages and limitations of composite materials, significance and objectives, sciences and technology, types and classification of typical composite materials, current status and future prospects;

Macromechanical behaviours of lamina: Stress-strain relations for anisotropic materials, engineering constants for orthotropic materials, stress-strain relations for a lamina of arbitrary orientation, biaxial strength theories.

Micromechanical behaviour of a lamina: Mechanics of materials approach to stiffness, elasticity approach to stiffness, comparison of approaches to stiffnes, mechanics of materials approach to strength. Hygrothermal effects: Hygrothermal effects on mechanical behaviours, hygrothermal stress-strain relations, coefficients of thermal and moisture expansion of unidirectional lamina

Macromechanical behaviours of a laminate: Classical lamination theory, lamina stress-strain behaviour, strain and stress variation in a laminate, laminate forces and moments, special cases of laminate, interlaminar stresses, design of laminates.

Manufacture and testing of composite materials: Manufacturing: Stamp moulding, diaphragm forming, thermoforming, filament winding, pultrution, compression moulding, injection moulding.

Testing: Determination of physical properties such as density, fibre volume ratio, void volume ratio, coefficient of thermal expansion, determination of tensile, compressive and shear properties of unidirectional lamina, determination of interlaminar and intralaminar strength, biaxial testing, characterisation of composites with stress concentration.

References :

1. Mechanics of Composite Materials by R.M.Jones, McGrawhill-Kogakusha Ltd., Tokyo.
2. Engineering Mechanics of Composite Materials by Issac M.Daniel and Ori Ishai,Oxford University press.
3. Analysis and Performance of Fiber Composites by B.D.Agarwal and L.J.Brotuman, John Wiley & Sons.

IC Engine Lab
ME-691
Contacts : 3P
Credits: 2

1. Study of different parts and their functions of Diesel / Petrol engine.
2. Estimation of minimum generating cost of Diesel engine.
3. Study of valve timing diagram of Diesel engine.
4. Performance studies of a four stroke double cylinder diesel engine with electrical load dynamometer
5. Performance studies of a four stroke single cylinder VCR diesel engine
6. Performance studies of a four stroke four cylinder computerized petrol engine with eddy current dynamometer
7. Study of cut models of IC engines
8. Study of cut models of Gas turbines
9. Performance test of a muticylinder Petrol engine by Morse method.
10. Diesel exhaust smoke testing by Diesel smoke meter
11. Petrol engine exhaust gas analysis using Petrol gas analyzer
12. Flue gas analysis by Orsat apparatus.
13. Determination of calorific value using Bomb calorimeter

Design Practice-II
ME-692
Contacts: 3P
Credits: 2

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

1. At least **two assignments** on 2-D and 3-D modelling of mechanical components and systems using software packages like AUTOCAD, CATIA, PRO E or similar software

2. At least **one assignment** on design analysis of mechanical components using software packages like CATIA, PRO E or similar software.
3. At least **one assignment** on Design Practice using codes, e.g., Pressure vessel codes, Gear design codes etc.
4. At least **one assignment** on Selection of mechanical components from manufacturers' catalogue, e.g., Rolling contact bearings etc.

ME-693, Seminar, 0-0-3-3-2

Each students has appear in seminars as assigned.

Advanced Machine Tools Lab

ME-694

Contacts: 3P

Credits: 2

Introduction of Advanced machining process by Capstan Lathe, Turret Lathe.
Study the working principal of Capstan Lathe, Turret Lathe. (3)1

1. To make Step turning and Taper Turning on Lathe machine. (3)1
2. Thread cutting and knurling on lathe machine. (3)1

Study of working principal of Universal drilling machine, Radial Drilling machine and different tools used for drilling operations. (3) 1

1. To make a counter sank drill on a specimen.
2. To make multi drill on a specimen using drilling jig. (3)1

Study the working principal of Shaping machine and the technical features of tools used.

1. To make a flat surface on a specimen using shaping machine. (3)1
2. To produce a square slot on a specimen. (3)1

Introduction of Milling operation and study the geometry of milling cutter. (3)1

1. To produce a spur gear with predetermined number of teeth and a matching pinion.(3)1
2. Tabulate the different parameter obtained in the produced spur gear. (3)1

SEMESTER – VII

HU-701 Financial Management &Accounts 3-0-0-3-3:

Introduction: Financial Management, Financial Planning and Capitalization- definitions, objectives, changing roles and functions, Financial Decision.
Capital Budgeting: Nature of Investment decision, Importance of Capital Budgeting, The Capital. Budgeting Process - Investment Criterion, Pay-back period, Accounting, ROR (Rate of Return) Method, Discounting Cash flow method, Net - present value method, IRR (Internal Rate of Return) method, The benefit-Cost Ratio method.
Management of Working Capital: Various concepts, Elements, Classification, Financing and importance of working capital, Investment analysis, Cash flow determination, cost of capital,capital budgeting methods.
Budgeting Control Technique: Concepts of Budget, budgeting and budgetary control, Objectives, Functions, Uses, Advantages, Limitations; Master Budget and Report.
Cost - Volume - Profit Analysis: Classification of costs, Allocation, apportionment and absorption, Cost centers, different costing systems, Cost analysis for managerial decisions, Meaning of Linear CVP analysis, Objectives, Assumptions, Break- Even analysis, determining the Break-Even point profit, Volume graph profit, Volume ratios margin of Safety.
Introduction to Accounting: Basic accounting concepts, important definitions, uses, limitations, advantages; types of Accounting, Financial statements, introduction to Journal Accounting; different types of Vouchers, double entry

bookkeeping, different types of transactions related to Financial Accounting.
Financial Control: Posting of Ledgers and preparation of Trial Balance; preparation of Balance Sheet and Profit and Loss Accounts; Controlling other departments by Financial Accounting (A practical Approach).
Books:
1. Financial Management and Accounting - P. K. Jain, S. Chand & Co.
2. Management & Accounting: Principles and Practice- R. K. Sharma & Shashi Kumar Gupta, Kalyani Publishers.
3. Advanced Management Accounting - Kaplan & Atkinson, PHI.
4. Fundamentals of Financial Management - Van Home,PE.
5. Financial Mgmt Accounting, Gupta,Pearson
6. Financial Mgmt, I.M. Pandey, Vikas
7. Financial Mgmt., Khan & Jain, TMH
8. Financial Mgmt , Mcmenamin, OUP
9. Financial Mgmt & Policy, Van Horne, PHI
10. Financial Mgmt,Kulkarni& Satyaprasad, Himalaya

Advanced Manufacturing Technology
ME 701
Contacts: 3L
Credits: 3
Introduction to and scope of the subject of Advanced Manufacturing Technology.
Manufacturing Systems and Automation : Job shop, Flow lines, Transfer lines. Project shop, Continuous processes, Cellular Manufacturing System, Flexible Manufacturing System.
Automation:
(i) degree of automation and their justified application in different levels of production.
(ii) benefits and draw backs of employing automation.
Integrated Manufacturing Production System:
Steps involved in implementation, forming the linked-cell factory. Group Technology and Computer-aided Process Planning. Computer-aided Quality Control.
An overview of Non Traditional Manufacturing – Advantages over traditional, classification, characteristics of all processes:
Abrasive Jet Machining (AJM): Working principle with help of layout, Applications, Effect of pressure, strand-off distance, grain size, abrasive flow rate on material removal rate (mrr) Mechanism of material removal. Advantages and limitations.
Water Jet Machining: Introduction, Machining System, Basic principle, Process parameters, Applications, Advantages and Disadvantages.
Ultrasonic Machining (USM): Schematic Diagram of USM- Working principle, Functions of each equipment used in the set up, Material removal process. Influence of Process parameters on (i) machining rate (ii) Surface finish and accuracy and repeatability, Applications.
Plasma Arc Machining : Basic principle, applications.
Chemical Machining- Introduction, Blanking, Chemical Machining to multiple depths, Design factors, advantages and disadvantages.
Electro-Chemical Machining- Process principle, Equipment, Applications.
Electron Beam Machining : Set up, Basic Principle, Applications.
Electrical Discharge Machining (EDM) : Diesinking- Basic principle, Schematic diagram of EDM setup, Dielectric fluid, Electrode materials. System for maintaining the spark gap constant, Effect of cutting parameters pulse-on-time, pulse off time, peak current setting, no load voltage, servo reference voltage, Applications.

Wire-cut EDM: Schematic diagram, working principle Dielectric fluid, use. Advantages & Disadvantages of EDM, Applications.

Laser Beam Machining (LBM) : Characteristics of Laser light, Basic mechanism of Ruby laser, Energy level diagram of Ruby laser. Carbon Dioxide laser, Energy level diagram. Commercial lasers available for machining, welding Heat treating, cladding.

Hybrid Machining- Introduction, Methodology for Hybrid Machining ,thermal interaction, chemical and electrochemical interaction, mechanical interaction, Electromechanical Discharge Machining (ECDM/ECAM), Electrical Discharge Machining with Ultrasonic Assistance (EDMUS).

Rapid Prototyping- Overview of Rapid Prototyping, Basic Process- CAD Model Creation, Conversion to STL format, Slice the STL File, Layer by layer construction, Clean and finish.

Principles, systems, relative advantages and applications of the common RP methods ;

(i) stereo lithography (SLG)
(ii) selective laser sintering (SLS)
(iii) fused deposition modelling (FDM)
(iv) laminated objects manufacturing (LOM)
(v) 3-D Inkjet Printing

Recommended Books :

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

Metrology & Measurement
ME-702
Contacts: 3L
Credits- 3

Introduction: Definition and importance of Metrology Measurement; Methods of measurements – direct, indirect, comparison, substitution, transposition, deflection and null measurement; Errors in measurement – absolute, relative, parallax, alignment, loading, dynamic and calibration error; Units of measurements – SI base and derived units, SI prefixes of units.

Limit, Fits, Tolerance and Gauges: Tolerance, Selective Assembly, Interchangeability, Limits of Size, Allowances, Clearances, Interference, IS 919-1993, Fits, Selection of Fits, Numerical problems on Limits of Size and Tolerance, Taylor's Principle, Gauge Design, hole and shaft base system, Go and No Go limit gauges; Plain plug Gauge, IS: 3484-1966, Plain Ring Gauge IS:3485-1972,Snap Gauge IS:3477-1973, thread, radius and filler gauges.

Linear Metrology: Least count for Vernier Calipers; micrometers (outside micrometer, inside micrometer, stick micrometer) construction and use of Vernier calliper, Vernier height and depth gauge, Feeler gauge, slip gauges.

Angular Metrology: Working principle and use of universal bevel protractor, Vernier bevel protractor, spirit level, clinometers, angle gauges, sine bar and slip gauges.

Measurements of: (i) Level using spirit-level; (ii) Flatness using straight edge, interferrometry (Newton's rings) and surface plate; Parallelism, cylindricity and concentricity using dial indicator.

Definition, classification, use and essential features of Comparators; working principle and application of different type of comparators like mechanical comparators (dial indicator, sigma comparator) Cook optical comparator, back pressure Bourdon gauge pneumatic comparator, optical comparator-profile projector, relative advantages and disadvantages.

Measuring Instruments: Functional elements of an instrument – sensing, conversion & manipulation, data transmission and presentation element; Characteristics – accuracy, precision, repeatability, sensitivity, reproducibility, linearity, threshold, calibration, response, dynamic or measurement error; Transducers – definition, primary and secondary, active and passive.

Measurement of Surface Finish: Definition; Terminologies – geometrical surface, effective surface, surface roughness, roughness (primary texture), waviness (secondary texture), form, lay, terminology as per IS 3073-1967,direction of lay, sources of lay and its significance, sampling length; Numerical evaluation of surface roughness: peak-to-valley height (Rmax), CLA, Ra,RMS,Rz values and their interpretation, average depth (Rm), smoothness value (G); Principle of operation of a Talysurf, working principle of stylus probe type instruments .

Principle of operation of a few measuring instruments: displacement by LVDT; force by strain – gauge load cell and piezoelectric load cell; pressure by Bourdon – tube gauge; temperature by liquid-in-glass thermometer, thermocouples, optical pyrometer; liquid velocity by pitot tube; water flow by orifice meter.

Texts & References:

1. E.O. Doebelin and D.N. Manik, Measurement Systems– Application and Design, Tata McGraw Hill.
2. R. Rajendra, Principles of Engineering Metrology, Jaico Pub. House.
3. Beckwith, Lienhard and Marangoni, Mechanical Measurements, Pearson.
4. Bewoor and Kulkarni, Metrology & Measurement, TMH.
5. R.K. Jain, Metrology, Khanna Publication, New Delhi.
6. Alan S. Morris- Principles of Measurement and Instrumentation, Prentice Hall of India.
7. B.C. Nakra and K.K. Chaudhary- Instrumentation, Measurement and Analysis, TMH.
8. by D. S. Kumar, Kataria & Sons- Mechanical Measurements

ME-703A : Advanced Welding Technology
Contacts : 4L
Credits: 4

1 Review of welding processes, joint design

2 Process descriptions of and parametric influences on fusion welding; arc welding- SMAW, stud arc welding, GMAW, GTAW and FCAW, solid state welding processes- pressure welding, friction welding, diffusion welding; resistance welding processes.

3 Arc welding- different types of equipment, power sources, arc characteristics, electrode selection.

4 Critical and precision welding processes like: PAW, LBW, EBW, USW, friction stir welding, under-water welding. Welding of plastics, ceramics and composites.

5 Welding metallurgy, HAZ, effects of different process parameters on the characteristics of weldment. Welding fixtures, welding automation and robotic applications

6 Weldability of plain carbon steels, stainless steel, cast iron, aluminium and its alloys.

7 Welding defects- types, causes, inspection and remedial measures; testing of welded joints by visual inspection, dye-penetration (DP) test, ultrasonics and radiography. Safe Practices in Welding.

Text and Reference Books:

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

ME 703B : Advanced Mechanical Vibrations, Contact per week: 4L, Credit: 4

1. Introduction to Mechanical Vibration.
2. Two Degree of Freedom Systems.
3. Multi Degree of Freedom Systems.
4. Determination of Natural Frequencies and Mode Shapes.

5. Continuous System.
6. Vibration Control.
7. Vibration Measurement and Applications.

References:

1. Singiresu S. Rao, 'Mechanical Vibrations', Pearson Education.
2. S Timoshenko, D H Young, W Weaver, 'Vibration problems in engineering', Wiley.
3. W T Thomson, 'Theory of vibration with applications', Allen and Unwin.
4. J P den Hartog, 'Mechanical Vibrations', McGraw Hill.
5. C F Beards, 'Vibration analysis and control system dynamics', Ellis Horwood.
6. C F Beards, 'Structural vibration - Analysis and Damping', Ellis Horwood.
7. M Lalanne, P Berthier, J der Hagopian, 'Mechanical vibrations for engineers', Wiley..
8. R F Steidel, 'An introduction to mechanical vibrations', 3rd Edition, Wiley.

ME703C
TOTAL QUALITY MANAGEMENT, Contact Periods: **4L , Credit: 4**

QUALITY: Evolution of quality, Quality Concept, Definitions of quality, Basic features of quality , Dimensions of quality Importance of quality, Quality policy, Quality objective, Quality metrics, Quality design ,Quality cycle, Economics of quality, Quality cost matrix, Trend analysis, Quality loss, Service
QUALITY MANAGEMENT: Evolution of quality management (1911), Quality management problem solving tools & techniques, Quality function deployment (QFD)(1966), House of quality ,Pareto diagram (1897) , Process flow diagram, Cause and effect diagram (1943) , Check sheet, Force field analysis (1943), PEEF cycle, PDCA cycle, Benchmarking (2000), Quality circles (1962), SWOT (1970s), Brainstorming (1953), Mind mapping (1974), Nominal group techniques, Charts, Quality management principle, Quality of work life (QWL), 8D methodology, 5S of quality (1995) , Seven quality management tools, Affinity diagram (1960), Interrelationship diagram (relations diagram), Tree diagram, Matrix diagram, Prioritization matrix (1994), Process decision program chart (PDPC) , Activity network diagram (1930), Quality council (QC) (1986), Institutional quality management,
TOTAL QUALITY MANAGEMENT: Historical background of total quality management, Chronological development of total quality management philosophy, TQM definition, TQM philosophy, Total quality management ,Total customer satisfaction, Core concepts of TQM, TQM policy promotions, Quality hierarchy, Inspection, Pentagon of TQM, Organizing TQM, Tools and techniques in TQM, Potential disadvantages of TQM, 4 C's in TQM, Elements of TQM, Building block of TQM, Benefits of TQM, Basic concepts of TQM, Golden rules of TQM, Ten steps of TQM process, Role of customer in TQM, Implementation of TQM, Total employee involvement (TEI), TQM operation, TQM and Zero defects, 4 essentials of TQM, 5 – M checklists, Seven guiding principles of TQM, TQM in academic institution, TQM organization, TQM efforts failure, Compare ISO 9000 and TQM philosophy, TQM and creativity, Cultural and attitudinal changes with TQM , TQM and kaizen philosophy, Components of TQM, Road maps for TQM, Criticism of TQM, Noritaki kano's model of quality, TQM and business cycle, TQM & Hawthorne effect (1924), Plan for a Total Quality Management system,
Process Control: Control Charts; Statistical Quality Control Tools; Statistical Process Control and Process Capability, Acceptance sampling, Zero defect programme; Six – Sigma approach;
Quality Management Systems: ISO 9000 Series of Standard; ISO 14000 Series of Standards;
Recommended Books:

1."Quality Control Handbook"- J. Juran, McGraw-Hill Book Company.
2. "Quality Planning and Analysis", M. Juran, F. M. Gryana, Tata McGraw Hill (3rd Edition), 1995
3. "Statistical Quality Control"- M. Mahajan, Dhanpat Rai publication
4. "Handbook of Total Quality Management"- R.P. Mohanty and R.R. Lakhe, Jaico Publishing House
5. "Total Quality Management" - D. H. Besterfield et. al., Pearson Education, Asia.
6. "Quality Control and Industrial Statistics"- A.J. Duncan, Richard D. Irwin Inc., USA.

7. "Introduction to ISO 9000 and Total Quality Management"- S. K. Ghosh, Oxford Publishing House, 1994

ME 703D , Non Destructive Testing, Contact: 4L, Credits: 4

Introduction: Non Destructive Testing, scope of NDT, advantages of NDT, comparison between destructive and non destructive testing, flaws and defects, application.

Visual Inspection: Visual inspection, equipments used for visual inspection, advantages and disadvantages of visual inspection.

Liquid Penetrant Test: Basic concepts, liquid penetrant system, test procedure, effectiveness and limitations of liquid penetrant testing.

Magnetic Particle Testing: Magnetic materials, magnetization and demagnetization of materials, principle of magnetic particle testing, scope of magnetic particle testing, magnetic particle test equipments, magnetic particle test procedure, standardization and calibration, interpretation and calibration, advantages and limitations of magnetic particle testing, applications.

Radiographic Inspection: Types of radiations, sources of X and gamma rays, X-ray film and accessories, general radiographic procedure, film interpretation and viewing, advantages and disadvantages of radiography, safety measures, applications.

Ultrasonic Testing: Piezo-electric effect, ultrasonic transducers and their characteristics, ultrasonic inspection techniques, interpretation of results, effectiveness and limitations of ultrasonic testing.

Eddy Current Test: Principle of eddy current, eddy current test system, application, effectiveness and limitations of eddy current testing.

Other Testing Methods: Thermal infrared testing, acoustic emission, leak testing.

Industrial Applications of NDT: Applications of NDT in railways, applications in nuclear, non- nuclear, chemical, aircraft, aerospace and automotive industries, offshore gas and petroleum projects.

References:

1. Non-Destructive Test and Evaluation of Materials by J.Prasad & C.G.K.Nair, TMH
2. Basics of Non-Destructive Testing by O. Lari & R.Kumar, S.K.kataria & Sons

OPERATIONS RESEARCH, ME704A, Contact Periods: 4L, Credit: 4

Introduction to OR, definition, linear programming; graphical method, simplex method, dual problem, dual simplex method, transportation and assignment problems, CPM and PERT, Queuing theory, Game theory, Markov chain, Monte Carlo Simulation , Decision theory, Linear programming, Transportation and Assignment problems, Network analysis, Sequencing, Project scheduling, Integer programming, Non-linear programming, Inventory control, Queuing or Waiting line problems, Markov chain, Monte Carlo Simulation, game theory, forecasting.

Decision Theory: Structure of the problem (decision table); Decision making under uncertainty with optimistic, pessimistic and average outcome criteria; Decision making under risk with expected value and expected loss criteria; Sequential decision using decision trees.

Linear Programming (LP); Nature of LP problems through examples; Formulation of LP Problems; Graphical solutions of two decision variable problems; Properties of a solution to LP problems: convex solution space and extreme point solution; General form of LP model; Simplex method and its meaning; Steps of simplex method in tabular form; Solving LP problems by Simplex Method; Sensitivity analysis, dual problem, dual simplex method

Transportation & Assignment Problems: Nature of a transportation or distribution problem; Tabular representation of a transportation problem; North-West Corner initial solution; Stepping stone method; Concept of dummy source or estimation; Vogel's approximation method. Nature of an Assignment problem; Tabular representation; Hungarian method for solving assignment problems.

Project Management: CPM and PERT, Project scheduling: Critical Path Method (CPM), Network construction and determination of critical path, Crashing, Resource smoothing, Resource leveling, **Network Analysis:** Network models and terminologies like arcs, nodes, paths, tree, spanning tree; shortest path/route problem; The minimum spanning tree problem; The maximal flow problem.

Game theory and its applications in OR

Waiting Line Models; Structure single channel waiting line model, Multiple channel waiting line models, economic analysis of waiting lines. **Queuing theory**, Structure of a waiting line System: Single-channel waiting line, process of arrivals, distribution of service times, queue discipline, steady stage operation; Single channel model with Poisson arrivals and exponential service time; Multiple channel model with Poisson arrival and exponential service times; Single channel model with Poisson arrivals and arbitrary service time (M/G/1); Economic analysis of waiting lines.

Inventory Models: EOQ model, Sensitivity analysis in EOQ model, economic lot size model, EOQ with planned shortage, quantity discounts for EOQ model, probabilistic models

Forecasting Techniques and its applications in OR

Non-Linear Programming: Graphical illustration of a non-linear programming problem; Unconstrained optimization by (i) direct search method, (ii) steepest decent method; Constrained optimization by lagrange multipliers; Integer linear programming by branch & bound technique; Dynamic programming problems and their characteristics; Bellman's principle of optimality; solving (i) Stagecoach problem, (ii) Knapsack problem.

BOOKS

1. R. Panneerselvam, Operations Research, Prentice Hall of India
2. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, The McGraw Hill Companies.
3. "Introduction to Operations Research" - Frederick S. Hiller, Gerald J. Lieberman, McGraw Inc.
4. "Operations Research, Principles and Practice"- Avindran, Phillips and Solberg, John Willey & Sons.
5. "Fundamentals of Operations Research"- R.L. Ackoff, M. W. Sasieni, West Publishing Co.
6. "Operations Research: An Introduction"- H. A. Taha, PHI
7. Operations Research : Theory and applications" - J. K . Sharma, MacMillan.

ME 704B : COMPUTATIONAL HEAT TRANSFER , Contacts : 4L , Credit: 4

Basic Concept: Governing differential equations, time-averaged equations for turbulent flow, nature of coordinates.

Discretization Methods : The discretization concept, methods of deriving discretization equations, discretization error.

Heat Conduction : One dimensional conduction, the basic equations of steady and unsteady conductions, grid spacing, source term linearization, boundary conditions, solutions of linear algebraic equations, Crank -Nicolson and fully implicit schemes, explicit schemes, solutions of algebraic equations, discussions on two and three dimensional heat conduction.

Convection and Diffusion: Derivation of basic equations, different schemes of discretization - upwind, exponential, hybrid and power law schemes, discretized equations and their solutions, examples.

Text / References : (Latest editions)

1. J. C. Tannehill, D. A. Anderson and R. H. Pletcher, Computational Fluid Mechanics and Heat Transfer, Taylor & Francis.
2. Y. Jaluria and K. E. Torrance, Computational Heat Transfer, Springer Verlag.3. S. V. Patankar, Computational Fluid Mechanics and Heat Transfer, Hemisphere.
3. S. V. Patankar, Computational Fluid Mechanics and Heat Transfer, Hemisphere.
4. P. S. Ghoshdastidar, Computer Simulation of Flow and Heat Transfer, Tata-McGrawhill.
5. K. Muralidhar and T. Sundararajan, Computational Fluid Flow and Heat Transfer, Narosa Publishing House, New Delhi.

ME 704C : THEORY OF COMBUSTION AND EMISSIONS , Contacts : 4L , Credit: 4

Fuels, Principles of Combustion, Chemical thermodynamics; Chemical kinetics and reaction mechanisms, flame propagation, inflammability limits, premixed and diffusion flames, flame stabilisation, radiation of flames, heat and mass transfer with chemical reactions, combustion in fixed, moving and fluidised beds, combustion of pulverized coal, oil, gas, design aspects of burners and furnaces, Combustion generated pollution – various sources and types of pollution, Industrial furnace and I.C. engine emissions.

Text / References : (Latest editions)
1. B. Lewis and G von Elbe, Combustion, Flames and Explosions of Gases, Academic Press.
2. Roger A. Strehlow, Combustion Fundamentals, McGraw-Hill.
3. Irvin Glassman, Combustion, Academic Press.
4. Samir Sarkar, Fuels and Combustion, University Press.
5. A. J. Johnson and G.H. Auth, Fuels and Combustion Handbook, McGraw-Hill.
6. I. H. Perry, Chemical Engineers' Handbook, McGraw-Hill.

ME 704D, Tribology , Contacts : 4L, Credit: 4

Introduction: History, Industrial Importance.

Engineering Surfaces: Properties and Measurement: Measurement Methods, Surface, Profilometry, Statistical Description of Roughness.

Surface Contact: Hertz contact theory, Greenwood-Williamson model, Elastic-plastic contact

Adhesion: Basic Models, Factors influencing Adhesion.

Friction: Measurement Methods, Origin of Friction, Friction Theories – adhesion and ploughing, Mechanisms, Friction of Metals, Non-metallic Materials.

Wear: Types: Adhesive, Abrasive, Corrosive, Fatigue, Minor Forms: Fretting, Erosion, Percussion, Delamination Theory, Wear Debris Analysis, Wear Testing Methods, Wear of Metals, Ceramics, Polymers.

Surface Engineering: Surface Treatments: Microstructural and Thermochemical Treatments, Surface Coatings: Hard Facing, Vapour Deposition Processes: PVD, CVD, PECVD etc.

Lubrication: Basic Equations for Fluid Film Lubrication. Hydrodynamic lubrication -Thrust and Journal bearings, Squeeze Film Bearings, Hydrostatic lubrication, Gas-Lubrication. Lubrication of rolling element bearings.Boundary lubrication – metal working lubrication, solid film lubrication. Hygiene of lubricants

Nanotribology: Measurement Tools: Surface Force Apparatus, Scanning Tunnelling Microscope, Atomic / Friction Force Microscope.

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

ME 704E : SAFETY & OCCUPATIONAL HEALTH , Contacts : 4L , Credit: 4

1. Development of industrial safety : Developments in Occupational Health, Occupational Safety and Health in India

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

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

4. Occupational health and safety : Occupational Health, Occupational Health Services in Places of Employment, Occupational Physician, Occupational Health in Developing Countries, Occupational Safety, Occupational Safety in Developing Countries, Promoting Occupational Health and Safety, Work Related Diseases, Occupational Health Hazards, Recognition of Hazards, Industrial Hygiene, Occupational Diseases, Basics of OHSAS 1800.

5. Health and safety at workplaces : Health and Safety hazards, Occupational Health Requirements, Occupational Safety Requirements, Occupational Welfare Requirements, Abstracts and Notices, Obligations of a Worker, Obligations of Occupier, Personal protective equipment , Causes of Accidents, Prevention of Accidents, Safety Legislation, Safety

Guidelines, emergency actions, related acts (related to chemical processes, mines, workshop practices, construction work, electrical installations)
6. Health and safety management : Basics of Safety management, Role of safety supervisor, planning for safety, Safety Policies, Safety Promotion, Safety Committee, safety education & training, Health and Safety Process, Measuring Safety, Risk Management and Loss Control.
7. Accident compensation : Brief introduction to different acts - The Dangerous Machines (Regulations) Act, 1983, The Employers' Liability Act, 1938. The (Indian) Fatal Accidents Act, 1855. The Public Liability Insurance Act, 1991. The Workmen's Compensation Act, 1923. The Employees' State Insurance Act, 1948. Role of National Safety Council, International labour office.
Text / References : (Latest editions)
1. Safety Management Systems, A. Waring, Chapman & Hall.
2. Environmental Health & Safety Management – A Guide to Compliance, N. P. Cheremisinoff, M. L. Graffia, Noyes Pub.
3. Safety at Work, J. Ridley & J. Channing, Butterworth & Heinemann.
4. Occupational Health & Hygiene, J. Stranks, Pitman Pub.
5. Safety Management: Strategy & Practice, R. Pybuss, Butterworth & Heinemann,
6. Essentials of Safety Management, H. L. Kalia, A. Singh, S. Ravishankar & S. V. Kamat, Himalaya Publishing House.
7. Industrial Health & Safety Management, A. M. Sarma, Himalaya Publishing House.
8. Encyclopaedia of Occupational Health & Safety, Vol : I–IV, Ed. J.M.Stellman – International Labour Office, Geneva.
9. Safety Management System, Alan Waring, Chapman & Hill, London.
10. Practical Health & Safety Management for small business, Jacqneline Jaynes, Butterworth Heinemann.
11. Industrial Safety and Human Behaviour, H. L. Kalia, AITBS Publisher, India.

ME 791
CAD-CAM Laboratory
Contacts : 3P
Credits : 2
Experiments to demonstrate the features of CNC machines, CNC programming on turning and milling machines,
Study of the geometry of the robot manipulators, actuators, grippers and experiment on robot programming and simple sensor experimentation.
Demonstration of basic CAD-CAM systems, generation of tool path from product geometry using CADCAM simulation tools, Robot simulation modeling.

Metrology & Measurement Lab
ME-792
Contacts: 3P
Credits: 2
List of experiments to be conducted:
1. Measurements using following instruments:
(i) Vernier height & depth gauge, (ii) Dial micrometer, (iii) Thread gauge, (iv) Radius gauge, (v) Filler gauge, (vi) Slip gauge.
2. Measurement of angle of a component using:
(i) Vernier bevel protractor, (ii) angle gauges, (iii) Sine-bar and slip gauges.
3. Checking / measuring parallelism, cylindricity and concentricity of components using dial indicator.
4. Measurement of surface finish by a Talysurf instrument.
5. Screw thread measurement and gear measurement using profile projector.
6. Determine natural cooling characteristics of a heated object by using a thermocouple.
7. Measurement of air velocity across an air duct using anemometer.

8. Fixing a strain gauge on a cantilevered flat section of steel. Then calibration of it as a force dynamometer using a Wheatstone bridge and loading arrangement.
9. To measure the stress & strain using strain gauges mounted on simply supported beam/cantilever beam.
10. To measure torque of a rotating shaft using torsion meter/strain gauge torque transducer.

ME 793 : Project I
Contacts : 6P
Credits : 4
Students will be exposed to lecture modules on Project and Thesis work followed by assignment of individual projects involving manufacturing/production/design of an engineering product. An industrial project may also be undertaken by the student to be supervised jointly by Industry personnel and the teacher.

ME-794: Industrial Training Evaluation , Contacts : 3P, Credits : 2
Student has to deliver a seminar on Industrial Training conducted after 6th semester

SEMESTER – VIII

INDUSTRIAL ENGINEERING & MANAGEMENT, ME 801, Contact Periods: 4L, Credit:4
Industrial Engineering: Production Planning and Control; Product: product design, customer requirements, value engineering, , Work study and Time and Motion study, Work/job evaluation, **Group Technology**, **Plant: location, layout**, material handling, equipment selection, maintenance of equipment and facilities; Processes: Job, batch and flow production methods,
Resource planning: production/ operation control, **forecasting**, **capacity management**, **scheduling and loading**, **line balancing, break-even analysis**,
Quality control (SPC), control charts; quality, reliability, service life, competitiveness;
Inventory of materials and their control, purchasing procedures, store, manufacturing planning, MRP - II, JIT.
Management:
Principles and functions of Management: Leadership and decision making,
Human resources: personnel management, industrial legislation and relations, industrial psychology, manpower planning, training and development, health, safety, welfare, remuneration and incentive schemes.
Sales and Marketing Management. Cost Accounting and Control, Budget and Budgetary control
References

1. Production, Planning and Inventory Control by S.L.Narasimhan, D.W.McLeavey, P.J.Billington,Prentice Hall.
2. "Production and Operations Management" - E. S. Buffa, New Age International (P) Ltd., New Delhi.
3. "Production Systems: Planning, analysis and Control" - J. L. Riggs, John Wiley & Sons, New York.
4. "Production and Operations Management" - S. N. Chary, Tata McGraw-Hill Publishing Co. Ltd., New Delhi
5. Productions and Operations Management by A.Muhlemann, J.Oakland and K.Lockyer, Macmillan
6. Total Quality Control, A. V. Feigenbum Mcgraw-Hill Book Company
7. Quality Control Handbook – Juran's , McGraw Hill Book Company

ME 802A : RENEWABLE ENERGY STUDIES , Contacts : 4L , Credit: 4
1. Introduction : Types of Energy : Primary and Secondary energy, Commercial and non-commercial energy, Non-renewable and renewable energy. Energy status of India and world – availability and consumptions : Past , Present and Future trends. Salient features of renewable energy applications. Energy, environment and sustainable development.
2. Solar radiation: Sun-Earth geometry, Solar angles, Extraterrestrial and terrestrial Solar Radiation, Estimation of solar radiation, Solar energy measuring equipments.
3. Solar Water Heating: Flat Plate Collectors – Description, Effects of various parameters on performance, Heat Transfer analysis, Testing procedures. Introduction to Evacuated Tube Collectors and Concentrating Collectors.

4. Other Solar Thermal Applications :
i) Solar Air heaters
ii) Solar Cookers
iii) Solar Distillation
iv) Solar Pond
v) Solar Refrigeration and Air-conditioning systems
vi) Solar Greenhouse
vii) Solar Passive Space heating and cooling
5. Solar Photovoltaic systems : Introduction, Description and working principle of solar cell, Performance characteristics of solar cell, Types of solar cell, Solar PV Panel and Array, Applications of solar PV systems.
6. Wind Power : Classification and description of wind turbines, Power extraction from wind, Performance of wind turbines, Applications of wind power.

7. Biomass & Biofuels : Biomass resources, Biomass conversion technologies, Biomass Gasification process and types of Biomass Gasifiers, Biogas production process from waste biomass, Classification and description of Biogas plants, Factors affecting production of Biogas, Vegetable oils and biodiesel.
8. Wave Energy : Basic concepts, Power from waves , Wave energy technology and application.
9. Tidal Energy : Basic concepts, Tidal energy conversion systems, Power generation from tides, Applications, advantages and limitations of Tidal energy.
10. Ocean Thermal Energy Conversion (OTEC) : Working principle and different methods of OTEC technology, Applications.
11. Geothermal Energy : Basic concepts, Nature of Geothermal regions – Non-thermal, Semi-thermal and Hyper-thermal, Types of Geothermal resources and energy harnessing technologies.
12. Small Hydro Energy : Basic concepts, Layout of a small/mini hydro scheme, Advantages and limitations of small hydro systems.
13. Introduction to Fuel Cells, Hydrogen energy and Magneto Hydrodynamic (MHD) systems.
Text / References : (Latest editions)
1) J. Twidell and T. Weir, Renewable Energy Resources, Taylor & Francis.
2) Godfrey Boyle (Editor), Renewable Energy – Power for a Sustainable future, Oxford University Press.
3) B. H. Khan, Non Conventional Energy Resources, Tata McGraw-Hill.
4) S. P. Sukhatme and J. K. Nayak, Solar Energy – Principles of Thermal Collection and Storage, Tata McGraw-Hill.
5) G. D. Rai, Non Conventional Energy Sources , Khanna Publishers.
6) H. P. Garg and J. Praksh, Solar Energy – Fundamentals and Applications, Tata McGraw-Hill.

ME 802B : Experimental Stress Analysis, Contacts: 4L, Credit: 4
Introduction to the theory of elasticity. General principles governing the approach to experimental stress analysis techniques - whole field and point per point information.
Photoelasticity: Light and optics as related to photoelasticity, Theory of photoelasticity, stress-optic relations, model materials, analysis techniques. Three dimensional photoelasticity.
Strain gauge techniques: Various types of strain gauges; Electrical resistance strain gauges, and semiconductor gauges, Parameters influencing the behaviour, Rosett analysis, Strain gauge circuits, and recording instruments for static and dynamic applications. Introduction to Moire fringes and Grid techniques.
References :
1. Experimental Stress Analysis by Dove & Adam, Mc. Graw Hill
2. Experimental Stress Analysis by Dolley & Raieley, Mc. Graw Hill

Computer Graphics & Solid Modeling, ME 802C, Contact: 4L, Credits: 4

Introduction to computer graphics & graphics systems [6L]: Overview of computer graphics, representing pictures, preparing, presenting & interacting with pictures for presentations; Visualization & image processing; RGB color model, direct coding, lookup table; storage tube graphics display, Raster scan display, 3D viewing devices, Plotters, printers, digitizers, Light pens etc.; Active & Passive graphics devices; Computer graphics software.
Scan conversion [8L]: Points & lines, Line drawing algorithms; DDA algorithm, Bresenham's line algorithm, Circle generation algorithm; Ellipse generating algorithm; scan line polygon, fill algorithm, boundary fill algorithm, flood fill algorithm.
2D transformation & viewing [15L]: Basic transformations: translation, rotation, scaling; Matrix representations & homogeneous coordinates, transformations between coordinate systems; reflection shear; Transformation of points, lines, parallel lines, intersecting lines. Viewing pipeline, Window to view port co-ordinate transformation, clipping operations, point clipping, line clipping, clipping circles, polygons & ellipse. Cohen and Sutherland line clipping, Sutherland-Hodgeman Polygon clipping, Cyrus-beck clipping method
3D transformation & viewing [5L]: 3D transformations: translation, rotation, scaling & other transformations. Rotation about an arbitrary axis in space, reflection through an arbitrary plane; general parallel projection transformation; clipping, view port clipping, 3D viewing.
Curves [3L]: Curve representation, surfaces, designs, Bezier curves, B-spline curves, end conditions for periodic B-spline curves, rational B-spline curves.
Hidden surfaces [3L]: Depth comparison, Z-buffer algorithm, Back face detection, BSP tree method, the Painter's algorithm, scan-line algorithm; Hidden line elimination, wire frame methods , fractal - geometry.
Color & shading models [2L]: Light & color model; interpolative shading model; Texture.
Introduction to Ray-tracing: [3L]: Human vision and color, Lighting, Reflection and transmission models.
Books:
1. Hearn, Baker – "Computer Graphics (C version 2nd Ed.)" – Pearson education
2. Z. Xiang, R. Plastock – " Schaum's outlines Computer Graphics (2nd Ed.)" – TMH
3. D. F. Rogers, J. A. Adams – "Mathematical Elements for Computer Graphics (2nd Ed.)" – TMH

ME 802D : INDUSTRIAL AND ORGANIZATIONAL PSYCHOLOGY , Contacts : 4L , Credit: 4
Introduction : Psychology as a science of Behaviour and Mental Processes: Nature, Scope and Subject Matter of Industrial and Organizational Psychology; Time and Motion Study, Classical Hawthorne Studies.
Employer Selection : Recruitment Process; Selection Process - Job and Worker Analyses, Matching Job with the Person; Selection Methods; Biographical Inventories, References and Recommendation Letters, Interviews.
Psychological Testing : Characteristics of Psychological Tests; Types of Psychological Tests; Tests of Knowledge, Skills and Abilities - Interest, Aptitude and Personality Tests; Limitations of Psychological Testing Programmes.
Training and Learning : Need Identification; Psychological Factors in Learning; Training Methods in the Workplace; Effective Training Programme; Career Planning and Development.
Motivation : Needs, Incentives and Motives; Financial and Non-financial Motives; Theories of Motivation; Management of Motivation; Organizational Commitment and Job Satisfaction.
Leadership : Changing Views of Leadership; Theories of Leadership; Leadership Styles; Role of Power in Leadership; Charismatic and Effective Leaders.
Group Behaviour : Formal and Informal Organizations in Industry; Conflicts in Organization; Resolution of the Conflicts; Decision Making Process.
Characteristics of the Workplace : Working Conditions - Physical and Psychological; Accident, Safety and Health; Management of Stress.
Organizational Communication : Process of Communications; Upward, Downward and Horizontal Communications; Barriers to Communication; Effective Communication.
Texts / References : (Latest editions)
1. Schultz, D. & Schultz, S.E.,sychology & Work Today : An Introduction to Industrial and Organizational Psychology, Prentice Hall.
2. Landy, F. J. & Conte, J. M., Work in the 21st Century : An Introduction to Industrial and Organizational Psychology, Wiley
3. Robins, S. P. & Judge, T. A., Organizational Behaviour, Prentice Hall.

Fracture Mechanics, ME-803A, Contacts: 4L , Credits: 4

- Introduction: Historical approach, Fracture Mechanics approach to design, overview and classification (LEFM & EPFM). Deformation vs. Fracture, Theoretical cohesive strength.
- Fundamental of brittle fracture: Energy approach, Griffith's criterion, concept of strain energy release rate (G), fixed load and fixed grip, R-curve instability, stress approach-Irwin's concept: stress intensity factor (K), K-controlled fracture, relationship between energy and stress approach (i.e. K&G).
- Crack tip plasticity, model concept of plane stress and plane strain fracture, CTOD, J-contour Integral, different method of measurement of J-CTOD relationship, J-R curve, J controlled fracture, fractography.
- Fracture Mechanics in metals (MVC), ceramics (Mirror-Mist-Hackle Zone), Polymers (crazing).
- Fracture toughness evaluation techniques, toughening mechanisms, intrinsic and extrinsic mechanism.
- Fatigue fracture, fatigue crack propagation, Paris law, life time prediction, persistent slip band, stress corrosion cracking.

Texts & References:

1. Principles of Fracture Mechanics by R.J Sanford, Pearson Education.
2. Fracture Mechanics: An Introduction by E.E Gdoutos, Kluwer Academic Publishers.
3. Fracture Mechanics, Fundamentals and applications by T.L Anderson, CRC Press..
4. Elementary Engineering Fracture by D.Broek, Kluwer Academic Publishers.
5. Elements of Fracture Mechanics, Prashant Kumar,TMH

ME 803B : ENERGY CONSERVATION AND MANAGEMENT, Contacts : 4L , Credit: 4

Energy Resources, Non-renewable and Renewable sources of energy, The need for Energy Conservation - estimation of Finite fuel resource, Hubbert's model for oil reserve; Energy conservation in Domestic, Industrial and Agriculture sectors; Energy Auditing : Elements and concepts, types of energy audits, instruments used in energy auditing; Cogeneration : Concepts, types of cogenerating systems, performance evaluation of cogenerating systems; Waste heat recovery: Potential, benefits, commercial waste heat recovery devices - Recuperators, Regenerative Heat Exchangers, Heat Pipes; Electrical energy conservation : Industrial uses of electrical power, load curve analysis, energy efficient motors, energy conservation - pf improvement methods. The Economics of Energy Saving Schemes, costs, investment analysis.

Text / References : (Latest editions)

1. W. R. Murphy and G. Mckey, Energy Management, Butterworth Heinmann.
2. Barun Kumar De, Energy Management,Audit & Conservation, Vrinda Publications, Delhi
3. T. D. Eastop and D. R. Croft, Energy Efficiency : for Engineers and Technologists, Longman.
4. Umesh Rathore, Energy Management, S. K. Karatia & Sons.
5. W. C. Turner, Energy Management Handbook, Wiley Interscience Publication.

AUTOMOBILE ENGINEERING, ME803C, Contact Periods: 4L , Credits: 4

Introduction: History & Development of Automobile. various sub system of Automobile.

Prime Mover: Engine for Two –Wheeler & Three- Wheeler vehicles, Engine for passenger cars, commercial and other vehicle, Fuel system for carburetted engine, MPFI engine and Diesel engine, Lubrication and cooling system.

Auto Electrical: Electric Motor as prime mover, Battery, generator, Ignition system, Starting system, lighting & signalling

Steering System: Devis steering & Ackerman steering system. Rack & pinion, cam & lever, worm & sector system.

Transmission System: Flywheel & clutch. Gearbox sliding and constant mesh type, Automoatic Transmission, Universal joint, Propeller shaft. Differential & Axle: Construction & function of differential, Different types of front & rear axles.

Suspension System: Conventional and independent suspension system, application.

Brake System: Disc & drum brake, Hydraulic brake, Parking brake. Stopping distance.

Power Requirement: Various resistances such as air resistance, gradient resistance, rolling resistance. Tractive effort. Torque- Speed curve. Horse power calculation.

Maintenance of Vehicle

Reference Books:

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

ME 803D : Advanced Mechanics of Materials, Contact per week: 4L, Credit: 4

Theories of Failure: Maximum principal stress theory, maximum shear stress theory, Total Strain energy theory, shear strain energy theory, graphical representation and derivation of equation for each and their application to problems relating to two dimensional stress systems

Leaf spring, deflection and bending stresses: Leaf spring, deflection and bending stresses; open coiled helical springs; derivation of formula and application for deflection and rotation of free end under the action of axial load and/or axial couple; flat spiral springs – derivation of formula for strain energy, maximum stress and rotation.

Thick Cylinders: Derivation of Lame's equations, calculation of radial longitudinal and hoop stresses and strains due to internal pressure in thick cylinders, compound cylinders, hub shrunk on solid shafts.

Shear centre and Unsymmetrical bending: Location of shear center for various thin sections - shear flows. Stresses and Deflections in beams subjected to unsymmetrical loading-kern of a section.

Bending of curved beams: Calculation of stresses in crane or chain hooks, rings of circular section and trapezoidal section and chain links with straight sides.

Rotational stresses: Rotational stresses in discs and rims of uniform thickness; discs of uniform strength

References:

1. Elements of Strength of Materials by Timoshenko and Gere.
2. Introduction to Mechanics of Solids by Crandell, Dahl and Lardner, - McGraw Hill
3. Mechanics of Materials by Beer & Johnston, TMH.
4. Engineering Mechanics of Solids by E.P. Popov; 2nd Ed., Prentice Hall India.
5. Advanced Mechanics of Materials by Seely and Smith.
6. Strength of Materials by R.Subramanian, 2nd Ed., Oxford Univ. Press.
7. Strength of Materials by Ryder, Mcmillan press
8. Strength of Materials by S. Ramamrutham, Dhanpat Rai Publishing Company.
9. Theory of Elasticity by Timoshenko and Goodier, McGraw Hill.

ME 891 : Industrial Engineering Laboratory
Contacts : 3P
Credits : 2

Experiments and computational work involving production planning and scheduling, process planning, Resource allocation, machine loading and optimization;
Plant facility layout models, mechanical, electro-analogue models for optimal plant facility location analysis, Analogue and computer aided models for physical path analysis of production program/project activity;
Network analysis and optimization; product quality planning and control analysis models; production system Simulation, simulated system in maintenance programs, system dynamics, computer applications in Industrial Engineering

ME 892 : Grand Viva Voce
Credits : 4

Students will have to appear at the Comprehensive Viva-Voce examination of all the subjects covering the whole syllabus before a board of examiners.

ME 893 : Project II
Contacts : 9P
Credits : 6

Students will be exposed to lecture modules on Project and Thesis work followed by assignment of individual projects involving manufacturing/production/design of an engineering product. An industrial project may also be undertaken by the student to be supervised jointly by Industry personnel and the guide.

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