# Revised Syllabus for First Year of B. Tech. and M.Sc. (Integrated) Programmes

## (Implemented from Academic Year 2019-20)

## (Approved by 43rd Senate dated 04-05-2019)

**SARDAR VALLABHBHAI NATIONAL INSTITUTE OF TECHNOLOGY, SURAT**

**Academic Year : 2018-19**

## Teaching Scheme of B. Tech.-I (Semester I & II)
## DIVISION – A, B, C, D, E & F

### SEMESTER – I

| Sr. No. | Subject | Code | Scheme | Credit |
|---|---|---|---|---|
| 1 | **Mathematics-I** | **MA 101 S1** | **3-1-0** | **04** |
| 2 | **Branch Specific Course-I** | **XXXX 102 S1** | **3-1-0/3-0-2** | **04** |
| 3 | Mechanics, Lasers and Fiber Optics | PH 103 S1/S2 | 3-0-2 | 04 |
| 4 | Applied Chemistry | CY 104 S1/S2 | 3-0-2 | 04 |
| 5 | Engineering Drawing | CEME 105 S1/S2 | 2-0-4 | 04 |
| 6 | Energy and Environmental Engineering | CEME 106 S1/S2 | 3-0-2 | 04 |
| 7 | Holistic Empowerment and Human Values* | HU 107 S1/S2 | 3-0-0 | 00 |
| | | **Total** | **20-2-10=32/ 20-1-12=33** | **24** |

* Audit Course (attendance would be compulsory as per institute norms)

### SEMESTER – II

| Sr. No. | Subject | Code | Scheme | Credit |
|---|---|---|---|---|
| 1 | Engineering Mechanics | AM 108 S2/S1 | 3-0-2 | 04 |
| 2 | Fundamentals of Computer & Programming | CS 109 S2/S1 | 3-0-2 | 04 |
| 3 | English & Professional Communication | HU 110 S2/S1 | 3-0-0 | 03 |
| 4 | Workshop Practice | ME 111 S2/S1 | 0-0-4 | 02 |
| 5 | Physics of Materials and Nuclei | PH 112 S2/S1 | 4-0-0 | 04 |
| 6 | **Branch Specific Course-II** | **XXXX 113 S2** | **3-1-0/3-0-2** | **04** |
| 7 | **Mathematics-II** | **MA 114 S2** | **3-1-0** | **04** |
| | | **Total** | **19-2-8=29/ 19-1-10=30** | **25** |

S1 = Semester-1, S2 = Semester-2
AM = Applied Mechanics, CH = Chemical, CE = Civil, CS = Computer,
ME = Mechanical, EE = Electrical, EC = Electronics,
PH = Physics, CY = Chemistry, MA = Mathematics, HU = Humanities

Branch Specific Course: First two letters indicate branch for which the course is offered and the last two letters indicate the department which is offering the course

## Teaching Scheme of B. Tech.-I (Semester I & II)
## DIVISION – G, H, I, J, K & L

### SEMESTER – I

| Sr. No. | Subject | Code | Scheme | Credit |
|---|---|---|---|---|
| 1 | **Mathematics-I** | **MA 101 S1** | **3-1-0** | **04** |
| 2 | **Branch Specific Course-I** | **XXXX 102 S1** | **3-1-0/3-0-2** | **04** |
| 3 | Engineering Mechanics | AM 108 S1/S2 | 3-0-2 | 04 |
| 4 | Fundamentals of Computer & Programming | CS 109 S1/S2 | 3-0-2 | 04 |
| 5 | English & Professional Communication | HU 110 S1/S2 | 3-0-0 | 03 |
| 6 | Workshop Practice | ME 111 S1/S2 | 0-0-4 | 02 |
| 7 | Physics of Materials and Nuclei | PH 112 S1/S2 | 4-0-0 | 04 |
| | | **Total** | **19-2-8=29/ 19-1-10=30** | **25** |

### SEMESTER – II

| Sr. No. | Subject | Code | Scheme | Credit |
|---|---|---|---|---|
| 1 | Mechanics, Lasers and Fiber Optics | PH 103 S2/S1 | 3-0-2 | 04 |
| 2 | Applied Chemistry | CY 104 S2/S1 | 3-0-2 | 04 |
| 3 | Engineering Drawing | CEME 105 S2/S1 | 2-0-4 | 04 |
| 4 | Energy and Environmental Engineering | CEME 106 S2/S1 | 3-0-2 | 04 |
| 5 | Holistic Empowerment and Human Values* | HU 107 S2/S1 | 3-0-0 | 00 |
| 6 | **Branch Specific Course-II** | **XXXX 113 S2** | **3-1-0/3-0-2** | **04** |
| 7 | **Mathematics-II** | **MA 114 S2** | **3-1-0** | **04** |
| | | **Total** | **20-2-10=32/ 20-1-12=33** | **24** |

* Audit Course (attendance would be compulsory as per institute norms)

S1 = Semester-1, S2 = Semester-2
AM = Applied Mechanics, CH = Chemical, CE = Civil, CS = Computer,
ME = Mechanical, EE = Electrical, EC = Electronics,
PH = Physics, CY = Chemistry, MA = Mathematics, HU = Humanities

Branch Specific Course: First two letters indicate branch for which the course is offered and the last two letters indicate the department which is offering the course

**Mathematics-I**

**MA 101 S1**

| | L | T | P | Credit |
|---|---|---|---|---|
| **Scheme** | **3** | **1** | **0** | **04** |

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- **DIFFERENTIAL CALCULUS** (**10 Hours**)
  Differentiation of Hyperbolic and Inverse Hyperbolic functions. Successive Differentiation, standard forms, Leibnitz's theorem and applications, Power series, Expansion of functions, Taylor's and Maclaurin's series. Curvature, Radius of curvature for Cartesian curve with application.

- **PARTIAL DIFFERENTIATION** **(10 Hours)**
  Partial differentiation, Euler's theorem for homogeneous function, Modified Euler's theorem, Taylor's and Maclaurin's series for two variables. Tangent plane and Normal line, Error and Approximation, Jacobians with properties, Extreme values of function of two variables, Lagrange's methods of undetermined multipliers

- **CURVE TRACING** **(05 Hours)**
  Cartesian, polar and parametric form of standard curves.

- **BETA AND GAMMA FUNCTION** **(04 Hours)**
  Beta and Gamma function with their properties and duplications formula without proof.

- **DOUBEL INTEGRALS** **(08 Hours)**
  Reorientation of concepts of integrals and Double integrals, evaluation techniques, change of order of Integration, change of variable, Application of double integrals for evaluation of area and volume.

- **TRIPLE INTEGRALS** **(05 Hours)**
  Triple integrals, evaluation techniques, Application of triple integrals for evaluation of volume.

**(Total Lecture Hours: 42)**

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**Books Recommended:**


1. James Steward De Calculas, Thomson Asia, Singapore, 2003.
2. O'Neil Peter., "Advanced Engg. Mathematics", Thompson, Singapore, Ind. Ed. 2002.
3. Kreyszing E., "Advanced Engineering Mathematics", John Wiley & Sons, Singapore, Int. Student Ed. 2015.
4. Wiley C. R., "Advanced Engineering Mathematics", McGraw Hill Inc., New York Ed. 1993.
5. F. B. Hilderband, "Methods of Applied mathematics", PHI, New Delhi, 1968


**Reference Books:**


1. Ramana D. V., "Higher Engg. Mathematics", The MaGraw-Hill Inc., New Delhi, 2007.
2. Srimanta Pal, Subodh C. Bhunia, " Engineering Mathematics", Oxford University Press, New Delhi, 2015.
3. Bali and Iyengar. Engg. Mathematics, Laxmi Publications, New Delhi, 2004.

| Mechanics, Lasers and Fiber Optics | | L | T | P | Credit |
|---|---|---|---|---|---|
| **PH 103 S1**<br>**PH 103 S2** | **Scheme** | **3** | **0** | **2** | **04** |

- **CLASSICAL MECHANICS** **(10 hours)**
  Constraints, Generalised Coordinates, Velocities and momenta, D'Alembert's Principle, Lagrange's equation of motion, Planet orbits, Virial theorem, Calculus of variations, Variational technique for many independent variables, Hamilton principle, Hamilton's canonical equation of motion, Physical significance of H, Advantage of Hamilton approach.

- **QUANTUM MECHANICS** **(10 hours)**
  Inadequacy of classical mechanics (black body radiation, photoelectric effect), Wave and particle duality of radiation, de Broglie concept of matter waves, Electron diffraction, Heisenberg's uncertainty principle, Schrodinger's wave equation, Eigenvalues and eigenfunctions, Superposition principle, Interpretation of wave function, Particle confined in one dimensional infinite potential box.

- **ELECTRODYNAMICS** **(06 hours)**
  Electromagnetic waves, Maxwell's equations in vacuum & medium, Types of polarization, Internal field and Claussius-Mosotti equation.

- **LASERS** **(08 hours)**
  Introduction to Laser, Characteristics of Lasers, Spontaneous and stimulated emissions, Einstein's coefficients, Population inversion and lasing action, Laser systems: Ruby laser, He-Ne Laser, Semiconductor Laser, Advanced lasers, Holography.

- **FIBER OPTICS** **(08 hours)**
  Fermat's principle and Snell's law-optical fiber, Principle and construction, Acceptance cone, Numerical aperture, V-Number, Types of fibers, Fabrication: Double Crucible Technique, Vapour phase Oxidation Process, Fiber optic communication principle, Fiber optic sensors, Other applications of optical fibers.

**(Total Lecture Hours: 42)**

**BOOKS RECOMMENDED:**

**Text Books:**


1. R. Resnick and D. Halliday Physics (Part I & II) Wiley 2007
2. A. Beiser Concept of the Modern Physics McGraw-Hill 2008
3. Landau and Lipschitz Mechanics Butterworth-Heinemann 1982


**Reference Books:**


1. D. J. Griffiths Introduction to Electrodynamics Addison-Wesley 2012
2. W. T. Silfvast Laser Fundamentals Cambridge 2004

**Applied Chemistry**

**CY 104 S1**
**CY 104 S2**

| | L | T | P | Credit |
|---|---|---|---|---|
| **Scheme** | **3** | **0** | **2** | **04** |

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- **WATER** **(08 Hours)**
  Structure of water, physical and chemical properties, Hydrogen bonding, Specifications for water in industries, types of water (raw water, cooling water, boiler water, nuclear water), Hardness of water, Estimation and units of Hardness, Boiler feed water, Boiler Problems - Scales & Sludge, Priming, Foaming, Carryover, Caustic Embrittlement, Boiler corrosion, Desalination. Water softening (lime-soda, zeolite and ion-exchange) methods.

- **POLYMER** **(06 Hours)**
  Introduction of Polymers: Classification of polymers, nomenclature, functionality in polymers, number and weight average molecular weight, molecular weight distribution (PDI), Chain Architecture (Linear/Branched, Tacticity, Isomerism), homopolymers, copolymers, graft copolymers and their characteristic properties in reference to their applications. Types of polymerization: addition, condensation, chain growth and step growth. Polymerization techniques: bulk, suspension and emulsion polymerization. Moulding constituents of Polymer, Moulding (Injection, Extrusion and Compressing) methods.

- **CHEMISTRY OF MATERIALS** **(08 Hours)**
  Alloys: Introduction, Necessity of making alloys, classification, Metal-Metal alloy: Brass (properties and applications), Metal-Non-metal alloy: Steel (properties), Composites: Introduction, classification, particulate composites, structural composites (Laminar and Sandwich), Advantages and applications of Composites, Nanomaterials – properties synthesis (sol-gel) and applications, Basics of Green Chemistry.

- **INSTRUMENTAL TECHNIQUES** **(06 Hours)**
  Theoretical and Experimental: Conductometry, Colorimetry, Potentiometry, pH-metry.

- **DYES AND DRUGS** **(09 Hours)**
  Introduction to Dyes: Sources and classification of dyes (chemical composition and applications), Requirements for a true dye, Witt's theory, Mode of application, Mechanisms of dyeing; Thermodynamics of dyeing; Kinetics of dyeing; Dye-fibre interactions; Role of fibre structure in dyeing.
  Introduction to Drugs: Sources and classification of drugs, requirement for an ideal drug, routes of administration, pharmaceutical phase, pharmacokinetic phase, bioavailability of a drug and pharmacodynamics phase, Examples of Drug Action: Concept of antibiotics, Structure and activity of Penicillin, Properties and synthesis of Vitamin-C.

- **CORROSION AND ITS CONTROL** **(05 Hours)**
  Introduction, types and mechanism of (Chemical and Electrochemical) corrosion, Types of Electrochemical corrosion (Galvanic, Pitting, Crevice), Passivity, Galvanic series, Factors influencing corrosion, Protective measures against corrosion: (i) Modification of the environment (ii) Modification of the properties of the Metal (iii) Prevention of corrosion by Materials selection and Design (iv) Other corrosion prevention methods.

**(Total Lecture Hours: 42)**

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**PRACTICALS:**

1. Potentiometric redox titration of $Fe^{2+}$ against standard $Ce^{4+}$ solution.
2. pH-metric titration of acidic water against standard base.
3. lodometric determination of Cu in Brass sample.
4. Complexometric determination of hardness of water.
5. Trimetric determination of *l* - Ascorbic acid (Vitamin-C).
6. Estimation of COD in waste water.
7. Determination of DO in waste water.
8. Conductometric titration to determine the strength of strong acid by strong base.
9. Electrode deposition study of Cu.
10. Concentration determination of Co as a Pollutant using Spectrophotometer.

**BOOK RECOMMENDED:-**


1. Jain P.C. and Jain M. 'Engg. Chemistry' Dhanpat Rai Publishing Co. New Delhi, 15th Edition 2006.
2. Chawla S., 'A Textbook of Engineering Chemistry', Dhanpat Rai & Co., Latest Edition, 2015.
3. Tripathy S.K., Pandhy A.K. and Panda A.K. 'Material Science & Engineering', Scitech Publications (India) Pvt. Ltd., 2nd Edition, 2009.
4. Vogel A. I. and Mendham J., 'Vogel's Textbook of Quantitative Chemical Analysis Hall, 6th Edition, 2002.
5. Sharma B. K. 'Engg. Chemistry', Krishana Prakashan Media (P) Ltd, 2008.

**Engineering Drawing**

**CEME 105 S1**
**CEME 105 S2**

| | L | T | P | Credit |
|---|---|---|---|---|
| **Scheme** | **2** | **0** | **4** | **04** |

- **INTRODUCTION** **(01 Hours)**
  Importance of Engineering Drawing, Drawing instruments and materials, B.I.S. and ISOConventions, First angle and third angle projection method.

- **ENGINEERING CURVES** **(03 Hours)**
  Classification of engineering curves, construction of conics, cycloidal curves, Involutes and spirals.

- **PROJECTION OF POINTS, LINES AND PLANES** **(04 Hours)**
  Introduction to principal planes of projection, Projections of the points located in same and different quadrant, projection of lines with its inclination to the reference planes, true length of the lines and its inclination with reference planes, projection of planes with its inclination with two reference planes, concept of auxiliary plane method for projection of planes.

- **PROJECTION AND SECTION OF SOLIDS** **(03 Hours)**
  Classification of the solids, projections of the solids like cylinder, cone, pyramid and prism with its inclination to two reference planes, Section of such solids and true shape of the section

- **PENETRATION CURVE** **(03 Hours)**
  Classification, line of interaction, line/generator method and section plane method;intersection of two prisms, two cylinders, interaction of cone and cylinder, pyramid with prism.

- **DEVELOPMENT OF THE LATERAL SURFACES** **(02 Hours)**
  Method of development, parallel line development, radial line development, developments of cylinder, cone, prism, pyramid, true length of edges – oblique surface.

- **ORTHOGRAPHIC PROJECTIONS** **(04 Hours)**
  Projections from pictorial view of the object on the principle planes for view from front, top and side using first and third angle of projection method

- **ISOMETRIC PROJECTIONS** **(04 Hours)**
  Terminology, isometric scale, isometric view and isometric projection, isometric axes and lines

- **INTRODUCTION TO COMPUTER AIDED DRAFTING** **(04 Hours)**
  Introduction of the drafting and modeling tools and demonstration of its application in latest machines.

**(Total Lecture Hours: 42)**

**PRACTICALS: Practice with drawing sheets**

1. Orthographic views
2. Isometric views
3. Engineering curves.
4. Projection of points and planes
5. Projection of solids.
6. Section of solids
7. Penetration curve and surface development
8. Demonstration of computer aided drafting and demonstration of its application in latest machines.

**BOOKS RECOMMENDED:**


1. Bhatt N. D., Engineering drawing, Charotar publishing house, 2014
2. Shah P. J., Engineering Graphics, S. Chand and Company, 2013

## Energy and Environmental Engineering

**CEME 106 S1**
**CEME 106 S2**

| | L | T | P | Credit |
|---|---|---|---|---|
| **Scheme** | **3** | **0** | **2** | **04** |

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- **ENVIRONMENT AND ECOSYSTEMS** **(12 hours)**
  Introduction: Concept of an ecosystem- structure and functions of ecosystem. Components of ecosystem - producers, consumers, decomposers, Food chains, food webs, ecological pyramids, Energy flow in ecosystem. Bio-geo- chemical cycles, Hydrologic cycle
  Components of Environment and their relationship, Impact of technology on environment, Environmental degradation. Environmental planning of urban network services such as water supply, sewerage, solid waste management.

- **ENVIRONMENTAL POLLUTION** **(10 hours)**
  Water, air, soil, noise, thermal and radioactive, marine pollution: sources, effects and engineering control strategies. Drinking water quality and standards, Ambient air and noise quality standards

- **GLOBAL ENVIRONMENTAL ISSUES AND ITS MANAGEMENT** **(8 hours)**
  Engineering aspects of climate change. Acid rain, depletion of ozone layer.Concept of carbon credit. Concepts of Environmental impact assessment and Environmental audit. Environmental life cycle assessment

- **ENERGY FUNDAMENTALS** **(8 hours)**
  Energy systems.Importance of energy. Quantifying energy, types of energy sources and end uses. Energy conversion processes.Conventional energy sources.Non-conventional energy sources.

- **ENERGY AND THE ENVIRONMENT** **(7 hours)**
  Global and Indian energy demand and growth. Environmental impacts of energy production – air and water. Climate change and energy.Energy and environment policy.Transportation and energy. Built environment and energy

**(Total Lecture Hours: 42)**

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**REFERENCES**


1. Daniel B Botkin& Edward AKeller,Environmental Sciences, John Wiley & Sons
2. R. Rajagopalan, Environmental Studies, Oxford UniversityPress
3. Benny Joseph,Environmental Studies, TMHpublishers
4. Dr. Suresh K Dhameja,Environmental Studies, S K Kataria& Sons, 2007
5. U K Khare,Basics of Environmental Studies, Tata McGrawHill, 2011


**Practical**

1. Study of different ecosystem and different Biochemical cycles.
2. Study of Water Treatment Plant.
3. Study of Water Distribution Network.
4. Study of Effluent Treatment Plant
5. Study of Solid Waste Management system for urban area.
6. Demonstration of air pollution and noise monitoring equipments
7. Exercise on life cycle Assessment
8. Exercise on EIA
9. Exercise on Quantifying energy and energy growth demand
10. Analysis of Carbon Credit
11. Tutorial on Energy in Built environment

## Holistic Empowerment and Human Values

**HU 107 S1**
**HU 107 S2**

| | L | T | P | Credit |
|---|---|---|---|---|
| **Scheme** | **3** | **0** | **0** | **00** |

- **INTRODUCTION** **(06 hours)**
  Motivation behind the course, Holistic Empowerment, Mental, Spiritual and Social Health

- **HUMAN VALUES AND ETHICS** **(12 hours)**
  Positive Attitude and Professional Ethics, Values through Literature, Sustainable Leadership for Professional and Personal Effectiveness, Social Media Pros and Cons.

- **HEALTH AND MEDICATION** **(12 hours)**
  Awareness about life style diseases, Emotional Intelligence, Substance Abuse, Life Management Skills

- **PHYSICAL FITNESS AND MENTAL HEALTH** **(12 hours)**
  Importance of games and exercises on Physical Fitness, Importance of Yoga and Meditation on Physical and Mental Health

**(Total Lecture Hours:42)**

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**Books Recommended:**


1. Chakraborty, S. K. and Chakraborty, Debanshu, Human Values and Ethics: Achieving Holistic Excellence, The ICFAI University Press, Hyderabad, (2006).
2. Gaur, R.R., Sangal, R. and Bagaria, G.P., A Foundation Course in Human Values and Professional Ethics
3. R. Subramanian, Professional Ethics, Oxford University Press, (2013).
4. Kalam, A P J Abdul, Ignited Minds: Unleashing the Power Within India, Penguin; Latest edition (12 November 2014), ISBN-13: 978-0143424123
5. Kalam, A P J Abdul, Wings of Fire: An Autobiography, Universities Press; 1st edition (1999), ISBN-10: 8173711461
6. Priestley, J. B., An Inspector Calls, Three Acts Play
7. http://livingvalues.net/ Living Values Education Activities for Young Adults, Book 1: 2019
8. Living Values Education Activities for Young Adults, Book 2: 2019

## Engineering Mechanics

**AM 108 S1**
**AM 108 S2**

| | L | T | P | Credit |
|---|---|---|---|---|
| **Scheme** | **3** | **0** | **2** | **04** |

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- **INTRODUCTION TO FORCES/EQUILIBRIUM OF RIGID BODY** **(08 Hours)**
  - Scalar and vector, system of forces, resultant force
  - Statics of particle. Free-body diagram. Equilibrium of particle in two dimensions.
  - Resultant of three or more concurrent forces, Resolution of a force into components. Rectangular components of a force. Resultant by rectangular components.
  - Concurrent force system in space: Resolution of a force into rectangular components in space.
  - Coplanar Non-Concurrent Force Systems, Moments about Point and Axis. Equilibrium of Non-coplanar Non-concurrent Forces

- **CENTROID AND MOMENT OF INERTIA** **(08 Hours)**
  - Distributed forces: Centroid and centre of gravity. Determination of centroid of lines and areas using integral technique.
  - Determination of centroid of composite wires and areas.
  - Centroid of volumes. Theorems of Pappus - Guldinus and its applications.
  - Second moment of areas. Definition of moment of inertia. Determination of moment of area by integration.
  - Parallel axis theorem for Moment of Inertia. MI of composite area. Concept of Mass moment of inertia of body.

- **TRUSS** **(06 Hours)**
  - Types of structure in Engineering. Trusses and beams: definition, stability and determinacy.
  - Determination of reactions at supports for planar trusses. Basic assumption for analysis of trusses. Procedures for analysis of trusses.
  - Analysis of plane trusses by method of joint. Concept of zero force member. Analysis of plane trusses by method of section.

- **BEAMS AND CABLES** **(06 Hours)**
  - ***Beams***
    Definitions, types of beam, types of loading, types of support. Determination of reactions for simply supported, overhanging beams and compound beam.
  - ***Cables***
    Cables with Concentrated Loads
- **FRICTION** **(05 Hours)**
  - The Law of Dry Friction. Coefficient of Friction, Angle of Friction.
  - Analysis of systems involving dry frictions such as ladder spheres etc.
  - Belt Friction, Analysis of flat belt, wedge friction.

- **KINETICS OF PARTICLES** **(08 Hours)**
  - Force and acceleration. Newton's laws of motion. D'Alembert's principle.
  - Dependent motion of particles. Analysis for dependent motion of particles.
  - Impulse and Momentum: Concept, Definition, Principle of linear momentum and impulse
  - Work Energy Principle.

- **VIBRATIONS** **(03 Hours)**
  - Definitions, Equation of motion for single degree of freedom.
  - Introduction to free and forced vibrations.
  - Procedure for analysis of system involving free and forced vibrations.
  - Example on free vibration.
  - Example on forced vibration.

**(Total Lecture Hours: 42)**

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**PRACTICAL:**

1. Plane force Polygone
2. Forces in space
3. Simple Plane roof truss
4. Coplanar Parallel foces
5. "E" by searle's apparatus
6. Belt Friction
7. Static Surface Friction
8. Gravitational acceleration
9. Mass M.I. of flywheel

**REFERENCES:**


1. Beer, F.P. and Johnston, E.R., Vector mechanics for engineers: Statics and Dynamics, Tata McGraw-Hill, New Delhi.
2. Desai,J.A. and Mistry, B.B., Engineering Mechanics: Statics and Dynamics, Popular Prakashan, Surat.
3. Hibbeler, R.C., Engineering Mechanics: Statics and Dynamics, Prentice Hall of India, New Delhi.
4. Meriam, J.L. and Kraige, L.G., Engineering Mechanics: Statics and Dynamics, John Wiley and sons, New York.
5. Rajsekaran s, Engineering Mechanics: Statics and Dynamics, Vikas Publication, New Delhi.
6. Shah H. J. and Junarkar S. B., Applied Mechanics, Charotar publication, Anand.
7. Bhavikatti S. S. and Rajashekarappa KG., Engineering Mechanics, Wiley 'Eastern Ltd

| Fundamentals of Computer and Programming | | L | T | P | Credit |
|---|---|---|---|---|---|
| CS 109 S1<br>CS 109 S2 | Scheme | 3 | 0 | 2 | 04 |

- **INTRODUCTION TO COMPUTER AND ITS ARCHITECTURE (02 Hours)**
  Introduction and Characteristics, Computer Architecture, Generations, Classifications, Applications, Central Processing Unit and Memory, Communication between various units, Processor speed, Multiprocessor system, Peripheral Buses, Motherboard Demonstration

- **MEMORY AND VARIOUS INPUT AND OUTPUT DEVICES (02 Hours)**
  Introduction to Memory, Input and Output Devices, Memory hierarchy, Primary memory and its types, Secondary Memory, Classification of Secondary memory, Various secondary storage devices and their functioning

- **NUMBER SYSTEMS (01 Hours)**
  Introduction and type of Number system, Conversion between number system, Arithmetic operations in different number system, Signed and unsigned number system

- **INTRODUCTION TO SYSTEM SOFTWARES AND PROGRAMMING LANGUAGES (04 Hours)**
  Classification of Computer Languages, Introduction of operating system, Evolution, type and function of OS, Unix commands, Evolution and classification of programming language, Feature and selection of good programming language, Development of program, algorithm and flowchart, Program testing and debugging, Program documentation and Paradigms, Characteristics of good program

- **WINDOWS OPERATING SYSTEM AND ITS ENVIRONMENT (02 Hours)**
  Introduction to GUI based OS, Configuration, Setup, Services, Network Configuration

- **LINUX OPERATING SYSTEM AND ITS ENVIRONMENT (02 Hours)**
  Introduction to Unix based OS, Configuration, Setup, Services, Scripting, Network Configuration

- **DEBUGGING TOOLS AND COMPILER OPTION (04 Hours)**
  Different debugging tools, Commands, Memory dump, Register and Variable Tracking, Instruction and Function level debugging, Compiler Options, Profile Generation

- **DATA COMMUNICATION, COMPUTER NETWORK AND INTERNET BASICS (02Hours)**
  Data communication and transmission media, Multiplexing and Switching, Computer network and network topology, Communication protocols and Network Devices, Evolution and basic internet term, Getting connected to internet and Internet application, Email and its working, Searching the web, Languages of internet, Internet and viruses

- **PROGRAMMING USING 'C' LANGUAGE – INTRODUCTION (06 Hours)**
  Characteristics of C language, Identifiers and keywords, Data types Constants and Variables, Declarations and Statements, Representation of expressions, Classification of Operators and Library Functions for Data input and output statements, Formatted input and output statements

- **PROGRAMMING USING 'C' LANGUAGE – CONTROL STATEMENT, DATA STRUCTURES, POINTERS (06 Hours)**
  Conditional Control Statements, Loop control statements, One dimensional array of numbers and characters, Two-dimensional array, Introduction and development of user defined functions, Different types of Variables and Parameters, Structure and union, Introduction to pointers, Pointer arithmetic, Array of pointers, Pointers and functions, Pointers and structures, File handling operations

- **PROGRAMMING USING 'C' LANGUAGE – FUNCTIONS (06 Hours)**
  Functions, Passing the arguments, Return values from functions, Recursion, Header Files Design, File handling operations, Read and Write to Secondary Devices, Read and Write to Input and Output Ports

- **PROGRAMMING USING 'C' LANGUAGE – GRAPHICS, DEBUGGING (05 Hours)**
  Include Graphics Library, Debugging, Linking, Compilation Option for Optimization, Make file

**(Total Lecture Hours: 42)**

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**Practicals will be based on the coverage of the above topics. (28 Hours)**

**BOOKS RECOMMENDED**


1. "Introduction to Computer Science", ITL Education Solutions Limited, Pearson Education, Fourth Impression, 2009.
2. "Programming with C Schaum's outline Series", Gottfried B.S., Outline Series, 2/E, Tata McGraw-Hill, 2006.
3. "The C Programming language", Brian W. Kernighan, Dennis M. Ritchie, 2/E, Prentice Hall PTR publication, 1988.
4. "Programming in ANSI C", E. Balagurusamy, 6/E, Tata Mc-Graw Hill, 2012.
5. "Programming in C", Pradip Dey, 2/E, Oxford University Press, 2012.

## English and Professional Communication

**HU 110 S1**
**HU 110 S2**

| | L | T | P | Credit |
|---|---|---|---|---|
| **Scheme** | **3** | **0** | **0** | **03** |

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- **COMMUNICATION** **(05Hours)**
  Introduction to Communication, Different forms of Communication, Barriers to Communication and some remedies, Non Verbal Communication – Types, Non-Verbal Communication in Intercultural Context

- **COMMON ERRORS** **(02Hours)**
  Common Errors, Indianisms through *Goodbye Party for Miss Pushpa T.S.* (Poem by Nissim Ezekiel)

- **LISTENING SKILLS** **(05 Hours)**
  Effective Listening – Process, Types- Appreciative, comprehensive, empathetic, analytical, Modes of Listening-Active and Passive, Listening and note taking practice, Listening for various purposes-Practice and activities

- **SPEAKING SKILLS** **(12 Hours)**
  Effective Speaking- Informal Speech, JAM, Presentation Skills- types, preparation and practice Interviews- types, preparation and mock interview; Group Discussion- types, preparation and practice

- **READING SKILLS** **(05 Hours)**
  Reading Skills- **Comprehension (unseen passage- literary /scientific / technical)** Reading with fluency and speed, Skimming and scanning, identifying relevant information, isolating fact from opinion Understanding concepts and arguments, Identifying distinctive features of language

- **WRITING SKILLS** **(13 Hours)**
  Technical Writing- types and practice, Memo, Letter Writing- types and practice, Email etiquette and Netiquette, Résumé writing- types and practice, Report Writing -types and practice, Editing- practice

**(Total Lecture Hours: 42)**

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**BOOKS RECOMMENDED:**


1. Kumar, Sanjay and Pushp, Lata. Communication Skills, 2nd Edition, OUP, New Delhi, 2015.
2. Raman, Meenakshi & Sharma Sangeeta. Technical Communication Principles and Practice, 3rd Edition, OUP, New Delhi, 2015.
3. Sharma R.C. & Mohan Krishna. Business Correspondence and Report Writing, 3rd Edition, Tata McGraw Hill, New Delhi, 2007.
4. Raymond V. Lesikar and Marie E Flatley. Basic Business Communication skills for Empowering the Internet generation. Tata McGraw Hill publishing company limited. New Delhi 2005.
5. Ezekiel, Nissim. Goodbye Party for Miss Pushpa T.S., http://www.english-for-students.com/Goodbye-Party.html

**REFERENCE BOOKS:**


1. Bovee, Courtland L., Thill, John V., and Chaturvedi, Mukesh. Business Communication Today. 9th Edition. Pearson, 2009.
2. Farahthullah, T.M. Communication Skills for Technical Students, 5th Edition, Orient Blackswan, Kolkatta, 2009.
3. Leech, Geoffery& Svartvil. A Communicative Grammar of English, Longman Group UK Ltd. 2006.
4. Pfeiffer, William Sanborn and Padmaja, T.V.S., Technical Communication: A Practical Approach. 6th edition. Pearson books, 2007.

## Workshop Practice

**ME 111 S1**
**ME 111 S2**

| | L | T | P | Credit |
|---|---|---|---|---|
| **Scheme** | **0** | **0** | **4** | **02** |

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**List of Practical**

- **UNIT 1** **(12 Hours)**
  Introduction of the tools used in carpentry shop and skill development in carpentry works.

- **UNIT 2** **(12 Hours)**
  Introduction of the tools used in Fitting shop and skill development in fitting works.

- **UNIT 3** **(12 Hours)**
  Introduction of the tools used in smithy shop, and skill development in smithy works.

- **UNIT 4** **(12 Hours)**
  Introduction of the tools used in soldering and other joining processes and skill development in soldering and other joining works.

- **UNIT 5** **(04 Hours)**
  Introduction to House writing, different types of cables. Types of power supply, types of motors, Relays and Contractors, ELCB, distribution of power supply, LED lighting, MCB, Electrical wiring symbols, Energy Meter, SPDT/DPDT switches.
  Earthing and Grounding, EMI & EMC issue

- **UNIT 6** **(04 Hours)**
  Identifications of Electronics Components,
  Soldering of components,
  Components Mounting on Bread Board,
  Functioning of Power supply, Function Generator, CRO, DSO.

**(Total Practical Hours: 56)**

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**Reference book:**


1. H.S. Bava, "Workshop Technology", Tata McGraw Hill Publishing Co. Ltd., 1995.
2. S.K. Hajra Chaudhary, "Elements of Workshop Technology Vol. I", Asia Publishing House, 1988.
3. W.A.J. Chapman, "Workshop Technology", ELBS Low Price Text, Edward Donald Pub. Ltd., 1961
4. Gupta K.N. & Kaushish J.P., "Workshop Technology Vol. I, II", New Delhi Heights Pub., New Delhi, 1991
5. Raghuvanshi B. S., "Course in Workshop Technology", Dhanpat Rai & Sons, New Delhi, 1991.
6. Tejwani V. K. "Basic Machine Shop Practice Vol. I, II", Tata McGraw Hill Pub. Co., New Delhi, 1989.
7. Arora B. D. "Workshop Technology Vol. I, II", Satya Prakashan, New Delhi, 1981.

**Physics of Materials and Nuclei**

**PH 112 S1**
**PH 112 S2**

| | L | T | P | Credit |
|---|---|---|---|---|
| **Scheme** | **4** | **0** | **0** | **04** |

- **CRYSTALLOGRAPHY** **(10 hours)**
  Crystalline and amorphous solids, Lattice and unit cell, Seven crystal system and Bravais lattices, Symmetry operation, Miller indices, Atomic radius, Coordination number, Packing factor calculation for SC, BCC, FCC, Bragg's law of X-ray diffraction, Laue Method, Powder crystal method.

- **SEMICONDUCTOR PHYSICS** **(06 hours)**
  Introduction, Direct and indirect band gap semiconductors, Intrinsic and extrinsic semiconductors, Law of Mass action, Charge neutrality, Hall effect.

- **NANOMATERIALS** **(10 hours)**
  Introduction and properties, Synthesis: Chemical vapour deposition, Ball milling and relevant applications, Carbon nanotubes: structure and properties and Synthesis: Arc method and Pulsed laser deposition, Applications.

- **MAGNETIC MATERIALS, CONDUCTORS AND SUPERCONDUCTORS** **(10 hours)**
  Magnetic materials: Definition of terms, Classification of magnetic materials and properties, Domain theory of ferromagnetism, Hard and soft magnetic materials, Conductors: Classical free electron theory (Lorentz–Drude theory), Electrical conductivity, Superconductors: Definition, Meissner effect, Type I & II superconductors.

- **STATISTICAL MECHANICS** **(10 hours)**
  Macroscopic and microscopic states, Phase space, Condition for statistical equilibrium, Micro-canonical ensemble, canonical ensemble, Grand-canonical ensemble, Partition function, Bose-Einstein and Fermi-Dirac distribution.

- **NUCLEAR AND PARTICLE PHYSICS** **(10 hours)**
  Nuclear properties and forces, Nuclear models, Shell model, Nuclear reaction, Radioactivity, Types and half-lives, Application in determining the age of rock and fossils, Stellar nucleosynthesis, Fundamental forces, Particle physics, Classification of matter, Quark model, Neutrino properties and their detection.

( **Total Lecture Hours: 56)**

**BOOKS RECOMMENDED:**

**Text Books:**


1. R. Resnick and D. Halliday Physics (Part I & II) Wiley 2007
2. A. Beiser Concept of the Modern Physics McGraw-Hill 2008
3. K. Huang Statistical mechanics Willey 2008


**Reference Books:**


1. M. N. Avadhanulu and P. G. Kshirsagar, A text book of Engineering Physics S Chan 2009
2. C. Kittel Introduction to Solid State Physics Wiley 2016
3. K. K. Chattopadhyay and A. N. Banerjee Nanoscience and Nanotechnology PHI 2014

**Mathematics-II**

**MA 114 S2**

| | L | T | P | Credit |
|---|---|---|---|---|
| **Scheme** | **3** | **1** | **0** | **04** |

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- **ORDINARY DIFFERENTIAL EQUATION** (**10 Hours**)
  Reorientation of differential equation first order first degree, exact differential equation and Integrating factors, first order higher degree odes, solvable for p, y and x, Solution of homogenous equations higher order, complementary functions, Particular Integrals, Linear differential equation with variable coefficient, Cauchy's Euler and Legendre's equation with variable coefficient, Method of variation of parameters.

- **APPLICATION OF DIFFERENTIAL EQUATION (Mathematical Modelling) (07 Hours)**
  Modeling of Real world problems particularly Engineering System, Electrical network models (LCR), spread of epidemic (SI, SIS, SIR), Newton's Law of cooling, Single compartment modelling, Bending of beam models.

- **SERIES SOLUTION AND SPECIAL FUNCTIONS (07 Hours)**
  Regular point, Singular point, series solution of ODE of 2nd order with variable coefficient with special emphasis to differential equation of Legendre's and Bessel's for different cases of roots of indicial equations.

- **INTRODUCTION TO PARTIAL DIFFERENTIAL EQUATION (07 Hours)**
  Introduction to Partial differential equation, Formation of partial differential Equation, Partial differential Equation of first order, Linear partial differential equation of first order ($P\mathbf{p} + Q\mathbf{q} = R$) and method of obtaining its general solution, Non-linear partial differential equation of first order $f(\mathbf{p}, \mathbf{q})=0$, $f(z, \mathbf{p}, \mathbf{q})=0$, $f(x, \mathbf{p})= g(y, \mathbf{q})$, $z= \mathbf{p}x + \mathbf{q}y + f(\mathbf{p}, \mathbf{q})$.

- **VECTOR CALCULUS (07 Hours)**
  Scalar and vector point function, differential operator, gradient, directional derivative, divergence, curl and Laplacian operator with their properties, Line integral, Surface Integral, Volume integral, Green's, Gauss and Stokes theorem (Only statement) & application.

- **SYSTEM OF LINEAR ALGEBRIC EQUATION (04 Hours)**
  Linear systems, Elementary row and column transformation, rank of matrix, consistency of linear system of equations, Linear Independence and Dependence of vectors, Gauss Elimination method, Gauss-Jorden Method, Gauss-Jacobi Iteration Method.

**(Total Lecture Hours: 42)**

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**Books Recommended:**


1. Kreyszing E., "Advanced Engineering Mathematics", John Wiley & Sons, Singapore, Int. Student Ed. 2015.
2. James Steward De, "Calculus", Thomson Asia, Singapore, 2003.
3. O'Neel Peter., "Advanced Engg. Mathematics", Thompson, Singapore, Ind. Ed. 2002.
4. F. B. Hilderband, "Methods of Applied mathematics", PHI, New Delhi, 1968
5. Wiley C. R., "Advanced Engineering Mathematics", McGraw Hill Inc., New York Ed. 1993.


**Reference Books**


1. Ramana D. V., "Higher Engg. Mathematics", The MaGraw-Hill Inc., New Delhi, 2007.
2. Hay George E., "Vector and Tensor Analysis". Dover Publications, 2012.
3. Srimanta Pal, Subodh C. Bhunia, "Engineering Mathematics", Oxford University Press, New Delhi, 2015.
4. Mary L. Boas, Mathematical Methods in the Physical Sciences, John Wiley & Sons, Ed.2005.
5. J. N. Kapur , Mathematical Models in Biology and Medicine. East west Press, New Delhi 1985.

# Branch Specific Courses

# Branch Specific Courses for Civil Engineering Department

| Introduction to Surveying | | L | T | P | Credit |
|---|---|---|---|---|---|
| CECE 102 S1 | Scheme | 3 | 0 | 2 | 04 |

- **BASIC CONCEPT OF SURVEYING** **(06 Hours)**
  Role of Civil Engineer in Surveying, Definition, Basic measurements, Scale and Mapping, Types of Maps and their uses, Map sheet numbers, Map projections, Principles of Surveying, Classification of Surveying, Division of Surveying, Control networks, Locating position and topographic detail

- **MEASUREMENT OF DISTANCE** **(06 Hours)**
  Linear Measurement, Chain and Tapes, Field work, Distance adjustment, Errors in taping, Accuracies, Optical distance measurement (ODM), Electromagnetic distance measurement (EDM)

- **MEASUREMENT OF ANGLES** **(12 Hours)**
  Angle Measurement, Bearing and Direction, Equipment viz. Compass and Theodolite, Field procedure, Measurement of Horizontal and Vertical Angles, Method of Repetition, Method of Reiteration, Theodolite Traverse, Adjustment of traverse, Gale's Traverse Table

- **VERTICAL CONTROL** **(10 Hours)**
  Definitions, Principle of leveling, Methods of leveling , About Equipment, Instrument adjustment, Different types of Leveling, Curvature and refraction, Leveling applications viz. Reciprocal leveling, Profile leveling and cross sectioning, Precise leveling, Digital leveling, Trigonometrical leveling, Contouring and Characteristics of Contours

- **PLANE TABLE SURVEY** **(04 Hours)**
  Definitions, Plane table accessories, Advantages & Disadvantages, Methods of plotting – Radiation, Intersection & Traversing.

- **LAYOUT SURVEYS** **(04 Hours)**
  Protection and referencing, Basic setting-out procedures using coordinates, Technique for setting out a direction, Use of grids, Setting out buildings, Roads etc., Controlling verticality, Controlling grading excavation

**(Total Lecture Hours: 42)**

**PRACTICALS / DRAWING*:**

1. Study of various types of maps and symbols used
2. Introduction of Various Basic Surveying Equipments
3. Introduction of Leveling Equipment
4. Exercise on Leveling (Differential Method)
5. Exercise on Profile leveling/Cross Sectioning and contouring
6. Introduction of Angle Measuring Equipment 1 – Various types of Compass
7. Introduction of Angle Measuring Equipment 2 – Vernier Theodolite
8. Introduction of Angle Measuring Equipment 3 – Digital Theodolite
9. Measurement of Horizontal angels by Repetition and Reiteration method
10. Exercise on Theodolite Traversing
11. Introduction of Area Measuring Equipment – Plannimeter (Mechanical and Digital)
12. Evaluation of Area of map with irregular boundary
13. Setting out of a building
14. Final Submission

**** Student has to prepare a journal with description of practical as well as to prepare drawing of given exercise in prescribed drawing sheet by the teacher and has to submit the same.***

**BOOKS RECOMMENDED:**


1. W. Schofield, “Engineering Surveying”, Butterworth-Heinemann Publication, New Delhi(2001)
2. Arora K. R., "Surveying and Levelling, Vol. I & II", Standard Publications, Delhi (2000).
3. Kanitkar T.P. & Kulkarni S.V., "Surveying and Levelling, Vol. I & II", Vidyarthi Gruh Prakashan, Pune(1995).
4. Punmia B.C., “Surveying and Levelling, Vol. II & III”, Laxmi Publications Pvt. Ltd., New Delhi(1994)
5. Basak, N. N., “Surveying and Levelling“, Tata McGraw-Hill Publishing Co. Ltd., New Delhi(1994)

**Building Technology**

**CECE 113 S2**

| | L | T | P | Credit |
|---|---|---|---|---|
| **Scheme** | **3** | **0** | **2** | **04** |

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- **BUILDING MATERIALS** **(12 Hours)**
  Types of stones and bricks,uses and tests, building codes, I.S.specifications, manufacturing process, tiles, stone ware pipes ,Types of limes and cements, applications in building construction, Characteristics and tests.
  Mortars, mix proportions and uses, cement concrete, mixes and uses, formworks, placing, compacting and curing , reinforced concrete, reinforcement of foundations, columns, beams and slabs, formworks.
  Timber, polymers and plastics, energy saving materials, aluminum, glass, paints, surface coatings.

- **BUILDING STRUCTURAL COMPONENTS** **(12 Hours)**
  Foundations: Objectives, types, field applications, failures, precautionary measures.
  Maonary**:** Brick and stone, bonds, cavity, composite and partition walls, arches.
  Concrete: Plain, R.C.C., Prestressed, Precast concrete, slabs, beams, columns, lintels chajjas, cantilever, Formwork, ready mix concrete plant,batching,mixing,testing laying and curing, Strengths of concrete
  Timbering: Scaffolding, Shoring, Underpinning
  Flooring: Types , conventional flooring, terrazzo, mosaic tiles, IPS floor, timber and jack arch floors, tiles, rubber, PVC covering, leak proof techniques.

- **BUILDING JOINERY SYSTEMS** **(8 Hours)**
  Openings and staircases**:** Doors, windows, ventilators, nomenclature, fixtures and choices, Staircase terminology, types, structural forms, selection criteria
  Roofs**:** Types, terminology, Trusses, special roofs, coverings, ACC and GI sheets.
  Finishes: Plastering, pointing, mortar proportions, choices, white and colour washing, distempering, cement painting, varnishing and painting of woodwork and steel, weathering effects.

- **ELEMENTS OF BUILDING PLAN** **(4 Hours)**
  Basics and practice of building plan drawings, Basic AutoCad commands for building plans.

- **BUILDING AND ENVIRONMENT:** **(6 Hours)**
  Building materials, environment and carbon emission, Concept of Green buildings and rating systems LEED and GRIHA, Role of IGBC, CBRI

**(Total Lecture Hours: 42)**

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**BOOKS RECOMMENDED:**


1. Arora D. S., "Geology for Engineers ", Mohindra Capital Publishers, Chandigarh.(1992)
2. Arora and Bindra , " A Textbook of Building Construction " , DhanpatRai& Sons, New Delhi. (1993)
3. Barry , " Building Constructions", Vol. I , II & III , ELBS Publications. (1989)
4. Ghosh D. N., " Materials of Construction ", Tata McGraw Hill Publication, New Delhi. (1991)
5. McCay , " Building Construction " , Vol. I , II & III , ELBS Publications. (1986)
6. Chudley, "Construction Technology – Volumes 1 and 2," 2nd Edition, Longman, UK, (1987).
7. Mehta Madan, Scarborough Walter, and Armpriest Diane, "Building Construction – Principles, Materials, and Systems" 2nd Edition, Pearson Education Inc.USA, (2008)
8. Edward Allen and Joseph Iano, "Fundamentals of Building Construction: Materials and Methods", Wiley Publication, (2008)

# Branch Specific Courses for Computer Engineering Department

**Electrical Networks**

**CSEE 102 S1**

| | L | T | P | Credit |
|---|---|---|---|---|
| **Scheme** | **3** | **0** | **2** | **04** |

- **AC FUNDAMENTALS AND CIRCUITS (07 Hours)**
  Alternating voltages and currents through purely resistive inductive and capacitive circuits, R-L, R-C, R-L-C series circuits, impedance and admittance, circuits in parallel, series and parallel resonance, Complex algebra and its application to circuit analysis, Circuit Transient, Initial and Final Value Theorem, DC and Induction Machines, Electrical Measurements, Power System

- **POLYPHASE CIRCUITS AND TRANSFORMES (04 Hours)**
  Balanced three phase systems, Star and Mesh connections, Relation between Line and Phase quantities, Measurement of power, Principle of transformer, construction, transformer on no-load, with load, phasor diagram for transformer under no-load and loaded condition (with unity, lagging power factor load) equivalent circuit, open circuit and short circuit test, efficiency, voltage regulation.

- **NETWORK CONCEPTS (04 Hours)**
  Network element symbols and conventions, Active element conventions, current and voltage conventions, loops and meshes, Nodes, coupled circuits and Dot conventions.

- **MESH CURRENT AND NODE VOLTAGE NETWORK ANALYSIS (07 Hours)**
  Kirchhoff's Voltage Law, Kirchhoff's Current Law, Definitions of mesh current and nodal voltage, Choice of mesh currents or nodal voltages for network analysis, Self and mutual inductances, Mesh Equation in the Impedance Matrix Form by inspection, Solution of Linear Mesh Equations, Nodal Voltage Analysis Nodal Equations in the Form of Admittance Matrices by inspection, Solution of Linear Nodal Equations.

- **NETWORK THEOREMS AND GRAPH (07 Hours)**
  Linearity and Superposition, Independent and Dependent Source and their Transformations, Thevenin, Norton, Reciprocity and Maximum Power Transfer Theorems, Use of these theorems in Circuit Analysis, Duality and Dual of a Planner Network, Fundamental Concepts, Definition of Graph and Various Related Terms, Paths and Circuits Connections, Tree Of a Graph, Cut Sets and Tie Sets, Non-separable Planner and Dual Graphs, Matrices of Oriented Graphs, Properties and Inter-Relationship of Incidence, Tie Set and Cut Set Matrices, Complete Analysis Using Tie Set and Cut Set Matrices.

- **WAVE FORM ANALYSIS BY FOURIER SERIES (06 Hours)**
  Trigonometric and complex exponential forms, the frequency spectra of periodic wave forms, the Fourier Integral and continuous frequency spectra, Fourier transform and their relationship with Laplace transform.

- **NETWORK FUNCTIONS AND TWO PORT PARAMETERS (07 Hours)**
  Poles and zeros of a function, physical and analytical concepts, Terminal and terminal pairs, Driving point immitances, Transfer functions, Definitions, calculations and interrelationship of impedance, admittance, hybrid and transmission line parameters for four terminal networks. Image impedance and its calculations for symmetrical and unsymmetrical $\pi$, T and Ladder Networks.

**(Total Lecture Hours: 42)**

**PRACTICALS**

1. To study Ammeter and Voltmeter for current and voltage measurement in circuit
2. To study Energy meter
3. To study Power measurement method for three phase circuits using watt meter method
4. Verification of superposition theorem for electric circuit
5. Verification of Thevenin's theorem of electric circuit
6. Calculation and verification Norton's theorem
7. Open circuit and short circuit test for the transformers for efficiency calculation
8. Verification of Kirchhoff's current law and Kirchhoff's voltage law for electric circuit
9. Capacitance measurement of parallel plates
10. Calculation of efficiency of auto transformer

**BOOKS RECOMMENDED**


1. "Engineering Circuit Analysis", W.H.Hyat, J.E.Kemmerly, S.M.Durbin, 6thEdition, TMH, 2006.
2. "Network Analysis", Van Valkenburg M E, 3rd Edition, PHI, 2002.
3. "Network Theory, Analysis & Synthesis", Samarjit Ghosh, PHI, 2005.
4. "Network Analysis & Synthesis", C.L.Wadhwa, Revised 3rdEdition, New Age International Publishers, 2007.
5. "Basic Electrical Engineering", Kothari and Nagrath, 2nd edition, 2007, Tata McGraw-Hill Education.
6. "Basic Electrical Engineering", V. N. Mittle & Arvind Mittal, 2nd edition, 2005, Tata McGraw-Hill Education.

**Web Programming**

**CSCS 113 S2**

| | L | T | P | Credit |
|---|---|---|---|---|
| **Scheme** | **3** | **0** | **2** | **04** |

- **INTRODUCTION** **(04 Hours)**
  Basics of Internet, World Wide Web, HTTP protocol, Universal resource locator, Web Server, Different types of Web Servers, Domain Name Server, Web Server Configuration, Internet Browser, Web document and Mark-up language, Hypertext mark-up language, Hyper media, Web site organization, Content organization, Web server on different operating system platforms, Web Applications, Web interface, Web Standards & Accessible Design.

- **WEB DESIGNING: STATIC WEB PAGES** **(08 Hours)**
  Web page, Static web page, Hypertext mark-up tags, Handling font style, types, size, colour etc., Handling table, list, images, graphics, menu etc.,

- **WEB DESIGING: DYNAMIC WEB PAGES** **(08 Hours)**
  Forms, Input Text box, Drop down menu, Name variable, Cookie management, Session management, Animation, Structure web pages, Image mapping, Link setup in image, Frames, Structuring web pages using Frames, Multimedia handling, Linking to Pages.

- **DYNAMIC WEB PAGES AND SCRIPTING** **(08 Hours)**
  Scripting language, Dynamic pages and Forms validation, Validation of Input Text box, Dynamic Drop down menu, Validation and accessing Name variable-value pair, Cookie management through scripting, Session management through scripting, Animation through scripting, Dynamic Image mapping through scripting, Link handling through scripting, Multimedia handling through scripting.

- **WEB PAGE STYLE SHEET** **(04 Hours)**
  Web page designing using Style Sheet, Different types of style sheet, Defining different styles, Export and Importing Style Sheet, Cascade style sheet.

- **PYTHON PROGRAMMING** **(08 Hours)**
  Basics of Python programming: variables, controlling statements, functions, Introduction to Module packages, Web designing with Python.

- **WEB HOSTING AND PUBLISHING** **(02 Hours)**
  Different steps of Web hosting and publishing, Documents Interchange Standards, Website Evaluation, Components of Web Publishing, Document Management, Search Engines, Registration of a Web Site on search Engines, Publishing Tools.

**(Total Contact Time: 42 Hours)**

**Practicals will be based on the coverage of the above topics.** **(28 Hours)**

**PRACTICALS**

1. To study web server setup.
2. To study web server configuration.
3. Static web page designing using hypertext mark-up tags.
4. Dynamic web page designing.
5. Dynamic web page designing using script langue.
6. Web page designing using different style sheets.
7. Basic Python programming exercise to familiar with variables and control statements, functions and packages.
8. Web page designing using Python.

**BOOKS RECOMMENDED**


1. B. Underdahle and K. Underdahle, ”Internet and Web Page/ Website design”, 2/E, IDG Books India (P) Ltd., 2001.
2. D. Comer, ”The Internet Books,” 2/E, Prentice Hall of India, 2001.
3. J. Sklar, “Principles of Web Design”, 7/E, Cengage Learning; 2017.
4. H. Deitel, A. Deitel, “Internet and World Wide Web How To Program”, 5/E, Pearson, 2012.
5. M.L. Young,” The Complete reference of Internet”, Tata Mc Graw Hill, 2002.
6. W.G. Lehnert, “Internet 101, 1/E, Person Education, 2001.
7. Jon Duckett, “HTML & CSS Design and Build Websites”, John Wiley & Sons, Inc., 2011.
8. Thomas Powell and fritz Schneider, “JavaScript: The Complete Reference, McGraw-Hill, 2017.
9. Martin C. Brown, “Python: The Complete Reference, Osborne / McGraw-Hill, 2018.

# Branch Specific Courses for Chemical Engineering Department

## Introduction to Chemical Engineering

## CHCH 102 S1

| | L | T | P | Credit |
|---|---|---|---|---|
| Scheme | 3 | 1 | 0 | 04 |

- **INTRODUCTION** **(5 Hours)**
  Introduction: Unit operations, basic laws, useful mathematical methods, unit and dimensions, dimensional analysis, monography

- **PHYSICO-CHEMICAL CALCULATIONS** **(4 Hours)**
  Introduction: Energy, equivalent mass, solutions, electrochemical processes, hardness of water, humidity and saturation

- **MATERIAL AND ENERGY BALANCE** **(4 Hours)**
  Introduction: Material balance, energy balance

- **FLOW OF FLUIDS** **(4 Hours)**
  Introduction: nature of fluid, viscosity, flow field, flow of a fluid past a solid surface, conservation of mass and energy, friction losses in laminar and turbulent flow, fluidization, cavitations, pumping of fluids

- **HEAT TRANSFER** **(4 Hours)**
  Introduction: Conduction, convection, radiation, flow arrangement in heat exchanger, temperature profile of fluids in heat exchanger, heat transfer equipments, evaporation

- **MASS TRANSFER** **(5 Hours)**
  Introduction: Diffusion, mass transfer operations, absorption, vapour-liquid equilibrium, relative volatility, boiling point diagram, distillation, reflux, terminology and equipment of gas-liquid mass transfer operation, liquid-liquid extraction, classification of industrial liquid-liquid contactors, crystallization, drying, adsorption

- **CHEMICAL KINETICS** (**4 Hours)**
  Introduction: Thermodynamic review, determination of the rate equation, effect of temperature, catalysis, reactors, some useful terms in chemical processing

- **MEASURING DEVICES** **(2 Hours)**
  Chemical composition, pressure, temperature, and flowrate measurement, other common parameter measurements

- **COMPUTERS AND CHEMICAL ENGINEERING** **(4 Hours)**
  Introduction to Mathematical Software Packages, writing codes in C-Language and or MATLAB to solve common chemical engineering problems. Validation of the same using MS Excel (graphical as well as numerical problems)

- **NATURAL RESOURCES AND THEIR UTILIZATION** (**3 Hours)**
  Introduction: Renewable raw materials, non- renewable raw materials

- **SAFETY, HEALTH, ENVIRONMENT AND ETHICS** (**3 hours)**
  Introduction: Safety and chemical Engineering, health issues, environment concerns and ethics

**(Total Lecture Hours: 42 + Tutorial Hours: 14)**

**BOOKS RECCOMENDED**


1. Salil K Ghosal, Siddhartha Datta, Shyamal K Sanyal, Introduction to Chemical Engineering, Tata McGraw - Hill Publication, 2004.
2. S. Pushpavanam, Introduction to Chemical Engineering, PHI Learning Pvt. Ltd., 2012.
3. Vivek Utgikar, Fundamental Concepts and Computations in Chemical Engineering, Prentice Hall, 2017.
4. Walter L Badger and Julius T Banchero, Introduction to Chemical Engineering, McGraw – Hill Publication, 1955.
5. D. M. Himmelblau, J. B. Riggs, Basic Principles & Calculations in Chemical Engineering Prentice Hall (India), 2012.
6. L. B. Andersen & L. A. Wenzel, Introduction to Chemical Engineering by McGraw Hill Publication, 1961.

**Process Calculations**

**CHCH 113 S2**

| | L | T | P | Credit |
|---|---|---|---|---|
| **Scheme** | **3** | **1** | **0** | **04** |

- **INTRODUCTION** **(4 Hours)**
  Introduction, Dimension and Units, system of units, conversion of units and equations, dimensional homogeneity and dimensionless quantities

- **BASIC CHEMICAL ENGINEERING CALCULATIONS** **(5 Hours)**
  Process Variables: Density, Flowrate, Pressure and Temperature, moles, average molecular weight, Chemical Composition. Equation of States for Gases, Phase Equilibria

- **MATERIAL BALANCE ON NON-REACTIVE SYSTEMS** (**4 Hours)**
  Law of conservation of mass, differential and integral balances, Material balances for unit operations including distillation, evaporation, drying, crystallization, extraction, mixing, gas absorption

- **MATERIAL BALANCE ON NON-REACTIVE SYSTEMS WITH MULTIPLE UNITS AND RECYCLE** **(4 Hours)**
  Balances on multiple unit operations with recycle, bypass systems, Degree of freedom analysis for non-reactive systems

- **MATERIAL BALANCE ON REACTIVE SYSTEMS** **(4 Hours)**
  The chemical equation and stoichiometry, Different approaches to solve material balance problems such as molecular balance, atomic balance and extent of reaction for reactive processes

- **MATERIAL BALANCE ON REACTIVE SYSTEMS WITH MULTIPLE UNITS AND RECYCLE** **(5 Hours)**
  Material balances on reactive system with recycle, bypass and purge systems, Degree of freedom analysis for reactive systems

- **ENERGY BALANCE WITH AND WITHOUT REACTIVE** (**5 Hours)**
  Law of conservation of energy, Energy balance for closed and open system, calculations of enthalpy changes of processes

- **ENERGY BALANCE WITH CHEMICAL REACTION** **(8 Hours)**
  Calculations of enthalpy changes of reactions, heats of reaction, heat capacity calculations, Formation reactions and heats of formation and combustion, energy balances for reactive systems, Combustion reactions. Estimation of calorific values of fuels

- **MATERIAL BALANCES ON UNSTEADY STATE PROCESSES** **(3 Hours)**

**(Total Lecture Hours: 42 + Tutorial Hours: 14)**

**BOOKS RECCOMENDED**


1. Felder R. M. & Rousseau R.W., "Elementary principles of chemical processes", 3rd Ed., John Wiley & Sons, Inc., New York, 2000.
2. Himmelblau D.M., "Basics Principles and Calculations in Chemical Engineering" 6th Ed., Prentice-Hall India,1996.
3. Bhatt B.I. & Vora S.M., "Stoichiometry", 4th Ed., Tata-McGraw-Hill, New Delhi, 2004.
4. Hougen O.A., Watson K.M. & Ragatz R.A., "Chemical Process Principals: Part-I", 2nd Ed., CBS Publishers and Distributors, New Delhi, 1995.

# Branch Specific Courses for Electrical and Electronics Engineering Department

## Basic Electrical Engineering

**EEEE 102 S1**
**ECEE 102 S1**

| | L | T | P | Credit |
|---|---|---|---|---|
| **Scheme** | **3** | **0** | **2** | **04** |

**MAGNETIC CIRCUIT AND ELECTROMAGNETIC INDUCTION (08 Hours)**
Amperes circuital law, analogy between electric & magnetic circuits, fringing, leakage, series, parallel, series-parallel circuits, Faradays law, Lenz law, self-inductance, mutual inductance, coefficient of mutual inductance, coefficient of coupling, inductance in series, parallel, series-parallel, Analysis of coupled coils, dot rule, conductively coupled equivalent circuit.

**SERIES AND PARALLEL AC CIRCUITS (06 Hours)**
Complex algebra and its application to circuit analysis, R-L, R-C, R-L-C series and parallel circuits, series and parallel resonance.

**ELECTRICAL NETWORKS ANALYSIS (10 Hours)**
Kirchhoff's Voltage Law, Kirchhoff's Current Law, independent and dependent sources, Mesh current and Nodal Voltage analysis, Super position theorem, Thevenin's theorem, Norton's theorem, Reciprocity theorem, Maximum power transfer theorem

**POLYPHASE CIRCUITS (06 Hours)**
Balanced three phase systems, star and mesh connections, calculations for balanced and unbalanced three phase networks, polyphase vector diagram, and measurement of power in three phase circuits.

**SINGLE PHASE TRANSFORMERS (04 Hours)**
Principle of transformer, construction - shell type, core type, transformer on no-load, with load, phasor diagram for transformer under no-load and loaded condition (with unity, lagging power factor load) equivalent circuit, open circuit and short circuit test, losses in the transformer, efficiency, voltage regulation.

**THREE-PHASE INDUCTION MOTORS (04 Hours)**
Rotating magnetic field, types of induction motor, Principle of operation, slip, different power stages, efficiency of the induction motor.

**ELECTRIC WIRING AND ILLUMINATION (04 Hours)**
Circuits in domestic wiring, simple control circuit in domestic installation, Types of lamps, fixtures & reflectors, illumination schemes for domestic, industrial & commercial premises, Lumen requirements for different categories, working principle of tube light (fluorescent tube) , LED.

**Total Lecture Hours: 42**

**List of Practical**

1. Power measurement in single phase R-L series circuit.
2. Power measurement in single phase R-C series circuit.
3. To study the working principle of tube light and fan.
4. Hysteresis loop on CRO.
5. Study the different types of wiring in electrical engineering.
6. Determination of single phase transformer equivalent circuit parameters using open-circuit and short circuit test.
7. Load test on single phase transformer.
8. Three phase power measurement using two wattmeter method.
9. Star- delta connection of three phase circuit.

**BOOKS RECOMMENDED:**


1. V. N. Mittle and Arvind Mittal, “Basic Electrical Engineering”, 2nd edition, Tata McGraw-Hill Education 2005.
2. Edminister Joseph A., “Electrical circuits”, Schaum’s outline series, McGraw hill, 2nd edition, 1983
3. B. L. Theraja and A. K. Theraja, “A text book of Electrical Technology: Volume I: Basic Electrical Engineering”, S. Chand, 2013.
4. Kothari Nagrath, “ Basic Electrical Engineering”, 2nd edition, Tata McGraw-Hill Education 2007.
5. A. chakrabarti, M. L. Soni, P.V. Gupta, U. S. Bhatnagar, “Power System Engineering”, Dhanpatrai & Co., Second edition, 2013.
6. A.Chakrabarti, “ Circuit Theory”, Dhanpat Rai & Co. , Sixth edition, 2012

## Electronic Devices and Circuits

**EEEC 113 S2**
**ECEC 113 S2**

| | L | T | P | Credit |
|---|---|---|---|---|
| **Scheme** | **3** | **0** | **2** | **04** |

- **SEMICONDUCTOR DIODES AND APPLICATIONS (10 Hours)**
  Quantitative theory of pn diode, volt-ampere characteristics and its temperature dependence, narrow- base diode, transition and diffusion capacitance of p-n junction diodes, breakdown of junctions on reverse bias, small signal models of diode, PN diode Application as Rectifier, Half Wave Rectifier, Center Tap and Bridge Rectifier, Filter circuits, C, LC and pie filter with circuit Diagram and waveforms.
  Zener Diode theory, Construcion, Operation with forward and reverse VI characteristics, Zener Voltage Regulator, construction and application of Schottkey and Varactor Diodes.

- **BIPOLAR JUNCTION TRANSISTOR ANALYSIS AND DESIGN (08 Hours)**
  Introduction to BJT, IV characteristics, Analysis of CE Configuration: Current Amplification in the Transistor Circuits, Power Calculations, Bypass Capacitor, Coupling Capacitors, concept of AC and DC Load Lines, Different DC Biasing Methods, Fixed Bias, Emitter Stabilized Bias, Potential Divider Bias, DC Bias with voltage Feedback, Common Base Configuration Analysis, Emitter follower, Charge Storage and transient response, small signal models of BJT, Ebers-Moll Model of BJT.

- **FIELD EFFECT TRANSISTOR CIRCUITS (08 Hours)**
  Introduction to FET, Bias stability in FET, Different FET Configuration, Analysis of CS, CG and CD Configuration, Voltage Biasing Techniques, Common Source Amplifier, MOS capacitor, Depletion Mode and Inversion, MOSFET Operation and Enhancement Mode of MOSFET, Transfer Characteristics.

- **SMALL SIGNAL LOW FREQUENCY ANALYSIS AND DESIGN (08 Hours)**
  Hybrid Parameters, CE Configurations, CB Configurations, CS Configurations, CD Configuration, Impedance Reflections, Phase Splitter.

- **DEVICES USED FOR POWER ELECTRONICS (08 Hours)**
  Diac,UJT, SCR, Triac, Power MOSFET and IGBT,

**(Total Lecture Hours: 42)**

**PRACTICALS**

1. Diode Characteristic
2. Rectifiers and Filters
3. Zener as a voltage Regulator
4. BJT Characteristics
5. BJT Biasing Methods
6. FET Characteristics
7. FET Biasing Methods
8. MOSFET Inverter
9. Common Emitter Amplifier
10. Common Source Amplifier
11. SPICE Modeling of Diode, BJT and MOSFET
12. MINI - PROJECT

**BOOKS RECOMMENDED**


1. Schilling Donald L. and Belove E., "Electronics Circuits- Discrete and Integrated", McGraw-Hill, 3rd Ed., 1989, Reprint 2008
2. Boylestad Robert L. and Nashlesky Louis, "Electronics Device & Circuits Theory", PHI, 10th Ed., 2009
3. Millman Jacob, Halkias Christos C. and Parikh C., "Integrated Electronics", McGraw-Hill, 2nd Ed., 2009
4. D. A. Neamen, Semiconductor Physics and Devices (IRWIN), Times Mirror High Education Group, Chicago) 1997
5. J. Milman and A. Grabel, Microelectronics, McGraw Hill, International, 1987. A.S. Sedra and K.C. Smith, Microelectronic Circuits, Saunder's College Publishing, 1991

# Branch Specific Courses for Mechanical Engineering Department

| Fundamental of Thermal and Fluid Engineering | L | T | P | Credit |
|---|---|---|---|---|
| MEME 102 S1 Scheme | 3 | 0 | 2 | 04 |

- **INTRODUCTION TO THERMODYNAMICS (12 Hours)**
  Classical thermodynamics & statistical thermodynamics, Thermodynamic system, properties, states, processes, cycle, equilibrium, Zeroth law of thermodynamics, Definition of work & heat and their evaluation for various thermodynamics processes , P-V-T behavior of a pure substance, Critical & triple point of a pure substance, Mollier diagram, Determination of dryness fraction of steam, Equation of state for ideal gas, Change in entropy, internal energy, enthalpy of gas in various thermodynamics processes. First law of thermodynamics for flow and non-flow processes, Application of first law of thermodynamics to boilers, engines, turbines, and compressors

- **INTRODUCTION TO FLUID MECHANICS (12 Hours)**
  Classification of fluids, Properties of fluids, Types of fluid flow, Static forces on surfaces, buoyancy and metacenter, Motion of fluid particles and streams, Continuity equations for 2-D and 3-D flow in Cartesian coordinates.

- **FUELS AND LUBRICANTS (04 Hours)**
  Classification of fuels, Calorific values of fuels, Dulong's formula, Proximate and ultimate analysis of fuel, Types of lubricants, Properties of lubricants, flash point, fire point, viscosity, vapor pressure, cloud point, pour point, etc.

- **STEAM GENERATORS (04 Hours)**
  Steam generators, Definition, Classification, General study of Cochran, Babcock Wilcox, Lancashire and Benson boilers, boilers mountings and accessories, Types of draught, Calculation of chimney height, boiler efficiency and numericals, Layout of thermal power plant.

- **INTERNAL COMBUSTION ENGINES (05 Hours)**
  Air standard cycles: Otto cycle, Diesel cycle, and Dual cycle with numericals, Classification of internal combustion engines, Spark ignition and compression ignition engines, two-stroke and four-stroke engines, various efficiencies.

- **REFRIGERATION AND AIR-CONDITIONING (05 Hours)**
  Unit of refrigeration, Coefficient of performance, Refrigerants, Vapour Compression refrigeration system, Domestic refrigerator, Psychrometric terms, Window and split air conditioners, Central air conditioning systems, Ice plant.

**(Total Lecture Hours: 42)**

**PRACTICALS:**

1. Determination of calorific value of solid fuels by Bomb Calorimeter
2. Determination of flash point and fire point of a given sample of oil.
3. Determination of viscosity of oil by viscometer (Redwood or Saybolt).
4. Study of working of 2-stroke and 4-stroke SI and CI engines
5. Study of different types of steam generators
6. Study of mountings and accessories of steam generators
7. Study of working of refrigerator and air conditioner
8. Study and determination of COP of ice plant
9. Determination of different types of flow patterns by Reynolds's experiment.
10. Determination of metacentric height of floating body.

**BOOKS RECOMMENDED:**


1. P. K. Nag. Engineering thermodynamics, 6th Edition, McGraw Hill, 2017.
2. R. K. Rajput. Thermal Engineering, 10th Edition, Laxmi Pubications, 2018.
3. G. Rogers and Y. Mayhew. Engineering thermodynamics: work and heat transfer, 4th Edition, Pearson Education India, 2002.
4. S. K. Som, G. Biswas and S. Chakraborty. Introduction to fluid mechanics and fluid machines, 3rd Edition, McGraw Hill, 2017.
5. D. S. Kumar. Fluid mechanics and fluid power engineering, S. K. Kataria and Sons, 2013.

| Fundamental of Materials and Manufacturing | | L | T | P | Credit |
|---|---|---|---|---|---|
| **MEME 113 S2** | **Scheme** | **3** | **0** | **2** | **04** |

- **ENGINEERING MATERIALS** **(14 Hours)**
  Classification of engineering materials, Metals (ferrous and non-ferrous) and alloys, Ceramics, Polymers (thermosets and thermoplastics), Composites (metal-matrix, ceramic-matrix, polymer-matrix), Semi-conductors, Bio-materials, Nano-materials, and Advance materials, Engineering properties of materials, Stress- Strain relationship, Effect of temperature on properties of materials.
  Crystalline structure, Nano-crystalline structure, Types of crystal systems, Crystal lattice, Lattice parameters, Metallic structures, Miller indices, Atomic radius & atomic packing factors for various crystal systems, Crystalline materials, Amorphous materials, Structure determination by X-ray diffraction, Bragg's law.

- **METAL CASTING PROCESSES** **(10 Hours)**
  Overview of casting processes, Applications – materials and products, Sand casting process – types of patterns, pattern allowances, core and mould making, molding materials, types of cores, elements of riser and gating system, melting and pouring, cleaning of castings, casting defects, Special casting techniques such as – permanent mould casting, shell mould casting, die casting, investment casting, continuous casting and centrifugal casting.

- **METAL FORMING PROCESSES** **(8 Hours)**
  Overview of metal forming processes, Applications - materials and products, Nature of plastic deformation, Temperature in metal forming, Forming processes - Rolling, Forging, Extrusion, Drawing (wire, bar and tube), and Sheet metal forming.

- **WELDING AND ALLIED PROCESSES** **(10 Hours)**
  Overview of welding processes, Weld joints, Gas welding (Principles of gas welding, types of gases used, types of flames, welding techniques, equipment used, filler rods), Gas cutting, Electric arc welding processes - manual metal arc welding, flux cored arc welding, gas tungsten arc welding (GTAW), gas metal arc welding (GMAW), submerged arc welding, Electric resistance welding processes – spot welding, seam welding, projection welding, upset welding, flash welding, Solid state welding processes – friction welding, friction stir welding, ultrasonic welding, Weld defects, Allied processes like brazing, soldering and adhesive bonding.

**(Total Lecture Hours: 42)**

**BOOKS RECOMMENDED:**


1. M. P. Groover, Fundamentals of Modern Manufacturing, Materials, Processes, and Systems, 4th Edition, John Willey, 2010.
2. S. Kalpakijan and S. R. Schmid, Manufacturing Processes for Engineering Materials, 6th Edition, Pearson Education, 2018.
3. P. N. Rao, Manufacturing Technology – Vol. 1, 5th Edition, McGraw Hill, 2018.
4. V. Raghavan, Materials Science and Engineering: A First Course, 6th Edition, Prentice Hall India, 2015.
5. J. T. Black and R. A. Kohser, DeGarmo's Materials and Processes in Manufacturing, Wiley India, 2017.

**Experiments to be performed**

1. Testing of clay content of moulding sand.
2. Determination of grain fineness number of moulding sand.
3. Determination of moisture content of moulding sand.
4. Demonstration of permanent mould casting process
5. Demonstration and practice on manual metal arc welding
6. Demonstration of the effects of the welding parameters on GTAW process
7. Demonstration and practice on oxy-acetylene gas welding
8. Demonstration of the effects of the welding parameters on oxy-acetylene gas welding
9. Demonstration and practice on gas cutting
10. Practice on soldering of galvanized steel
11. Demonstration of selected forming operations

# Branch Specific Courses for Applied Chemistry Department

| Chemistry-I | | L | T | P | Credit |
|---|---|---|---|---|---|
| CYCY 102 S1 | Scheme | 3 | 0 | 2 | 04 |

**ATOMIC STRUCTURE AND BONDING** **[12 Hours]**

De Broglie principle, postulates of quantum mechanics, Schrödinger wave equation: Derivation, significance of $\Psi^2$, Schrodinger wave equation for H-atom and particle in 1-D box, angular and radial wave function, Valence Band Theory, Valence Shell Electron Pair Repulsion theory, hybridization, geometry and shape of molecules, Molecular Orbital Theory, molecular orbital diagrams of diatomic and simple polyatomic molecules: $N_2$, $O_2$, $C_2$, $B_2$, $F_2$, CO, NO, and their ions; HCl, $BeF_2$, $CO_2$, (idea of s-p mixing and orbital interaction to be given), ionic solids, Born-Haber cycle, covalent bond, coordinate bond, hydrogen bond, dipole moment.

**THERMODYNAMICS** **[07 Hours]**

Scope and limitations of Thermodynamics, thermodynamic terms and basic concepts, first law of thermodynamics and its limitations, measurement of $\Delta E$, heat content or enthalpy, heat capacity, relation between Cp and Cv, temperature dependence of $\Delta H$, calculation of thermodynamic quantities.

**THE GASEOUS STATE** **[08 Hours]**

States of matter, general characteristics of gases, parameters of a gas, the gas laws, kinetic molecular theory of gases, derivation of kinetic gas equation and derivation of gas laws from it, deviations from ideal behavior and compressibility factor, effects of pressure and temperature on deviations and explanation for the deviations, van der Waals equation of state and its limitations, interpretation of deviations from van der Waals equation, liquefaction of gases-critical phenomenon, van der Waals equation and critical constants, methods of liquefaction of gases.

**CHEMICAL KINETICS** **[06 Hours]**

Rate of reactions, factors affecting reaction rates, molecularity of a reaction and order of reaction: zero, first, second and third, with their differential as well as integrated rate laws, characterization and examples, half-lives, methods of determination of order of reactions: integration, fractional change, graphical and isolation.

**ORGANIC COMPOUNDS AND REACTIONS** **[09 Hours]**

Structure and properties, relationship between shapes and properties of organic molecules: reactive intermediates, electrophiles and nucleophiles, free radical, carbonium ion and carbanion, carbenes, nitrenes, and arynes, types of organic reactions: stepwise, ionic and free radical mechanisms, single step concerted mechanism, addition, substitution, elimination and rearrangement, method of determining mechanisms (identification of product, isotope effects and determination of reaction intermediates).

**[Total Lecture Hours: 42]**

**LIST OF PRACTICALS**

1. Preparation of solution and its standardization (primary and secondary standards).
2. Titration (Acid-Base, Redox).
3. Purification of solid organic compounds using melting points.
4. Chemical kinetics (esterification/pseudo first/second order).

**RECOMMENDED/REFERENCE BOOKS:**


1. J. D. Lee, Concise Inorganic Chemistry, fourth edition ELBS, 1991.
2. P. Atkins, Paula J. D., Atkin's Physical Chemistry, Oxford (Indian Edition), Oxford University Press, 2012.
3. B. H. Mahan, University Chemistry, eighth edition, Narosa Publishing House, New Delhi, 1998.
4. R. P. Rastogi, R. R. Misra, An Introduction to Chemical Thermodynamcis, fourth edition, Vikas Publishing House Pvt. Ltd., New Delhi, India, 2000.
5. B. R. Puri, L. R. Sharma, Principles of Physical Chemistry, eighth edition, Vishal Publications, New Delhi, 2001.
6. M. B. Smith, Jerry March, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, sixth edition, Wiley-Interscience, 2012.
7. H. Maskill (Ed.), The Investigations of Organic Reactions and Their Mechanisms, first edition, Blackwell Publishing Ltd. Oxford, 2006.
8. A. I. Vogel, Elementary Practical Organic Chemistry: Qualitative Organic Analysis, second edition, Dorling Kindersley (India) Pvt. Ltd., Pearson Education, South Asia, 1997.

| Chemistry-II | | L | T | P | Credit |
|---|---|---|---|---|---|
| CYCY 113 S2 | Scheme | 3 | 0 | 2 | 04 |

- **THERMODYNAMICS** **(09 Hours)**
  Entropy and second law of thermodynamics, spontaneous thermodynamics processes, combined forms of the first and second laws of thermodynamics, criterion for distinguishing between irreversible and a reversible process, entropy changes for an ideal gas, entropy changes during phase changes, entropy changes in chemical reactions, physical significance of entropy, third law of thermodynamics and its conformation, applications and exceptions of third law of thermodynamics, free energy, thermodynamic functions and spontaneity, standard free energy of formation, free energy and equilibrium constants, temperature dependence of equilibria.

- **CATALYSIS** **(05 Hours)**
  Catalysis and its classification, characteristics of catalytic reactions, promoters and explanation of promotion action, catalytic poisoning and its explanation along with examples, autocatalysis and its examples, negative catalysis and its explanation with examples, activation energy and catalysis. Theories of catalysis: Intermediate compound formation theory and The adsorption theory, Acid-Base catalysis, Enzyme catalysis: examples, mechanism and characteristics.

- **PERIODIC PROPERTIES** **(08 Hours)**
  Long form of periodic table, effective nuclear charge, shielding, Slater rules, variation of effective nuclear charge in periodic table, atomic radii (van der Waals), ionic and crystal radii, covalent radii, ionization enthalpy and its applications, electron affinity, electronegativity, electronegativity scales. Variation of electronegativity with bond order, partial charge. Sanderson‟s electron density ratio. Introduction to s-block elements.

- **HYDROCARBONS** **(10 Hours)**
  Structure, preparation and reactions of: alkanes, alkenes and alkynes. Dienes: Nomenclature, classification, methods of formation of butadiene, chemical reactions, conjugated and isolated dienes, resonance stabilization, 1,2- versus 1,4- addition.

- **STEREOCHEMISTRY OF ORGANIC COMPOUNDS** **(10 Hours)**
  Conformations and configurations of alkanes; molecular chirality, enantiomers, diastereomers, threo- and erythro- diastereomers, meso compounds, resolution of enantiomers, retention and racemization. Relative and absolute configuration, sequence rules, D and L systems of nomenclature and R and S systems of nomenclature. Determination of composition of enantiomers and diastereomers. Geometric isomerism: determination of configuration of geometric isomers E and Z systems of nomenclature, geometric isomers of oximes and alicylic compounds.

**[Total Lecture Hours: 42]**

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**LIST OF PRACTICALS**

1. Inorganic Qualitative Analysis (Single salt).

**RECOMMENDED/REFERENCE BOOKS:**


1. B. H. Mahan, University Chemistry, eighth edition, Narosa Publishing House, New Delhi, India, 1998
2. S. Glasstone, Thermodynamics for Chemists, Affiliated East-West Press Pvt. Ltd., New Delhi, India. 2009.
3. B. S. Bahl, G. D. Tuli, A. Bahl, Essential of Physical Chemistry, fourth edition, S. Chand & Company Ltd, New Delhi, India, 2003.
4. J. D. Lee, Concise Inorganic Chemistry, fourth edition, ELBS, 1991.
5. B. E. Douglas, D. H. Mc Daniel, Concepts & Models of Inorganic Chemistry, Oxford, 1970. 6. M. C. Day, J. Selbin, Theoretical Inorganic Chemistry, second edition, ACS Publications, 1962.
6. E. L. Eliel, S. H. Wilen, Stereochemistry of Organic Compounds, first edition, WileyInterscience, 2008.
7. G. Svehla, Qualitative Inorganic Analysis, seventh edition, Dorling Kindersley (India) Pvt. Ltd., Pearson Education, South Asia, 2009.

# Branch Specific Courses for Applied Mathematics & Humanities Department

| **Foundation Course in Mathematics-I** | | **L** | **T** | **P** | **Credit** |
|---|---|---|---|---|---|
| **MAMA 102 S1** | **Scheme** | **3** | **1** | **0** | **04** |

- **SET THEORY** **(7 Hours)**
  Sets, Intervals, Boundedness of sets,Supremum and infimum, Neighborhood, interior points, Open and closed sets, Limits points, Bolzano – Weierstrass Theorem, Countable and uncountable sets, Compact sets and related results. Finite Sets, Countable sets, Schroder –Berstein Theorem and Knaster – Tarski Theorem, Axoim of choice, Zorn's Lemma, Haussdorff's Maximality Principle and Well – Ordering Theorem and their equivalence.

- **RELATIONS AND FUNCTIONS** **(7 Hours)**
  Definitions, Types of relations and related properties, Cartesian product, One to one and onto functions, composite functions, inverse of a function, Binary operations. Function as a special kind of relation from one set to another. Real valued function of the real variable, domain and range of these functions, constant, identity, polynomial, rational, modulus, signum and greatest integer functions with their graphs. Sum, difference, product and quotients of functions.

- **PARTIAL ORDER SET** **(7 Hours)**
  Basic Definitions: Partial Order, least element, greatest element, maximal element, minimal element, upper bound, lower bound, least upper bound, greatest lower bound, total order and totally ordered sets, chain. Hasse Diagrams and Lattices.LUB Property, GLB Property and their equivalence

- **LIMITS AND CONTINUITY OF FUNCTIONS ON R** **(7 Hours)**
  Limit of a function, Theorems on limits, Continuity of functions and properties, Uniform continuous functions and related results. Definitions of derivatives and related results, Increasing and decreasing functions, Darboux's theorem, Rolle's theorem, Mean value theorems of differential calculus and their applications.

- **FUNCTIONS OF BOUNDED VARIATIONS** **(7 Hours)**
  Functions of bounded variations and their properties, Variation function and related results, Jordon theorem, Vector valued functions, Vector valued functions of bounded variation and related results
  .
- **PRINCIPLE OF MATHEMATICAL INDUCTION** **(7 Hours)**
  Process of the proof by induction, motivating the application of the method by looking at natural numbers as the least inductive subset of real numbers.The principle of mathematical induction (weak and strong) and simple applications.

**Total Lecture Hours: 42+Tutorial Hours: 14**

**Books Recommended:**


1. W. Rudin: Principles of Mathematical Analysis, 3rdEdition, McGraw Hill, New York 1976.
2. S.C. Malik and Savita Arora: Mathematical Analysis, 2ndEdition, New Age International (P) Limited, New Delhi, 1994.
3. T. Apostol: Mathematical Analysis, 2nd ed., Narosa Publishers, 2002.
4. H. L.Royden: Real Analysis, 3rd Edition, Macmilan Publishing Co. Inc., New York, 4th Ed., 1993.
5. N.S. Gopalakrishnan: University Algebra- New Age International (P) Limited, New Delhi, 2018
6. Joseph.A. Gallian: Contemporary Abstract Algebra, 9th Edition, Cengage Learning, 2016

## Foundation Course in Mathematics-II

## MAMA 113 S2

| | L | T | P | Credit |
|---|---|---|---|---|
| **Scheme** | **3** | **1** | **0** | **04** |

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**Group Theory**

- **UNIT-I** **(6 Hours)**
  Binary relation, Function, Binary Operation, Groups, Various properties and examples of group, Subgroups, Properties of subgroups, Normal subgroups and important results, Cyclic groups, generator, Properties of Cyclic groups.

- **UNIT-II** **(6 Hours)**
  Cosets, Lagrange's theorem, Euler theorem, Fermat's theorem (with proofs), Isomorphism and homomorphism of groups and their examples and results, Quotient group.

- **UNIT-III** **(6 Hours)**
  First, Second and Third Isomorphism Theorems (with proofs), Direct product of groups and its related results.

- **UNIT-IV** **(6 Hours)**
  Permutations, even and odd permutations, transportation, disjoint cycles, permutation groups and its related results, Cayley's theorem, Cauchy's theorem (with proofs)

**Trigonometry**

- **UNIT-V** **(10 Hours)**
  Exponential values of sines, cosines and hyperbolic functions. Inverse circular and hyperbolic functions.Logarithm of the complex quantities.

- **UNIT-VI** **(08 Hours)**
  Gregory's series.Summation of series. Infinite product of sine and cosine

**(Total Lecture Hours: 42 + Tutorial Hours: 14)**

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**Text Book:**


1. N.S. Gopalakrishnan: University Algebra- New Age International (P) Limited, New Delhi, 2018
2. Joseph.A. Gallian: Contemporary Abstract Algebra, 9th Edition, Cengage Learning, 2016
3. J.B. Fraleigh: "First Course in Abstract Algebra", A. Third Editon, Narosa Publishing House New Delhi 2003.
4. S. L. Loney: Plan Trignometry-I, Palala Press, 2016
5. S. L. Loney: Plan Trignometry-II, Palala Press, 2016

# Branch Specific Courses for Applied Physics Department

## Introduction to Classical Mechanics

## PHPH 102 S1

| | L | T | P | Credit |
|---|---|---|---|---|
| Scheme | 3 | 0 | 2 | 04 |

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- **VECTORS FUNDAMENTALS AND DIFFERENT CO-ORDINATE SYSTEM (08 hours)**
  Unit vectors, Vector operations, Tripple products, Vector algebra in component form, ifferential calculus, Cartesian coordinate system, Spherical coordinate system, Cylindrical coordinate system.

- **NEWTON'S LAWS OF MOTION, CONSERVATION LAWS, MOMENTS OF INERTIA (08 hours)**
  Mechanics of the particle, Equation of motion, Different conservation laws, Moments of inertia, Motion in central force field.

- **RIGID BODY MOTION (06 hours)**
  Euler's theorem, Angular momentum and kinetic energy, Euler's quation of motion, Euler's angles.

- **ELASTICITY & HYDRODYNAMICS (08 hours)**
  Stress and Strain, Young's modulus, Shear modulus and Bulk Modulus, Buoyancy, Types of fluid flow, Bernoulli's equations.
  Viscocity, Terminal Velocity.

- **SIMPLE HARMONIC MOTION (04 hours)**
  Restoring force, Elastic potential energy, Period and frequency, Energy, Pendulums, Applications of SHM.

- **OSCILLATIONS (08 hours)**
  Damped oscillations, forced oscillations, coupled oscillations & resonance.

**(Total Lecture Hours: 42 Hours)**

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**BOOKS RECOMMENDED:**


1. Mathur D. S., Mechanics, S. Chand & Company, 2000.
2. Takwale R. G. & Puranik P.S., Introduction to Classical Mechanics, TMH, 1997.
3. Feymann R. P., Lighton R. B. and Sands M., The Feynman Lectures in Physics Vol. 1, Narosa Publishers, 2008.
4. Verma H. C., Concepts of Physics, Vol. 1 & 2, Bharati Bhavan, 2007.
5. Landau L. D. & Lifshitz E M, Course on Theoretical Physics, Vol. 1: Mechanics, Addison-Wesley, 2002

| Kinetic Theory and Thermodynamics | | L | T | P | Credit |
|---|---|---|---|---|---|
| **PHPH 113 S2** | **Scheme** | **3** | **1** | **2** | **05** |

- **KINETIC THEORY OF GASES** **(04 Hours)**
  Postulates of kinetic theory of gases, Velocity of gas molecules, Molecular energy, Kinetic-molecular model of an ideal-gas, Kinetic interpretation of temperature, Degree of freedom of gas molecules, Maxwell's law of equipartition of energy.

- **INTERMOLECULAR FORCES & TRANSPORT PHENOMENA** **(04 Hours)**
  Viscosity of a gas, Thermal conductivity of gases, Van der wall's equation of state, Brownian motion.

- **LAWS OF THERMODYNAMICS** **(12 Hours)**
  Zeroth law of Thermodynamics, Ist and IInd laws of Thermodynamics, Concepts of temperature, Internal energy and entropy, Calculations of change of internal energy and entropy in various thermodynamic processes.

- **THERMODYNAMIC POTENTIALS, HELMOLTZ & GIBBS FUNCTIONS, MAXWELL RELATIONS** **(10 Hours)**
  Giibs and Helmholtz energy, Gibbs paradox, Enthalpy, Maxwell's thermodynamic relations.

- **ELEMENTS OF STATISTICAL PHYSICS** **(08 Hours)**
  Fermi Dirac, Maxwell Boltzmann and Bose Einstein distributions.

- **THERMODYNAMICS OF BLACK BODIES** **(04 Hours)**
  Black body and characteristics, Radiation principles like Rayleigh Jeans, Weins and Planck's law of black body radiation.

**(Total Lecture Hours: 42)**

**BOOKS RECOMMENDED:**


1. Sears F.W. & Salingar, Thermodynamics, Kinetic theory and Statical Thermodynamics, 3rd Ed. Addison-Wesley/Pearson, 1975.
2. Young & Freedman, Sears and Zemansky's University Physics, Pearson Education, Singapore, 2004.
3. Feymann R. P., Leighton R. B. and Sands M., The Feymann Lectures in Physics, Vol. 1 Narosa Publishers, 2008.
4. Zemanasky M. W., Heat and Thermodynamics, (McGraw Hill), 1957
5. Carter A., Classical and Statistical Thermodynamics, Pearson Education, 1999.

# Teaching Scheme: B. Tech. (Mechanical Engineering) IV Year

**SEMESTER - VII**

| Sr. No. | Subject | Code | Scheme | Exam Scheme | | | | Total | Credit |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Tuto. | Pract. | | |
| | | | | Hrs. | Marks | Marks | Marks | | |
| 1. | Industrial Management Techniques | ME401 | 3 – 1 - 0 | 3 | 100 | 25 | - | 125 | 04 |
| 2. | CAD-CAM | ME403 | 4 – 0 – 2 | 4 | 100 | - | 50 | 150 | 05 |
| 3. | Core Elective – 3 | ME4AA | 3 – 0 – 0 | 3 | 100 | - | - | 100 | 03 |
| 4. | Core Elective - 4 | NE4BB | 3 – 0 – 0 | 3 | 100 | - | - | 100 | 03 |
| 5. | Summer Training | ME405 | 0 – 0 – 4 | 0 | - | - | 100 | 100 | 02 |
| 6. | Project Preliminaries | ME407 | 0 – 0 – 6 | 0 | - | - | 150 | 150 | 03 |
| | | Total | 13 – 1 – 12 | 13 | 400 | 25 | 300 | 725 | 20 |

**Core Elective – 3 (ME4AA)**

1. Refrigeration and Air Conditioning Systems: ME421
2. Automobile Engineering: ME423
3. Surface Engineering and Heat Treatment: ME425
4. Production and Operations Management: ME427
5. Fundamentals of Combustion: ME429

**Core Elective – 4 (ME4BB)**

1. Renewable Energy Systems: ME431
2. Mechanics of Composite Materials: ME433
3. Gas Dynamics: ME435
4. Fatigue, Fracture and Failure Analysis: ME437
5. Smart Materials and Structures: ME439

**Industrial Management Techniques**

**ME401**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 1 | 0 | 04 |

## 1. Course Outcomes (COs)

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Formulate Linear Programming(LP) models for engineering and management systems, and apply solution techniques and algorithms to solve these problems |
| CO2 | Formulate assignment & transportation models for engineering and management systems, and apply solutions techniques and algorithms to solve these problems. |
| CO3 | Formulate Network models for engineering and management systems, and apply solution techniques and algorithms to solve these problems |
| CO4 | Formulate Queuing models for engineering and management systems, and apply solution techniques and algorithms to solve these problems |
| CO5 | Apply strategies and payoff to solve game theory problems |
| CO6 | Apply statistical process control tools for designing of products and process controls. |

## 2. Syllabus

- **LINEAR PROGRAMMING PROBLEMS** (**10 Hours**)

  Formulation, Graphical method, Simplex method, Difficulties in Simplex method, Duality

- **ASSIGNMENT & TRANSPORTATION MODELS** **(08 Hours)**

  Allocations, Problem of imbalance, Hungarian assignment method, Alternate optima, Travelling salesman problem, basic transportation problem, unbalanced transportation problem, Optimal solution, degeneracy, Transhipment & Inventory control problems

- **NETWORK ANALYSIS** **(08 Hours)**

  Project Management, Network analysis, Critical Path Activities, Program Evaluation and Review Techniques (PERT), Crashing analysis, Activity on node analysis and Resource scheduling.

- **STATISTICAL PROCESS CONTROL** **(08 Hours)**

  Discrete and continuous probability distributions, Control Charts for variables and attributes, Type I and II errors, Process capability, Acceptance Sampling Plans (single, double and multiple sampling plans)

- **QUEUING THEORY** **(04 Hours)**

  Models, Elements, Operating Characteristics and Deterministic queuing models

- **GAME THEORY** **(04 Hours)**

  Two Person Zero Sum Games, Dominance Rule, Application of Linear Programming to game problems.

**(Total Lecture Hours: 42)**

## 3. Books Recommended:


1. H. A. Taha, Operations research: An Introduction. 10th Edition, Pearson Education, 2019.
2. S. D. Sharma, Operations Research: Theory, Method & Applications, 1st Edition, Kedarnath Ramnath Publishers, 2012.
3. P. K. Gupta and D. S. Hira, Operations Research, Revised Edition, S. Chand & Company Ltd., 2017
4. A. Mitra, Fundamentals of Quality Control and Improvement, 3rd Edition, John Wiley & Sons, 2008.
5. N. D. Vohra, Quantitative Techniques in Management, 5th Edition, Mc-Graw Hill, 2017.

**CAD-CAM**

**ME403**

| L | T | P | Credit |
|---|---|---|---|
| 4 | 0 | 2 | 05 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain the fundamental principles of CAD and learn drafting commands to generate part drawings. |
| CO2 | Explain knowledge about computer aided drafting and modelling for part models and drawings. |
| CO3 | Apply CAD concepts to design engineering components. |
| CO4 | Explain the fundamental principles of CAM and learn NC & CNC programming techniques and APT language to generate the tool paths and tool motion. |
| CO5 | Explain computer aided process planning and flexible manufacturing systems. |
| CO6 | Apply CAM concepts to manufacture components. |

## 2. Syllabus

- **PRINCIPLES OF COMPUTER AIDED DESIGN** **(03 Hours)**
  Computer configuration for CAD applications, Computer peripherals for CAD

- **FUNDAMENTALS OF COMPUTER GRAPHICS** **(12 Hours)**
  Two dimensional transformation, three dimensional transformation and projections, Two dimensional transformation of points, lines, parallel & intersecting lines, rotation, reflection, scaling and combined transformations. Rotation about an arbitrary point, reflection about arbitrary line. Homogeneous coordinate system. Three dimensional scaling, shearing, rotation, reflection and transformations.

- **PLANE CURVES AND SPACE CURVES** **(06 Hours)**
  Curve representation, Parametric and Non Parametric curves, Parametric presentation of circle, ellipse, parabola, and hyperbola. Cubic spline, Bezier curve and B spline curve.

- **DRAFTING AND MODELLING** **(07 Hours)**
  Computer Aided Drafting with drafting commands and 3d modelling commands for feature generation. Introduction to various software for drafting and 3D surface/solid modelling. Computer aided engineering and about CAE software.

- **INTRODUCTION TO COMPUTER AIDED MANUFACTURING** **(02 Hours)**
  Numerical control of machine tools, Functions, Classification, Open loop and closed loop CNC systems, MCU

- **CONSTRUCTIONAL FEATURES & PART PROGRAMMING FOR NC & CNC MACHINES** **(12 Hours)**
  Tooling for NC Machines, ISO G & M Codes, NC part programming, tool

setting, cutter compensation, tool length offset method, canned cycles, parametric programming.

- **APT language** **(08 Hours)**
  APT language structure, APT Geometry, motion commands, post processor commands, repetitive programming, compilation and control commands

- **COMPUTER AIDED PROCESS PLANNING (CAPP)** **(03 Hours)**
  Process and product planning, Concurrent Engineering, CAPP types, advantages and disadvantages, implementation consideration, commercial process planning system.

- **FLEXIBLE MANUFACTURING SYSTEMS (FMS)** **(03 Hours)**
  Introduction, General Considerations for FMS, types of FMS, hierarchy of computer control in FMS.

**(Total lecture hours: 56)**

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## 3. Practicals:

1. Applying drafting commands using drafting software/sketcher mode in packages.
2. Creating part drawings based on given sketches as per dimensions.
3. Applying programming technique for generating drawings in drafting.
4. Applying programming knowledge to design a mechanical part.
5. Applying CAD commands to build 3D models.
6. CNC part programming using linear and circular interpolation for FANUC controller.
7. CNC part programming using tool radius compensation for FANUC controller.
8. CNC part programming using peck drilling and canned cycle for FANUC controller.
9. CNC part programming using mirror and subroutine for FANUC controller.
10. CNC part programming using stock removal cycles for FANUC controller.

## 4. Books Recommended:


1. P. N. Rao, “CAD/CAM: Principles and Applications”, Tata McGraw Hill, 2010.
2. K. K. Tiwati and S. K. Sinha, “CNC Programming (Fanuc Control)”, Galgotia Publications, 2011.
3. M. P. Groover and E. W. Zimmers, “Computer Aided Design and Manufacturing”, Prentice Hall India (Pearson Education), 2003.
4. C. Elanchezhian, T. S. Sunder and G. S. Sundar, “Computer Aided Manufacturing”, Laxmi Publications, New Delhi, 2006.
5. D. F. Rogers and J. A. Adams, “Mathematical Elements for Computer Graphics”, McGraw Hill Education, 2017.

## Refrigeration and Air Conditioning

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

**ME421**

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Describe the properties of refrigerants and evaluate performance of the actual vapour compression refrigeration systems. |
| CO2 | Evaluate the performance of compound vapour compression refrigeration systems for various applications. |
| CO3 | Describe vapour absorption system for large cooling load application and evaluate its performance. |
| CO4 | Explain working principles of non-conventional refrigeration systems and evaluate the performance of steam jet refrigeration system. |
| CO5 | Compute cooling/heating loads for designing air conditioning systems for residential and commercial building. |
| CO6 | Design the air duct systems for large commercial buildings. |

## 2. Syllabus

- **VAPOUR COMPRESSION REFRIGERATION SYSTEM (06 Hours)**

Refrigerants – properties, applications, selection, mixed refrigerants, retrofit study, standard rating cycle for domestic refrigerator, methods of defrosting. refrigeration system components: compressors, condensers, expansion devices, evaporators

- **COMPOUND VAPOUR COMPRESSION REFRIGERATION SYSTEMS (08 Hours)**

Multi stage compression with water intercooler, liquid subcooler, flash chamber, flash intercoolers and multiple expansion valves, multi evaporator systems, cascade refrigeration system

- **VAPOUR ABSORPTION SYSTEMS (04 Hours)**

Temperature concentration and enthalpy concentration diagrams, enthalpy balance for various components of aqua ammonia systems, Vapour absorption system- Electrolux refrigerator

- **NON - CONVENTIONAL REFRIGERATION SYSTEMS (06 Hours)**

Steam jet refrigeration system, Performance analysis of steam jet refrigeration system, thermo electric refrigeration system, vortex tube Refrigeration, pulse tube refrigeration, adiabatic demagnetization. vapour adsorption refrigeration system

- **AIR CONDITIONING (10 Hours)**

Review of air conditioning processes, summer and winter load calculations, internal and external heat gains, cooling coils, bypass factor, effective sensible heat factor, design consideration for cooling coils, high latent heat load, design of evaporative cooling system, de-humidifiers and air washers, Comfort air conditioning, thermodynamics of human body, comfort charts, effective temperature, central air conditioning system, factory air conditioning.

- **AIR HANDLING UNIT** **(08 Hours)**

Air handling unit, room air distributions, fluid flow and pressure losses, duct design, air filters, humidifiers, fan, blowers

**(Total Lecture Hours: 42**)

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## 3. Books Recommended:


1. W. F. Stoeaker, Refrigeration and Air Conditioning, McGraw Hill, 2004.
2. R.J Dossat, Principles of Refrigeration, John Wiley & Sons, 2000.
3. C.P. Arora, Refrigeration and Air Conditioning, Tata McGraw Hill, 2008.
4. S.C. Arora and S. Domkundwar, A Course in Refrigeration and Air Conditioning, Dhanpat Rai & Sons, 2018.
5. P. Manohar, Refrigeration and Air Conditioning, New Age International, 2011.

**Automobile Engineering**

**ME423**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain vehicle dynamics and performance. |
| CO2 | Describe types of suspension systems and modern vehicles with latest developments. |
| CO3 | Analyze power transmission systems and drive mechanisms of an automobile. |
| CO4 | Analyze steering, braking and other ancillary systems of an automobile. |
| CO5 | Illustrate battery, electrical and ignition systems of an automobile. |

## 2. Syllabus

- **AUTOMOTIVE POWER SOURCES** **(03 Hours)**
  IC Engines: Types and Classification based on strokes (Four Stroke and Two Stroke engines), Rotary engines, based on fuel used (petrol, diesel, lpg, cng), electric motors for electric vehicles, hybrid vehicles.

- **VEHICLE DYNAMICS AND PERFORMANCE** **(05 Hours)**
  Resistance to motion of vehicle, air, rolling and gradient resistances, acceleration, gradebility, traction, force estimation, reaction estimation, C.G. estimation.

- **TRANSMISSION SYSTEM AND DRIVE MECHANISMS OF AUTOMOTIVE VEHICLE** **(04 Hours)**
  Manual, Semi-automatic, Automatic, Hydraulic, Pneumatic, CVT's, differential, Flywheel , Torque, thrust, propeller shaft, joints (universal) Differential, axles, materials , bearing loads, rear wheel drive, front wheel drive, all-wheel drive.

- **CLUTCH** **(04 Hours)**
  Types and necessity, description and working, torque converters, Pedal Pressure, Centrifugal automatic,vacuum hydraulic operated clutch, Fluid transmission – advantages and disadvantages.

- **GEAR BOX** **(05 Hours)**
  Types and necessity, Sliding mesh, constant mesh, synchromech, epicyclic, Overdrives, Electric transmission –advantages and disadvantages.

- **BRAKES** **(05 Hours)**
  Types (drum and disc), response time and distances, braking efficiency, weight transfer during braking, shoe and disc brakes, brake power ratio, mechanical , hydraulic and power brakes. Layout and details of components, pedal and braking force estimation, Anti Braking System (ABS).

- **STEERING SYSTEMS** **(05 Hours)**
  Statically determinate beams, support reactions, relationship between load, shear force and bending moment, shear force and bending moment diagrams; theory of flexure for initially straight beams, distribution of bending stresses across the beam cross-section, principal stresses in beams; equation

of elastic curve for the loaded beam, relationship between bending moment, slope and deflection; calculation of deflection by integration, moment area and unit-load methods, S.E. in flexure.

- **SUSPENSION SYSTEMS** **(04 Hours)**
  Suspension system types, springs, material used, shackles and mounting, independent suspension system , torsion bar, tie rods, shock absorber – types, construction and working, vibration and riding comforts, suspension geometry ( caster, camber, toe-in and toe-out, kingpin), anti squat, anti dive.

- **ELECTRICAL & ELECTRONICS EQUIPMENT** **(05 Hours)**
  Battery, Permanent Magnet & Electromagnet starting motors, magnetos, alternator and regulators, contact point ignition system, Electronic ignition systems, driver information & control devices power modulus, ECM, Dynamos, spark plugs, heaters, electrical systems of automotive vehicle, charging systems, sensors, actuators.

- **CHASSIS, WHEELS, TYRES - FUNCTIONS OF TYRES, TREAD DESIGN** **(02 Hours)**

**(Total Lecture Hours: 42)**

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## 3. Books Recommended:


1. W.H. Crouse, Automobile Mechanics, Tata McGraw Hill, New Delhi, 2007.
2. H. Heinz, Vehicle and Engine Technology, Arnold, London, 1999.
3. T.R. Banga and N. Singh, Automobile Engineering, Khanna Publishers, Delhi, 2005.
4. J. R. Ellis, Vehicle Dynamics, Wiley-Blackwell, 1994.
5. R. P. Sharma, Course in Automobile Engineering, Dhanpat Rai and Sons, New Delhi, 1998.

**Surface Engineering and Heat Treatment**

**ME425**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Describe the importance of surface engineering and heat treatment. |
| CO2 | Summarize concepts of various surface coating techniques. |
| CO3 | Determine phase transformation mechanism during heat treatment. |
| CO4 | Analyze various phases achieved through heat treatment and its significance |
| CO5 | Distinguish heat treatment processes adopted for various ferrous and non-ferrous metals. |
| CO6 | Express significance of various furnaces used for heat treatment. |

## 2. Syllabus

- **INTRODUCTION TO SURFACE ENGINEERING (05 Hours)**
  Introduction to surface modification, need for surface modification, surface dependent engineering properties, importance of substrate and their pretreatment. Significance of surface engineered materials in modern engineering application. Industrial case studies describing surface failures.

- **SURFACE ENGINEERING PROCESSES (09 Hours)**
  Classification of surface engineering processes. Various chemical/thermochemical treatment processes, electro-deposition and electro-less deposition techniques, various vapour deposition techniques, various surfacing techniques. Evaluation of coatings, importance of process parameters, criteria for selection of surface engineering techniques, case studies based on coatings and surface modification of important engineering component.

- **PHASE TRANSFORMATION DURING HEAT TREATMENT (06 Hours)**
  Principle of heat treatment, variables of heat treatment, effect of heat treatment on various properties of materials. Recapitulation of phase diagram and TTT diagram. Phase transformation mechanism in steel during heat treatment, decomposition of austenite, transformation products of austenite: pearlite, bainite, martensite, etc., significance of retained austenite. Effect of heat treatment cycle on microstructure.

- **HEAT TREATMENT OF FERROUS ALLOYS (09 Hours)**
  Study of microstructural changes at various temperatures during slow cooling of steel. Influence of alloying elements on phase stability. Heat treatments for carbon steels, alloy steels, structural and tool steels, cast irons, etc. Hardenability of steels, effect of quenching media, PWHT. Surface treatment processes.

- **HEAT TREATMENT OF NON-FERROUS ALLOYS (07 Hours)**
  Principle of heat treatment for non-ferrous alloys. Heat treatment of aluminium alloys, magnesium alloys, copper and its alloys, nickel alloys and titanium alloys.

- **FURNACES AND OTHER ISSUES DURING HEAT TREATMENT (06 Hours)**
  Classification of heat treatment furnaces, controlled atmospheres for furnace. Industrial heat treatment practices. Distortion in heat treated components, possible defects, causes and remedies.

Air pollution during heat treatment, environmental and safety regulations. Energy economy of heat treatment.

**(Total Lecture Hours: 42)**

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## 3. Books Recommended:


1. T. Burakowski and T. Wierzchon, Surface Engineering of Metals: Principles, Equipment, Technologies, 1st Edition, CRC press, 1998.
2. M. Ohring, Material Science of Thin Films, 2nd Edition, Academic press, 2002.
3. J. Takadoum, Materials and Surface Engineering in Tribology, 1st Edition, John Wiley & Sons, 2008.
4. T. V. Rajan, C. P. Sharma and A. Sharma, Heat Treatment: Principles and Techniques, 2nd Edition, PHI Learning Pvt. Ltd., 2011.
5. R. C. Sharma, Principles of Heat Treatment of Steels, 1st Edition (Reprint), New Age International, 2018.

## Production and Operations Management

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## ME427

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## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Develop an understanding of how the operations and processes have strategic importance and can provide a competitive advantage. |
| CO2 | Evaluate and rank capacity and constraint management by solving the problems. |
| CO3 | Evaluate and rank aggregate plan and schedule production by solving the problems. |
| CO4 | Develop Material Requirement Planning (MRP) structure and apply various lot sizing techniques to the dependent inventory models. |
| CO5 | Describe the concepts of lean, agile and quick response manufacturing and compare them. |

## 2. Syllabus

- **OPERATIONS STRATEGY AND PROCESS STRATEGY** (**06 Hours**)

  Operations of goods and services, Developing Mission and strategy, Issues of operations strategy, Strategy development and implementation, Strategic planning, Core competency, Outsourcing, Design and selection of goods and services, Product development Product design issue, Process strategy, process analysis and design.

- **CAPACITY AND CONSTRAINT MANAGEMENT** (**07 Hours**)

  Capacity, Bottleneck analysis and theory, Break -Even Analysis (Single & Multiproduct), Risk Reduction, Capacity Decisions using Expected monetary value, investment analysis

- **AGGREGATE PLANNING** (**08 Hours**)

  Planning Process, Nature of Planning, Strategies, methods, Aggregate planning in services.

- **MATERIAL REQUIREMENT PLANNING AND ERP** (**08 Hours**)

  Dependent Demand, Dependent inventory model, Material Requirement Planning (MRP) structures, Management, Lot sizing techniques, Extension of MRP, MRP in-services

- **SHORT TERM SCHEDULING** (**08 Hours**)

  Issues, Scheduling process, Focused facilities, Loading jobs, Sequencing jobs, Finite capacity scheduling, Service scheduling

- **LEAN, AGILE AND QUICK RESPONSE MANUFACTURING** (**05 Hours**)

  Lean and Just-In-Time, Total Quality Management (TQM), Toyota production System, Lean organization, Lean in Services, Agility, Dimensions of agility, Quick response manufacturing, Manufacturing excellence, Total productive maintenance (TPM)

**(Total Lecture Hours: 42)**

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## 3. Books Recommended:


1. J. Heizer, B. Render, C. Munson and A. Sachan, Operations Management, 12th Edition, Pearson Education, 2017.
2. Everett E. Adam, R. J. Ebert, Production and Operations Management: Concepts, Models and Behaviour, 4th Revised Edition, Prentice Hall, 1989.
3. E. S. Buffa and R. K. Sarin, Modern Production/ Operations Management, 8th Edition, John Wiley & Sons, 1987.
4. S.Eilon, Elements of Production Planning and Control, 3rd Edition, Universal Publishing Corporation, 1991.
5. L. J. Krajewski and L. P. Ritzman, Operations Management: Strategy and Analysis, 5th Edition, Pearson Education, 1999.

## Fundamentals of Combustion

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

**ME429**

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Describe different combustion mechanisms and how these can be efficiently used in engineering applications. |
| CO2 | Illustrate elementary chemical and physical processes of combustion phenomena |
| CO3 | Describe combustion characteristics and how these can be measured. |
| CO4 | Illustrate different type of pollutants generated by combustion, their effects on health and on the environment. |
| CO5 | Explain basic concepts about combustion processes for efficient designing of burners for different types of fuels and combustion chambers. |

## 2. Syllabus

- **INTRODUCTION** **(04 Hours)**
  Introduction to combustion, Applications of combustion, Types of fuel and oxidizers, Characterization of fuel, Various combustion mode, Scope of combustion.

- **THERMODYNAMICS OF COMBUSTION** **(08 Hours)**
  Thermodynamics properties, Laws of thermodynamics, Stoichiometry, Thermochemistry, adiabatic temperature, chemical equilibrium.

- **COMBUSTION KINETICS** **(08 Hours)**
  Basic Reaction Kinetics, Elementary reactions, Chain reactions, Multistep reactions, simplification of reaction mechanism, Global kinetics.

- **PHYSICS OF COMBUSTION** **(04 Hours)**
  Fundamental laws of transport phenomena, Conservations Equations.

- **PREMIXED FLAME** **(08 Hours)**
  Laminar premixed flame, laminar flame structure, Laminar flame speed, Flame speed measurements, Flame stabilizations.

- **DIFFUSION FLAME** **(08 Hours)**
  Gaseous Jet diffusion flame, Liquid fuel combustion, Atomization, introduction to Spray and Solid fuel combustion.

- **COMBUSTION AND ENVIRONMENT** **(02 Hours)**
  Atmosphere, Chemical Emission from combustion, Quantification of emission, Emission control methods.

**(Total Lecture Hours: 42)**

## 3. Books Recommended:


1. K.K. Kuo, Principles of Combustion, John Wiley and Sons, 2005.
2. S.R. Turns, An introduction to combustion, New York: McGraw-Hill, 2017.
3. C.K. Law, Combustion physics, Cambridge University Press, 2010.
4. D.P. Mishra, Fundamentals of Combustion, Prentice Hall of India, 2010.
5. H. S. Mukunda, Understanding combustion, Universities Press, 2009.

**Renewable Energy Systems**

**ME431**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Design solar systems for a given energy utility by applying principles of solar energy conversion |
| CO2 | Estimate the wind potential and perform power forecast analysis |
| CO3 | Design bio-energy based systems for a given utility by applying principles of bio-mass to bio-energy conversion. |
| CO4 | Characterize different types of waste and compare various conversion technologies. |
| CO5 | Compare Hydrogen with other energy resources in present context |

## 2. Syllabus

- **SOLAR RADIATION (12 Hours)**
  Extra-terrestrial and terrestrial, Solar radiation measuring instruments, Estimation of Solar Radiation, Various earth-sun angles. **Solar Energy Conversion Systems:** Solar Thermal Systems: Basics, Flat plate collectors-liquid and air type. Theory of flat plate collectors, selective coating, advanced collectors, Concentrators: optical design of concentrators, solar water heater, solar dryers, solar stills, Solar ponds, solar cooling and refrigeration, Solar thermal power generation. Solar Photovoltaic Systems: Principle of photovoltaic conversion of solar energy, Solar cells, Home lighting systems, Solar lanterns, Solar PV pumps, Govt. policies. Introduction to Solar Photovoltaic Thermal Systems: Air based, Water based, Refrigerant based Systems. Solar energy storage options: Electrical and Thermal Energy storage options for Solar Energy

- **BIOMASS & BIOENERGY (12 Hours)**
  **Biogas System:** Anaerobic digestion, biogas production, Types of digesters, installation, operation and maintenance of biogas plants, Biogas plant manure utilisation and manure values, factors affecting biogas production, Biogas utilisation and storage, biogas for motive power generation, design calculations for biogas plants, Govt. policies. **Liquid Biofuels:** Biodiesel – The mechanism of transesterification, fuel characteristics of biodiesel, technical aspects of biodiesel/Ethanol and other liquid fuels utilization in engine. **Biomass gasification:** Different types, power generation

- **WIND ENERGY CONVERSION SYSTEMS: (08 Hours)**
  History of wind energy, Current status and future prospects, Wind energy in India. Power available in the wind, Components of Wind Energy Conversion Systems, Horizontal and Vertical axis wind turbine, Wind turbine power and torque characteristics, Tip speed ratio, Wind speed prediction and forecasting, Betz limit, Govt. Policies

- **WASTE TO ENERGY CONVERSION (06 Hours)**
  Introducing Municipal Solid Waste Management; Waste Generation and characterization, Waste

Processing Techniques; Source Reduction, Biological Conversion Products: Compost and Biogas, Incineration pyrolysis and Energy Recovery, waste plastic, RDF utilization, Govt. Policies

- **HYDROGEN ENERGY AND FUEL CELLS** **(04 Hours)**
  Benefits of Hydrogen Energy, Hydrogen Production Technologies, Hydrogen Energy Storage, Use of Hydrogen Energy, Advantages and Disadvantages of Hydrogen Energy, Problems Associated with Hydrogen Energy, Basic principle of working of fuel cell.

**(Total Lecture Hours: 42)**

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## 3. Books Recommended:


1. J. A. Duffie and W.A. Beckman, Solar Engineering and Thermal Processes, John Wiley and Sons., 2013.
2. G. N. Tiwari, Solar Energy, Narosa Publishing House Pvt. Ltd., 2012.
3. H. S. Mukunda, Understanding Clean Energy and fuels from biomass. Wiley India Pvt. Ltd, 2011
4. K. M. Mital, Biogas Systems, Principle and Applications. New Age International Ltd, 1996
5. G. D. Rai, Non-Conventional Energy Sources, Khanna Publication, 1988

**Mechanics of Composite Materials**

**ME433**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain the composite materials and their constituents |
| CO2 | Explain the mechanical properties and behaviour of composite materials |
| CO3 | Apply constitutive equations of composite materials at micro and macro levels |
| CO4 | Determine stresses and strains relation in composites materials |
| CO5 | Apply failure criteria and critically evaluate the results |

## 2. Syllabus

- **INTRODUCTION** **(04 Hours)**
  Introduction of composite materials, Need for composites, Types of composites, Metal matrix, Ceramic matrix and Carbon-Carbon composites, Polymer matrix composites.

- **COMPOSITE CONSTITUENT MATERIALS** **(05 Hours)**
  Characteristics of thermosetting and thermoplastic resins. Characteristics of Glass, Carbon and Kevlar Fibers, method of making and properties, types of fiber materials.

- **MICROMECHANICS OF UNIDIRECTIONAL FIBER COMPOSITES** **(10 Hours)**
  Prediction of elastic properties using strength of materials approach. Introduction to elasticity based approach for prediction of elastic constants (concentric cylinder model). Empirical relations (Halpin-Tsai) for elastic property prediction. Comparison of different approaches with examples. Prediction of strength and discussion on failure modes, Prediction of thermal and diffusion properties.

- **SHORT FIBERCOMPOSITES** **(03 Hours)**
  Load transfer length, Prediction of elastic properties. Elastic property calculation for random fiber composites.

- **ANALYSIS OF ORTHOTROPIC LAMINA** **(10 Hours)**
  Generalized Hooke's law, Material symmetry. Orthotropic materials and transversely isotropic materials. Transformation of stress and strain. Stress-strain relations for transversely isotropic lamina under plane stress in material axis and off axis Failure theories (Maximum stress, strain, Tsai-Hill and Tsai-Wu).

- **ANALYSIS OF LAMINATED COMPOSITES** **(10 Hours)**
  Description of laminate sequence and type of laminates (UD, Symmetric and Asymmetric, Balanced, Quasi-Isotropic) etc. Classical laminate theory (CLT). Failure analysis of laminates using CLT: First ply failure, progressive failure analysis. Hygro-thermal stresses in laminates. Discussion on interlaminar stresses.

**(Total Lecture Hours: 42)**

## 3. Books Recommended:


1. K. K Autar, Mechanics of Composite Materials, 2nd Edition, CRC Press, 2006.
2. J. N. Reddy, Mechanics of laminated composite plates and shells theory and analysis, 2nd Edition, CRC press, 2003.
3. R. M. Jones, Mechanics of composite materials, 2nd Edition, Taylor and Fransis, 2018.
4. K. Serope, S. Steven, Manufacturing engineering and technology, 8th edition, Pearson, 2019.
5. P. K. Mallick, Fiber-reinforced composites: Materials, Manufacturing, and Design, 3rd Edition, CRC Press, 2007.

**Gas Dynamics**

**ME435**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Predict the effect of compressibility and flow behavior in the field of gas dynamics |
| CO2 | Solve 1-D design problems based on Isentropic, Fanno and Rayleigh flow |
| CO3 | Evaluate the different possible conditions for flow without chocking in 1-D duct with variable area, friction and heat transfer. |
| CO4 | Estimate the position and effect of shock within the 1-D duct. |
| CO5 | Explore the shock phenomenon and learn to use shock polar diagram for 2-D flows. |

## 2. Syllabus

- **INTRODUCTION** **(04 Hours)**
  Thermodynamics of compressible flow, Perfect Gas, General effect of compressibility, Wave Motion, Propagation of Infinitesimal waves, Mach number, Pressure disturbances in a Compressible flow, Stagnation condition.

- **1-DIMENSIONAL, STEADY, ISENTROPIC FLOW IN VARIABLE AREA PASSAGES** **(09 Hours)**
  Introduction, governing equations, Effect of area change in the fluid properties, Equations for Isentropic flow, Maximum mass flow rate, Flow through nozzle & diffuser, Numerical.

- **FLOW IN CONSTANT AREA DUCT WITH FRICTION** **(06 Hours)**
  Introduction, governing equations, Fanno flow equations, Variation of Mach number with duct length, Numerical.

- **FLOW IN CONSTANT AREA DUCT WITH HEAT TRANSFER** **(06 Hours)**
  Introduction, governing equations, Slope of Rayleigh line on p-v diagram, Fundamental equation of Rayleigh line, Maximum heat transfer, Numerical

- **NORMAL SHOCK** **(10 Hours)**
  Introduction, classification of shock, Physical equations of Normal shock, Rankine – Hugoniot Relations, Prandtle equation, Numerical

- **OBLIQUE SHOCK** **(07 Hours)**
  Introduction, governing equations, Rankine–Hugoniot Relations, Prandtle Equations, θ-β-M relation, Shock polar diagram & Hodograph method for the solution of 2- D flows.

**(Total Lecture Hours: 42)**

## 3. Books Recommended:


1. S.M. Yahya, Fundamental of Compressible Flow with Aircraft & Rocket Propulsion, New Age International Ltd., 2016
2. E. Rathakrishnan, Gas Dynamics, PHI Learning Pvt. Ltd., 2017
3. A. H. Shapiro, Compressible Fluid Dlow, Ronald Press Company, 1953
4. M. J Zucrow and J.D. Hoffman, Gas Dynamics, John Wiley & Sons, 1976
5. R. D. Zucker and Oscar Biblarz, Fundamental of Gas Dynamics, Wiley, 2002

## Fatigue, Fracture and Failure Analysis

## ME437

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain the principles of fatigue analysis and fracture mechanics |
| CO2 | Explain the S-N curve with respect to mean stress, material surface effect and performance fatigue life analysis |
| CO3 | Describe the behaviour of ductile and brittle failure |
| CO4 | Calculate fracture parameter and analyze crack propagation |
| CO5 | Evaluate stress intensity factor by various methods |

## 2. Syllabus

- **INTRODUCTION AND MECHANISM OF FATIGUE (08 Hours)**
  Fatigue limit, relation between static strength and fatigue strength. Different approaches to fatigue, Stress-life approach (S-N curves), Variable Amplitude Loading, Applications, Environmental effects.

- **THEORY OF ELASTICITY AND PLASTICITY (08 Hours)**
  Notion of stress and strain, Principal Stresses and Principal Coordinates, Maximum shearing Stress, Stress tensors, Compatibility equations, Generalized Hoke's Law, General formulation of elastic problem, Tresca's and von-Mises' Yield Criteria

- **FRACTURE MECHANICS (06 Hours)**
  Introduction to fracture mechanics, fracture modes, Griffith's Fracture Criterion and Irwin's Fracture Criterion, Linear elastic fracture mechanics (LEFM)

- **METHODS FOR EVALUATING STRESS INTENSITY FACTORS (10 Hours)**
  Analytical Solutions- Exact Solutions, Energy approach, Green's function. Semi-Analytical Solutions- Collocations, Conformal mapping. Numerical Methods- Finite element method (FEM), Finite difference method (FDM), Extended finite element method (XFEM). Experimental Methods- Compliance method, Photo elasticity, Interferometry and Holography.

- **INTRODUCTION TO FAILURE (06 Hours)**
  Philosophy and criteria of material selection, Importance of failure analysis and its relationship to material selection, different types of failures, Fundamental causes of failure, General practice in failure analysis, ductile brittle and fatigue failure.

- **CRACK PROPAGATION AND ANALYSIS (04 Hours)**
  The Crack tip Plastic Zone, Methods for Measuring Fracture Toughness, Crack Initiation and Crack Propagation under different loading conditions.

**(Total Lecture Hours: 42)**

## 3. Books Recommended:


1. S.P Timoshenko and J.N Goodier , Theory of Elasticity, 3rd Edition, McGraw Hill , 2017.
2. R.B Charlie and A Chaudhary, Failure Analysis of Engineering Materials, McGraw Hill, New York, 2001.
3. K Hellan, Introduction to Fracture Mechanics, McGraw-Hill, 1984.
4. S Mohammadi, Extended finite element method, 1st Edition, Blackwell, 2007.
5. P Kumar, Elements of fracture mechanics, Tata McGraw Hill, New Delhi, 2017.

**Smart Materials and Structures**

**ME439**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain the basic principles of smart materials. |
| CO2 | Explain various actuators and sensors in smart structures. |
| CO3 | Analyse smart composites. |
| CO4 | Explain signal processing and control systems. |
| CO5 | Describe the utilization of smart materials in engineering applications. |

## 2. Syllabus

- **INTRODUCTION: (12 Hours)**
  Introduction to Smart Materials and Structures, Principles of Piezoelectricty, Single Crystals and Polycrystalline, Piezoelectric Polymers, Magnetostrictive materials, Electro-active Materials, Electronic Materials, Electro-active Polymers, Ionic Polymer Matrix Composite (IPMC), Shape Memory Effect, Shape Memory Alloys, Shape Memory Polymers, Electro-rheological Fluids, Magneto Rhelological Fluids.

- **SENSING AND ACTUATION: (10 Hours)**
  Piezeoelctric Sensors and actuators, Accelerometers, Active Fibre Sensing, Magnetostrictive Sensing, Shape Memory Actuators, Application of Smart Sensors and actuators for Structural Health Monitoring (SHM), Closed loop and Open loop Smart Structures, Active Vibration Control, Active Shape Control, Passive Vibration Control, Hybrid Vibration Control.

- **SMART COMPOSITES: (08 Hours)**
  Review of Composite Materials, Micro and Macro-mechanics, Modelling Laminated Composites based on Classical Laminated Plate Theory, Effect of Shear Deformation, Dynamics of Smart Composite Beam, Governing Equation of Motion and Finite Element Modelling of Smart Composite Beams.

- **SIGNAL PROCESSING AND CONTROL SYSTEMS: (08 Hours)**
  Data Acquisition and Processing – Signal Processing and Control for Smart Structures – Sensors as Geometrical Processors – Signal Processing – Control System.

- **ADVANCES IN SMART STRUCTURES AND MATERIALS: (04 Hours)**
  Self-Sensing Piezoelectric Transducers, Energy Harvesting Materials, Autophagous Materials, Self- Healing Polymers, Intelligent System Design, Emergent System Design.

**(Total Lecture Hours: 42)**

## 3. Books Recommended:


1. A.V. Srinivasan, Smart Structures –Analysis and Design, 1st Edition, Cambridge University Press, New York, 2001
2. M. V. Gandhi and B. S. Thompson, Smart Materials and Structures, Chapmen & Hall, London, 1992.
3. C. Brian, Smart Structures and Materials, Artech House, 2000
4. P. Gauenzi, Smart Structures, Wiley, 2009
5. W. G. Cady, Piezoelectricity, Dover Publication, New York, 2014.

# Teaching Scheme: B. Tech. (Mechanical Engineering) IV Year

**SEMESTER - VIII**

| Sr. No. | Subject | Code | Scheme | Exam Scheme | | | | Total | Credit |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Tuto. | Pract. | | |
| | | | | Hrs. | Marks | Marks | Marks | | |
| 1. | Core Elective – 5 | ME4XX | 3 – 0 – 0 | 3 | 100 | - | - | 100 | 03 |
| 2. | Core Elective - 6 | ME4YY | 3 – 0 – 0 | 3 | 100 | - | - | 100 | 03 |
| 3. | Core Elective - 7 | ME4ZZ | 3 – 0 – 0 | 3 | 100 | - | - | 100 | 03 |
| 4. | Innovation, Incubation and Entrepreneurship | HU410 | 3 – 0 – 0 | 3 | 100 | - | - | 100 | 03 |
| 5. | Project | ME402 | 0 – 0 – 12 | 0 | - | - | 300 | 300 | 06 |
| | | Total | 12 – 0 – 12 | 12 | 400 | - | 300 | 700 | 18 |

**Core Elective – 5 (ME4XX)**

1. Design of Heat Exchanger: ME422
2. Design of Pressure Vessels: ME424
3. Radiation Heat Transfer: ME426
4. Theory of Elasticity and Plasticity: ME428
5. Sheet Metal Forming: ME432
6. Total Quality Management: ME434

**Core Elective – 6 (ME4YY)**

1. Jet Propulsion Systems: ME436
2. Robotics: ME438
3. Experimental Fluid Mechanics: ME442
4. Data Analytics: ME444
5. Advanced Welding Processes: ME446

**Core Elective – 7 (ME4ZZ)**

1. Automation and Smart Manufacturing: ME448
2. Theory and Analysis of Cryogenic Systems: ME452
3. Computer Aided Machine Design: ME454
4. Foundry Technology: ME456
5. Logistics and Supply Chain: ME458
6. Two Phase Flow: ME462

## Design of Heat Exchangers

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

**ME422**

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain the different types of heat exchangers used in applications. |
| CO2 | Analyze heat exchanger based on LMTD and e-NTU method |
| CO3 | Develop mathematical model for double pipe and Shell and tube type heat exchanger |
| CO4 | Solve the sizing problem of Shell and tube type heat exchanger |
| CO5 | Develop and solve mathematical model for tube finned and plate finned heat exchanger |
| CO6 | Analyze the radiation furnace using well stirred model and longitudinal model. |

## 2. Syllabus

- **INTRODUCTION** **(08 Hours)**
  Classification of heat exchanger, selection of heat exchanger, overall heat transfer coefficient, LMTD method for heat exchanger analysis for parallel, counter, multi-pass and cross flow heat exchanger, e-NTU method for heat exchanger analysis, fouling, cleanliness factor, percent over surface, techniques to control fouling, additives, rating and sizing problems, heat exchanger design methodology

- **DESIGN OF DOUBLE PIPE HEAT EXCHANGERS** **(10 Hours)**
  Thermal and hydraulic design of inner tube and annulus, total pressure drop, Tube – Side heat transfer and pressure loss calculations

- **DESIGN OF SHELL & TUBE HEAT EXCHANGERS:** **(10 Hours)**
  Basic components, basic design procedure of heat exchanger, approximate sizing of shell & tube heat exchangers, shell – side and tube – side calculations. Design procedure for plain and finned tubes, TEMA code, J-factors, conventional design methods, Bell-Delaware method.

- **DESIGN OF COMPACT HEAT EXCHANGERS AND REGENERATORS** **(08 Hours)**
  Heat transfer enhancement, plate fin heat exchanger, tube fin heat exchanger, heat transfer and pressure drop, Types of regenerator matrix. Design of coils. Design of automobile radiator.

- **DESIGN OF RADIATION FURNACES** **(03 Hours)**
  Well stirred model and longitudinal model.

- **FOULING MECHANISMS** **(03 Hours)**

**(Total Lecture Hours: 42)**

## 3. Books Recommended


1. R. K. Shah and D. P. Sekulic, Fundamentals of Heat Exchangers Design, John Wiley & Sons, 2003.
2. S. Kakaç, H. Liu, A. Pramuanjaroenkij, Heat Exchangers: Selection, Rating, and Thermal Design, Third Edition, CRC Press, 2012.
3. W. M. Kays and A. L. London, Compact Heat Exchangers, McGraw Hill, New York, 1964.
4. Saunders E.A.D., Heat Exchangers - Selection, Design and Construction, Longman Scientific & Technical, 1998.
5. J.E. Hesselgreaves, R.Law, D. Reay, Compact Heat Exchangers, Selection, Design and Operation, 2nd Edition, Butterworth-Heinemann, 2016

**Design of Pressure Vessels**

**ME424**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Describe the factors influencing the design of pressure vessels |
| CO2 | Analyze stresses in pressure vessels |
| CO3 | Describe requirements of the relevant industry standards in the design of pressure vessels. |
| CO4 | Design and select heads, covers nozzles, openings and supports of pressure vessels |
| CO5 | Analyse buckling of pressure vessels |

## 2. Syllabus

- **INTRODUCTION** **(07 Hours)**
  Factors influencing the design of vessels**,** Classification of pressure vessels, material selection, loads & types of failures.

- **STRESSES IN PRESSURE VESSELS** **(13 Hours)**
  Stresses in circular ring, cylinder & sphere, membrane stresses in vessels under internal pressure, thick Cylinders, Shrink-Fit stresses, Autofrettage of thick cylinders, thermal stresses.

- **DESIGN OF HEADS AND COVERS** **(05 Hours)**
  Introduction, Design for hemispherical head, ellipsoidal head, torispherical head, conical and toriconical head, flat heads and covers.

- **DESIGN OF NOZZLES AND OPENINGS** **(05 Hours)**
  Introduction, stress concentration about a circular hole, cylindrical and spherical shell with circular hole under internal pressure, nozzles in pressure vessels.

- **SUPPORTS FOR VERTICAL & HORIZONTAL VESSELS** **(05 Hours)**
  Design lugs support, Skirt support and saddle supports.

- **BUCKLING OF VESSELS** **(07 Hours)**
  Buckling phenomenon – Elastic Buckling of circular ring and cylinders under external pressure – collapse of thick walled cylinders or tubes under external pressure – Effect of supports on Elastic Buckling of Cylinders – Buckling under combined External pressure and axial loading.

**(Total Lecture Hours: 42)**

## 3. Books Recommended:


1. M.V. Joshi and V.V Mahajan, Process Equipment Design, McMillan, India, 1996.
2. J.F. Harvey, Theory and Design of Pressure Vessels, 1st edition, CBS, 2001.

3. K. P. Singh and A. L. Soler, Mechanical Design of Heat Exchangers, Arcturus Publishers, New Jersey, 1984.
4. Moss Demis R.,Pressure Vessel Design Manual, Gulf Publishing Co., Houston, 1987.
5. IS 2825: 1969, Code for Unfired Pressure Vessels.

## Radiation Heat Transfer

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

**ME426**

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## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Describe the basic laws of radiation heat transfer |
| CO2 | Calculate radiation heat transfer between black and gray body surfaces |
| CO3 | Develop solutions for surface-to-surface radiation heat transfer |
| CO4 | Analyse problems involving gas radiation heat transfer |
| CO5 | Develop solutions for radiation transfer in participating media |
| CO6 | Develop solutions to estimate radiation parameters using inverse method |

## 2. Syllabus

- **RADIATION** **(02 Hours)**
  Importance of thermal radiation, Nature of Radiation.

- **BLACKBODY AND ITS CHARACTERISTICS** **(07 Hours)**
  Key attributes of a black body, Solid angle, Spectral or Monochromatic radiation intensity, Spectral hemispherical emissive power, Radiation pressure and radiation energy density, Relationship between intensity and temperature, Candidate blackbody distribution function, Planck's blackbody radiation distribution function, Wein's displacement law, universal blackbody function, Problems.

- **RADIATIVE PROPERTIES OF NON-BLACK SURFACES** **(08 Hours)**
  Why do we need a gray body model?, Spectral directional emissivity, Hemispherical spectral emissivity, Directional total emissivity, Hemispherical total emissivity, Kirchoff law, Absorptivity, Spectral directional absorptivity, Directional total absorptivity, Hemispherical total absorptivity, Reflectivity, Transmissivity, Spectral transmissivity, Optical pyrometry, Problems.

- **RADIATIVE HEAT TRANSFER BETWEEN SURFACES** **(10 Hours)**
  Enclosure theory, View factor, View factor algebra, View factors from direct integration, Enclosure analysis – Gray surface, Enclosure analysis – Non gray surface, Problems.

- **RADIATION IN PARTICIPATING MEDIA** **(10 Hours)**
  Principal difficulties in studying gas radiation, Important properties fir study of gas radiation, Equation of transfer or Radiative transfer equation, Solution to the Radiative transfer equation, Concept of mean beam length, Enclosure analysis in the presence of absorbing/emitting gas, Emissivity and absorptivity of gas mixture, Radiation Combined with Conduction and Convection, Problems.

- **INVERSE PROBLEMS IN RADIATION** **(05 Hours)**
  Introduction to inverse problems, Parameter estimation by least squares minimizations, Problems.

**(Total Lecture Hours: 42)**

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## 3. Books Recommended:


1. R. Siegel and J.R. Howell, Thermal Radiation Heat Transfer, Taylor & Francis, 2015.
2. M.F. Modest, Radiative Heat Transfer, McGraw Hill, 2013.
3. C. Balaji, Essentials of Radiation Heat Transfer. John Wiley & Sons, 2014.
4. M.N. Ozisik, Inverse Heat Transfer: Fundamentals and Applications. CRC Press, 2000.
5. F.P. Incropera, A.S. Lavine, T.L. Bergman, and D.P. DeWitt, Fundamentals of Heat And Mass Transfer. John Wiley & Sons Inc., 2011

## Theory of Elasticity and Plasticity

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

**ME428**

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## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Examine the theoretical concepts and principles underlying elasticity and plasticity. |
| CO2 | Apply concept of material yielding and plastic behaviour to solve engineering problems. |
| CO3 | Explain stress-strain relations in elastic and plastic deformation |
| CO4 | Explain load instability and tearing in sheet metal forming. |
| CO5 | Describe slip - line field theory in plastic deformation. |

## 2. Syllabus

- **Stress & Strain Analysis** **(08 Hours)**
  Introduction, Definition of stress & strain, Stress & Strain Tensor, Principal Stresses & Strains, Stress & Strain invariants, Stress & Strain Deviator Tensor, for state of stress and state of strain, generalized Hooke's law, Hooke's law for isotropic and homogeneous materials, plane stress and plane strain.

- **Yield Criteria** **(06 Hours)**
  Criteria for yielding – Tresca criterion, Von mises Criterion, Effective stress -strain.

- **Plastic Stress - Strain Relationships** **(12 Hours)**
  Stress - strain relation in plasticity, State of plastic stress - strain rate, Strain rate sensitivity, plastic Anisotropy, stress - stain relations for strain hardening metals, Saint Venant's theory of plastic flow, Levy-Mises (flow rule), Prandtl - Reuss Theory of elastic and plastic deformation

- **Load instability and Tearing** **(10 Hours)**
  Uniaxial tension of a perfect strip, Tension of an imperfect strip, Tensile instability in stretching continuous sheet - condition for local necking in uniaxial and biaxial tension.

- **Slip - Line Field Theory** **(06 Hours)**
  Slip line theory, Hencky's theory of small plastic deformation plasticity conditions, Velocity Equations, Geometry of Slip-line, Geometrical Construction of Slip-line fields, Upper and Lower Bounds, Slip Line Characteristics, Hodograph.

**(Total Lecture Hours: 42)**

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## 3. Books Recommended:


1. R. Hill, The Mathematical Theory of Plasticity, Oxford University Press, London, 2004.
2. S. J. Hu, Z. Marciniak, J. L. Duncan, Mechanics of Sheet Metal Forming, Butterworth-Heinemann, 2002.
3. S. Singh, Theory of Elasticity, Khanna Publishers, New Delhi, 2000.
4. U. C. Jindal, Experimental Stress Analysis, Pearson Education India, 2012.
5. H. Jane Helena, Theory of Elasticity and Plasticity, PHI, 2017

## Sheet Metal Forming

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## ME432

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## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain the concept of material yielding and plastic behaviour of sheet. |
| CO2 | Explain the significance of intrinsic material properties used in the sheet metal forming.. |
| CO3 | Examine an insight of the sheet deformation processes, load instability and tearing in sheet metal forming. |
| CO4 | Classify various modes of deformation and defects involved in sheet metal forming Processes. |
| CO5 | Analyse principles, capabilities and applications of sheet metal forming processes. |
| CO6 | Evaluate the formability criteria for sheet metal component manufacturing. |

## 2. Syllabus

- **FUNDAMENTALS OF METAL FORMING** **(03 Hours)**

  Introduction, Advantages of metal forming, cold and hot forming, various metal forming processes, Uniaxial Tensile Test - load–extension diagram, engineering stress–strain curve, true stress–strain curve, Anisotropy, Rate sensitivity, Effect of properties on forming.

- **BIAXIAL STRESS TESTING METHODS FOR SHEET METALS** **(03 Hours)**

  Introduction, Geometry of cruciform specimen, method of strain measurement, Biaxial stress strain curve, measurement of yield locus, factors affecting the maximum equivalent plastic strain applicable to gauge area, case studies.

- **SHEET DEFORMATION PROCESSES (PLANE STRESS)** **(09 Hours)**

  Deformation in uniaxial tension, stress and strain ratios, theory of yielding in plain stress condition - Maximum shear stress, Hydrostatic stress, Tresca yield condition, Von Mises yield condition, Levy–Mises flow rule, Relation between the stress and strain ratios, Work of plastic deformation, Work hardening hypothesis, Effective stress and strain functions, Concept of Formability, formability limits and formability diagram. Factors affecting the forming limit curve.

- **LOAD INSTABILITY AND TEARING** **(10 Hours)**

  Uniaxial tension of a perfect strip, Tension of an imperfect strip, Tensile instability in stretching continuous sheet - condition for local necking in uniaxial and biaxial tension.

- **ANALYSIS OF STAMPING AND DEEP DRAWING PROCESS** **(06 Hours)**

  Two-dimensional model of stamping, stretch and draw ratios in a stamping, three-dimensional stamping model, limiting drawing ratio and anisotropy, effect of strain-hardening and friction on drawing stress, redrawing and reverse redrawing of a cylindrical cup, wall ironing of deep-drawn cups, estimation of drawing force.

- **ANALYSIS OF BENDING PROCESS** **(04 Hours)**

  Strain distribution in bending, bending without tension, bending of sheet in v-die, determination of work load, stock length and punch angle, springback and reverse bending, bending line construction.

- **ANALYSIS OF PUNCHING AND BLANKING PROCESS** **(03 Hours)**

  Mode of metal deformation and failure, deformation model and fracture analysis, determination of working force.

- **ANALYSIS OF SHEET HYDROFORMING** **(04 Hours)**

  Free expansion of a cylinder by internal pressure, Forming a cylinder to a square section, Tube forming in a frictionless die, Tube forming with sticking friction (or very high friction), Constant thickness forming, sequential hydroforming

**(Total Lecture Hours: 42)**

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## 3. Books Recommended:


1. R. Hill, The Mathematical Theory of Plasticity, Oxford University Press, London, 2004.
2. S.J. Hu, Marciniak Z., J.L. Duncan, Mechanics of Sheet Metal Forming, Butterworth-Heinemann, 2002.
3. G. Schuler, Metal forming handbook, Springer Verlag Berlin, Heidelberg, 1998.
4. S.P. Timoshenko, Theory of Elasticity, McGraw Hill, 2017.
5. A. Ghosh and A. K. Malik, Manufacturing Science, East-West Press Pvt Ltd, 2010.

## Total Quality Management

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

**ME434**

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## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Develop an understanding of quality concepts and total quality management and to examine the prominent philosophies such as those of Deming and Juran. |
| CO2 | Identify the key aspects of the quality improvement cycle and to select and use appropriate tools and techniques for controlling, improving and measuring quality. |
| CO3 | Explain the cost of quality and concept of quality circle. |
| CO4 | Explain the basic frameworks for quality and performance such as ISO certifications, Total Quality Management (TQM), and six sigma. |
| CO5 | Review and summarize the case studies of organizations in the manufacturing, service and education industries. |

## 2. Syllabus

- **QUALITY CONCEPTS AND TOTAL QUALITY MANAGEMENT (TQM)** (**10 Hours**)

  Quality concepts & Quality management philosophies, TQM linkages with productivity - factors affecting quality & productivity, Quality – Productivity Determinant model, Traditional versus modern quality management, principles of Total Quality (TQ). Concepts, features and element of TQM, TQM versus traditional management practices, Models of TQM, TQM implementation – Strategic framework and Roadblocks. Philosophies of Quality Gurus

- **QUALITY TOOLS** (**04 Hours**)

  Seven basic (Fishbone Diagrams, Histograms, Pareto Analysis, Flowcharts, Scatter Plots and Run Charts) quality tools. Seven new quality tools (Affinity Diagrams, Relations Diagrams, Tree Diagrams, Matrix Diagrams, Arrow Diagrams, Process Decision Program Charts, Matrix Data Analysis)

- **QUALITY COST AND QUALITY CIRCLE** (**04 Hours**)

  Costs of quality (COQ), Juran's model of optimum quality costs, analysis of COQ for improvement, Quality Circle Philosophy, its structure, implementation & operation, Brainstorming – field of application, Types of Brainstorming, 5 – M checklists.

- **TOTAL ORGANIZATIONAL INVOLVEMENT AND TOTAL PRODUCTIVE MAINTENANCE** (**04 Hours**)

  Total employees involvement (TEI), Effective communications, training & mentoring, recognition & reward, feedback & performance appraisal competencies required for different managerial roles, techniques of TEI, reward, techniques of zero defects programme, Features of TPM, Causes of machine failures, types of maintenance, overall equipment effectiveness (OEE), Case studies

- **QUALITY FUNCTION DEPLOYMENT** **(03 Hours)**

  Voice of Customer (VOC), House of Quality, QFD methodology, Case studies

- **5 - S OF HOUSEKEEPING** **(03 Hours)**

  Seiri, Seiton, Seiso, Seiketsu and Shjitsuke, Audit of 5 - S (Auditor's checklist and Display of 5 - S status), Case studies

- **KAIZEN PDCA CYCLE AND POKA YOKE** **(05 Hours)**

  Kaizen versus innovation, The seven wastes, Techniques of Kaizen, kaizen implementation, Techniques, Pillars and working principles of Poka yoke, Case studies

- **SIX SIGMA AND PROCESS CAPABILITY ANALYSIS** **(05 Hours)**

  Methodology of Six Sigma – DMAIC, Statistics associated with Six Sigma, Determination of First – time yield (FTY) of process, Z value, Defects per unit (DPU), Defects per million opportunities (DPMO) and calculating of sigma value of the process, Process capability index, upper and lower capability indices, The CpK index, capability ratio, the Taguchi capability index etc.

- **QUALITY CERTIFICATIONS AND QUALITY AWARDS** **(02 Hours)**

  ISO 9000 series and QS 9000 series certification, ISO 9000 series of standards, ISO 9001 requirements Implementation, Documentation, Internal Audits, Registration.

- **FAILURE MODE & EFFECT ANALYSIS** **(02 Hours)**

  Design and Process FMEA, Case studies

**(Total Lecture Hours: 42)**

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## 3. Books Recommended:


1. P. N. Mukherjee, Total Quality Management, 1st Edition, Prentice Hall India Learning Private Limited, 2006
2. P. M. Charantimath, Total Quality Management, 1st Edition, Pearson Education, 2003.
3. L. Suganthi and A. A. Samuel, Total Quality Management, New title edition, Prentice Hall India Learning Private Limited, 2004.
4. S. Ramasamy, Total Quality Management, 1st Edition, Tata Mcgraw Hill Publishing Co Ltd, 2015.
5. J. R. Evans and W. M. Lindsay, 6th Edition, The Management and Control of Quality, South-Western College Publication, 2004.

**Jet Propulsion Systems**

**ME436**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explore various components of gas turbine cycles with basic cycle variations for application in jet propulsion systems |
| CO2 | Analyze the thermodynamics and performance parameter of jet propulsion systems. |
| CO3 | Illustrate ideal and actual air breathing gas turbine cycles with performance curves |
| CO4 | Evaluate fluid flow properties for different performance parameters |
| CO5 | Explore rocket propulsion theory and discuss types of chemical rockets |

## 2. Syllabus

- **INTRODUCTION & OVERVIEW (6 Hours)**
  Introduction of Gas Turbine cycle and various components of GTP, Introduction of Jet propulsion systems, Computation of stagnation properties, Basic components of air breathing engines, Inlet ducts for aircraft gas turbines, Brief idea about compressor, combustion chamber, turbine, and aircraft nozzles.

- **AIR BREATHING ENGINES (12 Hours)**
  Performance parameters for air breathing engine (Thrust, Efficiency, Aircraft Range, Take-off Thrust, Specific Fuel Consumption), Basic gas generator & its variations, Turbojet, Turboprop, Turbofan, Pulse jet, Ram jet, Scramjet, Thrust Augmentation

- **PARAMETRIC CYCLE ANALYSIS OF IDEAL AND ACTUAL AIR BREATHING GAS TURBINE ENGINES (16 Hours)**
  Parametric Cycle Analysis of Ideal Turbo Jet Engine, Real Turbojet Cycle, Analysis of Turbofan Engine, Analysis of Turbofan Engine, Analysis of Turboprop Engine, Ramjet & Scramjet Engine, Numerical

- **INTRODUCTION TO ROCKET PROPULSION (8 Hours)**
  Introduction, Rocket propulsion theory, Chemical Rockets (Solid Rockets, Liquid Rockets, Solid & Liquid Propellants, Propellant feed system

**(Total Lecture Hours: 42)**

## 3. Books Recommended:


1. M. S. Ramgir and M. J. Sable, Gas Turbine & Jet propulsion, Technical Publications, 2006.
2. J. D. Mattingly, Elements of Propulsion: Gas Turbines & Rockets, the American Institute of Aeronautics and Astronautics, 2006.
3. V. Ganeshan, Gas Turbines, Tata McGraw Hill Education Pvt. Ltd, 2010.
4. S. M. Yahya, Fundamentals of Compressible flow, New Age International Publishers, 2005.
5. G. P. Sutton and O. Biblarz, Rocket Propulsion Elements, John Wiley & Sons, Inc., 2016.

**Robotics**

**ME438**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain the concept of robot arm kinematics. |
| CO2 | Apply the concept of robot arm dynamics. |
| CO3 | Analyze manipulator trajectories and robot end effectors. |
| CO4 | Describe the control of robot manipulators |
| CO5 | Analyze sensors and vision systems in robot. |

## 2. Syllabus

- **INTRODUCTION** **(03 Hours)**
  Background, Historical development, Robot arm kinematics & dynamics, Manipulator trajectory planning & motion control, Robot sensing, Robot programming language, Machine intelligence.

- **ROBOT ARM KINEMATICS** **(07 Hours)**
  Introduction, The direct kinematics problem, The inverse kinematics problems and their solutions.

- **ROBOT ARM DYNAMICS** **(07 Hours)**
  Introduction, Lagrange-Euler formulation, Newton-Euler formulation, Generalized D'Alembert equations of motion.

- **MANIPULATOR TRAJECTORIES** **(05 Hours)**
  Introduction, General considerations in trajectory planning, Joint interpolated trajectories, Planning of manipulator trajectories.

- **CONTROL OF ROBOT MANIPULATORS** **(06 Hours)**
  Introduction, Control of robot arm, Computed torque technique, Near minimum time control, Variable structure control, Nonlinear decoupled feedback control, Resolved motion control, Adaptive control.

- **ROBOT END EFFECTORS** **(04 Hours)**
  Types of end effectors, Types of grippers, Tools as end effectors, Robot-End effecter Interface, Gripper selection & design.

- **SENSORS IN ROBOTICS** **(04 Hours)**
  Introduction, Transducers & sensors, Sensors in robotics, Range sensing, Proximity sensors, Touch sensors, Tactile sensors, Force & torque sensor, Misc. sensors & sensor based system.

- **ROBOT VISION SYSTEMS** **(04 Hours)**
  Introduction, Low level, medium level and high level vision, Image acquisition, Illumination technique, Imaging geometry, Preprocessing, Relationship between pixels.

- **ROBOT PROGRAMMING LANGUAGES** **(02 Hours)**
  Introduction, Characteristics of robot level languages, Characteristics of task level languages.

**(Total Lecture Hours: 42)**

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## 3. Books Recommended:


1. A. Ghosal, Robotics: Fundamental Concepts and Analysis, 1st Edition, Oxford University Press, 2006.
2. K.S. Fu, R.C. Gonzalez, C.S.G. Lee, Robotics: Control, Sensing, Vision, and Intelligence, 1st Edition, McGraw-Hill, 2008.
3. J. J. Craig, Introduction to Robotics: Mechanics and Control, 4th Edition, Pearson, 2018.
4. S. K. Saha, Introduction to Robotics, 2nd Edition, McGraw-Hill, 2015.
5. N. Odrey, M. Weiss, M. Groover, R. N. Nagel, A. Dutta, Industrial Robotics: Technology, Programming and Applications, 2nd Edition, McGraw-Hill, 2012.

## Experimental Fluid Mechanics

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## ME442

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## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain the need of experiments in fluid mechanics |
| CO2 | Explain the concepts and methods of various measurements techniques in fluid mechanics |
| CO3 | Explore different analysis techniques commonly used in experimental work |
| CO4 | Explore modern experimental techniques in fluid mechanics |
| CO5 | Interpret experimental data in fluid mechanics |

## 2. Syllabus

- **INTRODUCTION** **(04 Hours)**
  Need of Experiments, Model making, non-dimensional parameters.

- **WIND TUNNELS** **(08 Hours)**
  Low Speed wind tunnel, Losses in wind tunnel Circuit, High Speed/ supersonic wind tunnels, Shock tubes, Hypersonic facilities.

- **MEASUREMENT OF MATERIAL PROPERTIES** **(10 Hours)**
  Density, Surface tension, Contact Angle, Viscosity, Thermal conductivity, Thermal diffusivity, Diffusion.

- **PRESSURE MEASUREMENTS** **(04 Hours)**
  Measurements of the pressure with the wall tapings, Measurements of the pressure with the static tubes, Pressure sensitive paints.

- **VELOCITY, VORTICITY AND MACH NUMBER** **(04 Hours)**
  Pressure based velocity measurements, Thermal Anemometry, Particle based techniques.

- **DENSITY BASED TECHNIQUES** **(04 Hours)**
  Shadow graphy, Schlieren method, background-oriented Schlieren, Interferometry.

- **TEMPERATURE MEASUREMENTS** **(04 Hours)**
  Thermochromic Liquid Crystals, infrared imaging, Temperature measurement by absorption, light scattering and laser induced fluorescence, Temperature sensitive paints

- **FLOW VISUALIZATION** **(04 Hours)**
  Aims and principles of flow visualizations, dye lines and contours in liquid flow, smoke visualization in air flows, hardware of flow visualization experiments, modern flow visualization techniques, image processing.

**(Total Lecture Hours: 42)**

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## 3. Books Recommended:


1. C. Tropea and A.L. Yarin, Springer handbook of experimental fluid mechanics, Springer Science & Business Media, 2007.
2. E.O. Doebelin and D. N. Manik. Measurement systems: application and design, Mc. Graw Hill, 2019.
3. R. Goldstein, Fluid mechanics measurements, Taylor & Francis 1996.
4. S. P. Venktesh, Mechanical measurements, John Wiley & Sons, Ltd, 2015.
5. J. P. Holman, Experimental methods for engineers, Mc. Graw Hill, 2017.

## Data Analytics

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## ME444

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# 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain the importance of data analytics in decision making. |
| CO2 | Apply the descriptive analytics and probability concepts in decision making. |
| CO3 | Apply the sampling and estimation techniques in decision making. |
| CO4 | Formulate and test the hypothesis in decision making. |
| CO5 | Apply the regression models in decision making. |

# 2. Syllabus

- **Introduction to Business Analytics** **(06 Hours)**
  Business Analytics: The Science of Data Driven Decision Making, Descriptive Analytics, Predictive Analytics, Prescriptive Analytics, Descriptive, Predictive and Prescriptive Analytics Techniques, Buf Data Analytics, Web and Social Media Analytics, Machine Learning Algorithms, Framework for Data-Driven Decision Making, Analytics Capability Building

- **Descriptive Analytics** **(04 Hours)**
  Introduction to Descriptive Analytics, Data Types and Scales, Types of Data Measurement Scales, Population and Sample, Measures of Central Tendency, Percentile, Decile, and Quartile Measures of Variation, Measures of Shape – Skewness and Kurtosis, Data Visualization

- **Probability** **(08 Hours)**
  Probability Theory – Terminology, Fundamental Concepts in Probability – Axioms of Probability, Application of Simple Probability, Bayes' Theorem, Random Variables, Probability Density Functions and Cumulative, Distribution Function of a Continuous Random Variable, Binomial Distribution, Poisson Distribution, Geometric Distribution, Parameters of Continuous Distribution, Uniform Distribution, Exponential Distribution, Normal Distribution, Chi-Square Distribution, Student's t-Distribution, F- Distribution.

- **Sampling and Estimation** **(08 Hours)**
  Population Parameters and Sample Statistic, Sampling, Probabilistic Sampling, Non-Probability Sampling, Sampling Distribution, Central Limit Theorem, Sample Size Estimation for Mean of the Population, Estimation of Population Parameters, Methods of Moments, Estimation of Parameters Using Methods of Moments, Estimation of Parameters Using Maximum Likelihood Estimation, Confidence Interval for Population Mean, Population Proportion, Population Mean When Deviation is Unknown, Population Variance

- **Hypothesis Testing, Analysis of Variance, Correlation Analysis** **(08 Hours)**
  Setting Up a Hypothesis Test, One-Tailed and Two Tailed Test, Hypothesis Testing for Population mean with known Variance: Z-test, Population Proportion: Z-test for Proportion, Variance: t-test, Paired Sample- t-Test, Comparing Two Populations: Two Sample Z- and t-test, Non-Parametric Tests: Chi-Square Tests, Analysis of Variance, Correlation

- **Simple Linear Regression and Multiple Linear Regression** **(08 Hours)**

Simple Linear Regression, History of Regression-Francis Galton's Regression Model, Simple Linear Regression Model Building, Estimation of Parameters Using Ordinary Least Square, Interpretation of Simple Linear Regression Coefficients, Validation of the Simple Linear Regression Model , Outlier Analysis, Confidence Interval for Regression Coefficients, Confidence Interval for the Expected Value of Y for a Given X, Prediction Interval for the Value of Y for a Given X, Multiple Linear Regression

**(Total Lecture Hours: 42)**

## 3. Books Recommended:


1. U. D. Kumar, Business Analytics: The Science of Data Driven Decision Making, Prentice Wiley, 2017
2. S. C. Albright and W. L. Winston, Business Analytics: Data Analysis & Decision Making, Cengage Learning, 2015
3. R. Bartlett, A Practitioner's Guide to Business Analytics: Using Data Analysis Tools to Improve your Organization's Decision Making and Strategy, McGraw Hill Professional, 2013
4. R. N. Prasad and S. Acharya, Fundamentals of Business Analytics, Wiley India Pvt. Ltd., 2016.
5. R. E. James, Business Analytics, Pearson Education, 2017

**Advanced Welding Processes**

**ME446**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Classify advanced welding processes and explain the importance of the same. |
| CO2 | Explain principles of advanced welding processes. |
| CO3 | Describe equipments and procedures of advanced welding processes. |
| CO4 | List process variables of advanced welding processes, and correlate the effects of the same on quality of welds. |
| CO5 | Explain applications, advantages and limitations of advanced welding processes. |

## 2. Syllabus:

- **INTRODUCTION** **(02 Hours)**
  History, Importance, classification, advantages and limitations in general, comparison between fusion & non-fusion welding processes

- **DIFFUSION WELDING** **(07 Hours)**
  Theory and principle of process, key variables, intermediate materials, equipment and tooling, joint design, economics, advantages and limitations, materials and applications.

- **ULTRASONIC WELDING** **(07 Hours)**
  Principles of operation, process characteristics and applications, vacuum brazing theory, mechanisms and key variables, equipment and tooling, stop-off and parting agents, advantages, limitations, economics materials and applications.

- **FRICTION WELDING** **(03 Hours)**
  Basic principles, process variants, different stages of friction welding, mechanism of bonding, influence of process parameters, weld quality and process control, joining of dissimilar materials, advantages, limitations and applications.

- **FRICTION STIR WELDING & PROCESSING** **(07 Hours)**
  Metal flow phenomena, equipments, tool materials & design, types of joints process variables, advantages, limitations, applications; Friction Stir Processing - Process, Tools, Applications; Allied processes -friction stir spot welding process, friction stir channeling; future trends of developments and growth.

- **RADIANT ENERGY BEAM WELDING PROCESSES** **(08 Hours)**

Electron beam welding - background of the process, guns, weld environment, welding in different degrees of vacuum, equipments and safety, joint design, applications; Laser beam welding - physics of lasers, types of lasers, process parameters, applications and limitations.

- **PLASMA ARC WELDING** **(06 Hours)**

  Theory and principle, transferred arc and non-transferred arc techniques, equipment and tooling, operating characteristics, shielding, process parameters, joint design, advantages, disadvantages, economics, materials and applications, needle arc micro plasma welding - characteristics of process, weld penetration and bead shape, applications; plasma arc spraying process, cladding process, process parameters for cladding.

- **EXPLOSIVE WELDING** **(02 Hours)**

  Theory and key variables, parameters, weld quality, equipment and tooling, advantages and limitations, joint design, materials and applications.

**(Total Lecture Hours: 42)**

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## 3. Books Recommended:


1. R. S. Parmar, Welding Processes and Technology, Khanna Publishers, Delhi, 2003.
2. R. S. Mishra and M. W. Mahoney, Friction Stir Welding and Processing, ASM International, 2007.
3. D. Lohwasser and Z. Chen, Friction Stir Welding - From Basics to Applications, CRC press, Woodhead Publishing Limited, Delhi, 2009.
4. D. H. Phillips, Welding Engineering - An Introduction, Wiley, 2016.
5. O. P. Khanna, A Text book of Welding Technology, Dhanpat Rai Publications, 2015.

**Automation and Smart Manufacturing**

**ME448**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain the concepts of automation, smart manufacturing and industry 4.0. |
| CO2 | Apply the knowledge of automation for improvement of existing mechanical engineering systems. |
| CO3 | Analyze the working of key elements of the automation systems such as sensors, transducers, actuation system, etc. |
| CO4 | Evaluate the efficacy of existing automation systems. |
| CO5 | Analyze the key drivers of a smart manufacturing system such as additive manufacturing, internet of things and augmented reality. |
| CO6 | Create a pathway for smart factory development. |

## 2. Syllabus

- **AUTOMATION** **(12 Hours)**
  Introduction to Automation of different manufacturing processes. Levels of automation, types of automation system, Data conversion devices, transducers, Microprocessor based controllers and its application, Programmable Logic Controllers, system interfacing, ladder logic, functional blocks, structured text, and applications. Modular Production Systems – Distribution, Conveying, Pick & Place etc.

- **MEASUREMENT AND MOTION CONTROL SYSTEMS** **(08 Hours)**
  Brief overview of measurement systems, classification, characteristics and calibration of different sensors. Measurement of displacement, position, motion, force, torque, strain gauge, pressure flow, temperature sensor sensors, smart sensor. Principles and structures of modern micro sensors. Basics of motion control, Mechanically and Electronically Coordinated Motion, Component of Motion Control system, Example of single axis and multi-axis motion control system

- **SMART MANUFACTURING** **(12 Hours)**
  Introduction to smart manufacturing, Key Drivers of Smart Manufacturing, Role of Additive Manufacturing technologies in smart manufacturing, Manufacturing of Smart Materials, 4D Printing, Artificial Intelligence in manufacturing.

- **INDUSTRY 4.0** **(10 Hours)**
  The concept of Industry 4.0 and Smart factories, Design Principles and Goals of Industry 4.0, Impact of Industry 4.0, Components of Industry 4.0, Introduction to the concept of Dark Factories, Big data analysis, Internet of Things.

**(Total Lecture Hours: 42)**

## 3. Books Recommended:


1. M. P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, 4th Edition, Pearson, 2015.
2. A. Esposito, Fluid Power with Applications, 6th Edition, Pearson Prentice Hall, 2012.
3. W. Bolton, Mechatronics, 4th Edition, Pearson Education (India), 2011.
4. D. Shetty, A. R. Kolk, Mechatronic System Design, 2nd Edition, PWS Publicity Boston, 2010.
5. Z. Luo, Smart Manufacturing Innovation and Transformation: Interconnection and Intelligence, Business Science Reference (an imprint of IGI Global), 2014.

**Theory and Design of Cryogenic systems**

**ME452**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

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## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Select suitable cryogen and material for development of cryogenic system for different applications |
| CO2 | Design and analyze gas liquefaction system and cryogenic refrigeration systems including cryocoolers. |
| CO3 | Select proper cryogenic insulating material and designing of cryogenic insulation. |
| CO4 | Analyse and design gas purification and separation system using cryogenics. |
| CO5 | Select and design storage, handling, and transfer systems for cryogens. |
| CO6 | Design vacuum system for cryogenic application. |

## 2. Syllabus

- **INTRODUCTION AND APPLICATIONS (03 Hours)**
- **CRYOGENICS FLUIDS (03 Hours)**
  Properties of air, Oxygen, Nitrogen, Hydrogen, Helium and its isotopes
- **CRYOGENICS REFRIGERATION SYSTEMS (04 Hours)**
  Recuperative & regenerative cycles, Joule Thomson cycle ; Gifford, Mcmohan cycle, Stirling cycle, Pulse Tube refrigeration, Magneto caloric refrigeration, Vuilleumier refrigerator.
- **GAS LIQUEFACTION SYSTEMS (04 Hours)**
  Ideal systems, Linde, Linde dual pressure system, Claude, Heylandt, Kapitza systems, Cascade cycle.
- **CRYOGENIC INSULATION (03 Hours)**
  Vacuum insulation, Multilayer insulation (MLI), Methods of measuring effective thermal conductivity of MLI, Liquid & vapour shield, Evacuated porous insulation, Gas filled powders and fibrous materials, Solid foams
- **CRYOGENIC INSTRUMENTATION (03 Hours)**
  Peculiarities of cryogenic strain measurement, Pressure, Flow, Density, Temperature and liquid level measurement for cryogenic application
- **PURIFICATION AND SEPARATION OF GASES, LIQUEFIED NATURAL GAS (04 Hours)**
  Principles of gas separation: Separation by condensation & flashing, Separation by distillation. Air separation system: Linde single column system, Linde double Column systems etc., Liquefaction of Natural Gas
- **STORAGE & HANDLING SYSTEMS (03 Hours)**

Dewar vessel design, Piping, Support systems, Vessel safety devices and storage systems, Industrial storage systems

- **TRANSFER SYSTEMS** **(03 Hours)**
  Transfer from storage, Uninsulated transfer lines, Insulated lines, Transfer system components.

- **PROPERTIES AND SELECTION OF MATERIALS** **(04 Hours)**
  Study of material properties & their selection for cryogenic application.

- **VACUUM SYSTEMS, CRYO PUMPING** **(03 Hours)**

- **EQUIPMENTS FOR LOW TEMPERATURE SYSTEMS** **(05 Hours)**
  Heat exchangers, Compressor, Expanders.

**(Total Lecture Hours: 42)**

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## 3. Books Recommended:


1. C. Hastlden Cryogenic Fundamentals, Academic Press, 2001.
2. R. Barron, Cryogenic Systems, Plenum Press, 2001.
3. G. Walker, Cryocoolers, Springer, 2014.
4. Y. Mikulin, Theory and Design of Cryogenic systems, MIR Publication, 2002.
5. R. F. Barron, Cryogenics Systems, Oxford Press., 2002

## Computer Aided Machine Design

## ME454

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 3 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain the computer aided aspects of mechanical design. |
| CO2 | Explain the concept of static analysis methods. |
| CO3 | Describe the transient and dynamic analysis methods. |
| CO4 | Analyze cyclic symmetric structures. |
| CO5 | Analyze and design of machine components. |

## 2. Syllabus

- **COMPUTER AIDED ASPECTS OF MECHANICAL DESIGN (06 Hours)**
  Introduction, mechanical design, formulation of specific design problem, computer aided aspects of design, failure under dynamic loading.

- **OPTIMIZATION OF DESIGN (07 Hours)**
  Unconstrained minimization of function, Lagrange multipliers, numerical optimization, Newton's and gradient methods, quadratic convergence, direct search methods, methods of successive linear approximation.

- **STATIC ANALYSIS (06 Hours)**
  Determinant and matrices, Gaussian elimination, Gauss-Jordan method, Cholesky's factorisation method, Potter's method, Jacobi's method, Gauss-Siedel method.

- **TRANSIENT ANALYSIS (06 Hours)**
  Single degree of freedom system, multi-degree of freedom system, explicit schemes, implicit schemes, mode superposition method, modal analysis, stability analysis.

- **DYNAMIC ANALYSIS (06 Hours)**
  Basic concepts of Eigenvalue problems, properties of Eigenvalues and vectors, Eigenvalue bounds and inequalities, Iteration method, transformation methods, approximation methods.

- **CYCLIC SYMMETRIC STRUCTURES (05 Hours)**
  Static analysis under symmetric loading, asymmetric loading, free vibration analysis, force vibration analysis.

- **STRESS ANALYSIS OF MACHINE COMPONENTS (06 Hours)**
  Cases of static analysis: analysis of frames, analysis of cylindrical shells, analysis of spur gear teeth. Computer aided dynamic analysis, case studies: dynamic analysis of frames, dynamic analysis of cylindrical shells, dynamic analysis of spur gear teeth, bladed discs, transient vibrations of turbine blades.

**(Total Lecture Hours: 42)**

## 3. Books Recommended:


1. R. V. Dukkipati, M. A. Rao and R. Bhat, Computer Aided Analysis and Design of Machine Elements, New Age International Pvt. Ltd., 2015.
2. V. Ramamurti, Finite Element Method in Machine Design, Narosa Publishing House Pvt. Ltd., 2009.
3. R. G. Budynas and K. Nisbett, Shigley's Mechanical Engineering Design, 11th Edition, McGraw Hill, 2020.
4. M. F. Spotts, Design of Machine Elements, Pearson Education India Ltd., 2004.
5. C. S. Krishnamoorthy, S. Rajeev and A. Rajaraman, Computer Aided design Software and Analytical Tools, 2nd Edition, Narosa Publishing House Pvt. Ltd., 2018.

**Foundry Technology**

**ME456**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain about flow and heat transfer of molten metal and correlate the effects of the same on resultant structure-properties of cast metals. |
| CO2 | Describe the design of patterns and mold parts and explain procedures of testing of core and mold materials. |
| CO3 | Calculate the size of gating system elements and pouring time for sand castings. |
| CO4 | Calculate the size and determine the shape and location of risers and describe effects of feeding aids for achieving directional solidification. |
| CO5 | Describe and compare procedures of casting various ferrous and non-ferrous metals and alloys. |

## 2. Syllabus:

- **SCIENCE OF SOLIDIFYING METAL (08 Hours)**
  Metal flow analysis - pressure, velocity and losses, turbulence & fluidity of molten metals, gas evolution and venting, heat flow during solidification – thermal gradient & cooling rate, conduction, Chvorinov's rule for solidification time, shrinkage, cooling stresses, distortion, effect on microstructure of metals.

- **TECHNOLOGY OF TOOLINGS (10 Hours)**
  Design of Tools for metal casting – intermediate tools (pattern), final tools(molds/die), part orientation and mold parting; testing of mold materials, positioning of undercuts, types of core and core print design , core strength, No-bake cores, core heat transfer and gas transfer, pattern allowances, multi-cavity mold layout. Pattern & mold material for investment casting and shell molding processes.

- **DESIGN OF RISERS (09 Hours)**
  Types of risers – top & side risers, Open & blind risers; requirements, location, capacity & efficiency, Design of risers – riser size, riser shape, modulus method, Caine's curve method, shape factor method, Neck size; Directional solidification, Feeding aids – external & internal chills, insulating/exothermic sleeves and covers, paddings, fin, effective feeding distance of chills, concept of Modulus extension factor(MEF) for feeder sleeves.

- **DESIGN OF GATING SYSTEM (09 Hours)**
  Elements of gating system, Calculation of ideal filling time, filling rate of ferrous and non-ferrous metals, size & position of choke, gating ratio, pressurized and non-pressurized gating system, design of down sprue, sprue well, runner, gate, selection of gates, gate-casting junction, filtration of molten metal, evaluation of gating design.

- **CASTING OF FERROUS AND NON-FERROUS ALLOYS (06 Hours)**

Molding, melting, pouring, solidification, major issues in casting of Grey Iron, S. G. Iron, Steels and alloy steels, Aluminum alloys, Cu alloys.

**(Total Lecture Hours: 42)**

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## 3. Books Recommended:


1. B. Ravi, Metal Casting: Computer Aided Design and Analysis, PHI Learning Pvt. Ltd., 2005.
2. R.W. Heine, C. R. Loper and P.C. Rosenthal, Principles of Metal Casting, Tata McGraw-Hill, 2017.
3. P. L. Jain, Principles of Foundry Technology, TMH Publications, 2014.
4. P. Beeley, Foundry Technology, Elsevier (reprint by: Butterworth-Heinemann), 2001.
5. A. K. Chakrabarti, Casting Technology and Cast Alloys, PHI Ltd., 2005.

## Logistics and Supply Chain Management

## ME458

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain the concepts of logistics, supply chain, supply chain performance, supply chain drivers and metrics. |
| CO2 | Identify the key factors for distribution network and to develop the framework for network design decisions. |
| CO3 | Evaluate the forecast, aggregate plan and sales & operation plan for supply chain. |
| CO4 | Apply deterministic and probabilistic inventory control models for evaluating the supply chain inventory level. |
| CO5 | Apply analytics for solving the supply chain problems. |

## 2. Syllabus

- **LOGISTICS MANAGEMENT** **(04 Hours)**

  Logistics Management-An Introduction, Key actors, Classification of Logistics Applications, Total logistics cost, Logistics to supply chain Management

- **BUILDING A STRATEGIC FRAMEWORK TO ANALYSE SUPPLY CHAINS** **(05 Hours)**

  Historical evolution of supply chain, Understanding the supply chain, supply chain performance: achieving strategic fit, supply chain drivers and metrics and case studies

- **DESIGNING THE SUPPLY CHAIN NETWORK** **(05 Hours)**

  Designing distribution networks and applications to e-business, network design in the supply chain, network design in an uncertain environment, and case studies

- **PLANNING DEMAND AND SUPPLY IN A SUPPLY CHAIN** **(10 Hours)**

  Demand forecasting strategy in a supply chain, aggregate planning in a supply chain, sales and operation planning: Planning supply and demand in a supply chain, and case studies.

- **PLANNING AND MANAGING INVENTORIES IN A SUPPLY CHAIN** **(08 Hours)**

  Managing economies of scale in a supply chain: cycle inventory, managing uncertainty in a supply chain: safety inventory, determining the optimal level of product availability, and case studies.

- **SUPPLY CHAIN MANAGEMENT ANALYTICS** **(10 Hours)**

  Techniques for evaluating supply chain, evaluating disaster risk in supply chain, Managing bullwhip effect, Supplier selection analysis, Transportation mode analysis and Warehouse storage.

**(Total Lecture Hours: 42)**

## 3. Books Recommended:


1. S. Chopra and P. Meindel, Supply Chain Management: Strategy, Planning, and Operation, 6th Edition, Pearson Education, 2016.
2. M. Christopher. Logistics and Supply Chain Management: Strategies for Reducing cost and Improving Services, 1st Edition, Pearson Education, 1998.
3. D. Simchi-Levi, P. Kaminsky, E. Simchi-Levi, Designing and Managing the Supply Chain: Concepts, Strategies, and Case Studies, 3rd Edition Revised, McGraw-Hill/Irwin, 2008.
4. J. F. Shapiro, Modeling the Supply Chain, 2nd Wadsworth Publishing Co Inc., 2006.
5. J. Heizer, B. Render, C. Munson and A. Sachan, Operations Management, 12th Edition, Pearson Education, 2017.

**Two Phase Flow**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

**ME462**

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Solve commonly encountered two phase flow with or without phase change in a variety of engineering processes. |
| CO2 | Develop one-dimensional models of two-phase flow with and without phase change. |
| CO3 | Explain modern gas-liquid measurement techniques and instruments. |
| CO4 | Perform simple numerical analysis for Euler-Euler and Euler-Lagrange two-phase flow. |
| CO5 | Predict pressure drop for gas-solid and gas-liquid flow as well as flow boiling. |

## 2. Syllabus

- **INTRODUCTION**: **(08 hours)**
  Introduction, simultaneous flow of liquids and gases, horizontal two phase flow, lockhart and Martinelli procedure, flow factor method, vertical two phase flow, two phase flow through inclined pipes.

- **FLOW REGIMES**: **(05 hours)**
  Flow regimes in vertical horizontal and inclined pipes, gas-liquid flow in pipes, flow regimes in vertical, horizontal and inclined pipes, pressure drop and void fraction modelling for specific flow regimes.

- **BOUNDARY LAYER ANALYSIS**: **(08 hours)**
  Pneumatic transport and hydro-transport of solids in pipes, modelling of interaction forces, air-lift pump modeling, two phase flow boundary layer analysis, circulation in boiler-natural and forced, effective pressure head in boiler tubes, variation of major parameters of drum during transient conditions, hydrodynamics stability of vapor-liquid system.

- **SIMULTANEOUS FLOW OF FLUIDS AND SOLIDS:** **(08 hours)**
  Introduction, dynamics of particles submerged in fluids, flow through packed bed, fluidization, calculation of pressure drop in fixed bed, determination of minimum fluidization velocity, expanded bed, dilute phase, moving solid fluidization, elutriation in fluidized bed, semi-fluidization, pulsating columns, oscillating fluidized bed.

- **TWO PHASE FLOW WITH CHANGE OF PHASE:** **(05 hours)**
  Film wise condensation of pure vapors, drop wise condensation in plated surfaces, condensation in presence of non-condensable gas-pool boiling, boiling in forced flow inside tubing.

- **GAS LIQUID FLUIDIZATION:** **(08 hours)**
  Gas-liquid particle process, gas liquid particle operation, flow of gas-bubble formation, bubble growth gas holdup, gas mixing liquid holdup, liquid mixing, flow of liquid mixing, gas liquid mass transfer.

**(Total Lecture Hours: 42)**

## 3. Books Recommended:


1. J.G. Collier and J.R. Thome, Convective Boiling and Condensation, Oxford University Press, 1996.
2. C. Kleinstreuer, Two-Phase Flow: Theory and Applications, Taylor & Francis, 2003.
3. P. B. Whalley, Boiling, Condensation and Gas-Liquid Flow. Oxford University Press, 1990.
4. L.S. Tong and Y.S. Tang, Boiling Heat Transfer and Two-Phase Flow, Taylor and Francis, 1997.
5. M. Ishii and T. Hibiki, Thermo-Fluid Dynamics of Two-Phase Flow, Springer, 2011.

## Innovation, Incubation and Entrepreneurship

## HU 406

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

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# 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain the concepts of Entrepreneurship |
| CO2 | Develop skills related to various functional areas of management (Marketing Management, Financial Management, Operations Management, Personnel Management etc.) |
| CO3 | Develop skills related to Project Planning and Business Plan development |
| CO4 | Demonstrate the concept of Innovation, Intellectual Property Rights (IPR) and Technology Business incubation |
| CO5 | Build knowledge about Sources of Information and Support for Entrepreneurship |
| CO6 | Develop Entrepreneurial Culture |

# 2. Syllabus:

- **CONCEPTS OF ENTREPRENEURSHIP (10 Hours)**
  Scope of Entrepreneurship, Definitions of Entrepreneurship and Entrepreneur, Characteristics of an Entrepreneur, Entrepreneurial Development models and Theories, Entrepreneurs Vs Managers Classification of Entrepreneurs; Major types of Entrepreneurship – Techno Entrepreneurship, Women Entrepreneurship, Social Entrepreneurship, Intrapreneurship (Corporate entrepreneurship), Rural Entrepreneurship, Family Business etc.; Problems for Small Scale Enterprises and Industrial Sickness; Entrepreneurial Trait Tests; Entrepreneurial Environment – Political, Legal, Technological, Natural, Economic, Socio – Cultural etc. ; Motivation; Business Opportunity Identification

- **FUNCTIONAL MANAGEMENT AREA IN ENTREPRENEURSHIP (12 Hours)**
  Marketing Management: Basic concepts of Marketing, Development of Marketing Strategy and Marketing plan, Online Marketing, New Product Development Strategy
  Operations Management: Basic concepts of Operations management, Location problem, Development of Operations strategy and plan
  Personnel Management: Main operative functions of a Personnel Manager, Development of H R strategy and plan
  Financial Management: Basics of Financial Management, Ratio Analysis, Capital Budgeting, Working Capital Management, Cash Flow Statement, Break Even Analysis

- **PROJECT PLANNING (06 Hours)**
  Product Development – Stages in Product Development; Feasibility analysis – Technical, Market, Economic, Financial etc.; Project report; Project appraisal; Setting up an Industrial unit – procedure and formalities in setting up an Industrial unit; Business Plan Development

- **PROTECTION OF INNOVATION THROUGH IPR (04 Hours)**
  Introduction to Intellectual Property Rights – IPR, Patents, Trademarks, Copy Rights

- **INNOVATION AND INCUBATION (06 Hours)**

Innovation and Entrepreneurship, Creativity, Green Technology Innovations, Grassroots Innovations, Issues and Challenges in Commercialization of Technology Innovations, Introduction to Technology Business Incubations, Process of Technology Business Incubation

- **SOURCES OF INFORMATION AND SUPPORT FOR ENTREPRENEURSHIP**

  **(04 Hours)**

  State level Institutions, Central Level institutions and other agencies

(**Total Lecture Hours: 42)**

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## 3. Books Recommended:


1. Vasant Desai, Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House, India, 6th Revised Edition, 2011
2. P. M. Charantimath, Entrepreneurial Development and Small Business Enterprises, Pearson Education, 3rd Edition, 2018
3. H. David, Entrepreneurship: New Venture Creation, Pearson Education, 2016
4. P. Chandra, Projects: Planning, Analysis, Selection, Financing, Implementation and Review, Tata McGraw Hill, 9th Edition, 2019
5. T. R. Banga & S. C. Shrama, Industrial Organisation & Engineering Economics, Khanna Publishers, 25th Edition, 2015


## Further Reading:


1. L. M. Prasad, Principles & Practice Of Management, Sultan Chand & Sons, 8th Edition,2015
2. Everett E. Adam, Ronald J. Ebert, Production and Operations Management , Prentice Hall of India, 5th edition, 2012
3. P. Kotler, K. L. Keller, A. Koshi & M. Jha, Marketing Management – A South Asian Perspective, Pearson, 14th Edition, 2014
4. P. C. Tripathi, Personnel Management & Industrial Relations, Sultan Chand & sons, 21st Edition, 2013
5. P. Chandra, Financial Management, Tata McGraw Hill, 9th Edition, 2015

# Teaching Scheme: B. Tech. (Mechanical Engineering) II Year

**SEMESTER - III**

| Sr. No. | Subject | Code | Scheme | Exam Scheme | | | | Total | Credit |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Tuto. | Pract. | | |
| | | | | Hrs. | Marks | Marks | Marks | | |
| 1. | Mathematics - III | MA219 | 3 – 1 – 0 | 3 | 100 | 25 | - | 125 | 04 |
| 2. | Engineering Thermodynamics | ME201 | 4 – 1 – 0 | 3 | 100 | 25 | - | 125 | 05 |
| 3. | Theory of Machines | ME203 | 3 – 1 – 2 | 3 | 100 | 25 | 50 | 175 | 05 |
| 4. | Metallurgy | ME205 | 3 – 0 – 2 | 3 | 100 | - | 50 | 150 | 04 |
| 5. | Measurement and Instrumentation | ME207 | 3 – 1 – 2 | 3 | 100 | 25 | 50 | 175 | 05 |
| | | Total | 16 – 4 – 6 | 15 | 500 | 100 | 150 | 750 | 23 |

## Engineering Mathematics-III

## MA219

| L | T | P | Credit |
|---|---|---|---|
| 3 | 1 | 0 | 04 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | understand the concept of convergence and divergence of infinite series |
| CO2 | expand the periodic functions in the form of Fourier series along with different cases |
| CO3 | obtain Fourier integral from Fourier series and understand the concept of integral transforms with their applications |
| CO4 | aware the methods to obtain the solution of certain partial differential equations |
| CO5 | understand the fundamental of numerical methods and apply in engineering problems |

## 2. Syllabus

- **INFINITE SERIES** **(06 Hours)**
  Introduction, positive term series, comparison test, Cauchy's root test, D'Alembert's test, Raabe's test, Logarithmic test, Integral test, Gauss's test, Series with arbitrary terms, Rearrangement of terms.

- **FOURIER SERIES** **(06 Hours)**
  Definition, Fourier series with arbitrary period, in particular periodic function with period $2\pi$. Fourier series of even and odd function, Half range Fourier series.

- **FOURIER INTEGRAL AND FOURIER TRANSFORMS** **(07 Hours)**
  Fourier Integral theorem, Fourier sine and cosine integral complex form of integral, Inversion formula for Fourier transforms, Fourier transforms of the derivative of a function.

- **PARTIAL DIFFERENTIAL EQUATION** **(08 Hours)**
  Second order PDE of Mathematical Physics (Heat, wave and Laplace equation, one dimensional with standard boundary conditions, solution by separation of variable method using Fourier series, Solution by separation of variables & transformation techniques.

- **SOLUTION OF ORDINARY DIFFERENITAL EQUATIONS** **(07 Hours)**
  Introduction to initial and boundary value problem, Euler's method, Runge-Kutta method, Taylor's series method, Predictor-Corrector method. Shooting method for boundary value problems and eigen value problem.

- **FINITE DIFFERENCE METHOD** **(08 Hours)**
  Introduction to finite difference method. Approximation to derivatives and boundary conditions of different kinds. Finite difference method to boundary value problems. Explicit and implicit Finite difference method for parabolic PDEs in one dimension with different boundary conditions. Approximation to $\nabla^2$, Five point formula for Laplace and Poisson equation.

**(Total Lecture Hours: 42)**

## 3. Books Recommended:


1. E. Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley, 2011.
2. C. R. Wylie, Advanced Engineering Mathematics, 6th Edition, McGraw Hill Education, 1995.
3. P. V. O'Neil, Advanced Engineering Mathematics, 7th Edition, Cengage, 2012.
4. M. D. Greenberg, Advanced Engineering Mathematics, 2nd Edition, Pearson Education, 2002.
5. B. V. Ramana, Higher Engineering Mathematics, 1st Edition, McGraw-Hill, New Delhi, 2010.


**Further Reading:**


1. S.S. Chapra and R.P. Canale, Numerical Methods for Engineers, 7th Edition, McGraw Hill International Edition, 2015.
2. K.S. Rao, Numerical Methods for Scientists and Engineers, 3rd Edition, Prentice-Hall India, 2007.

## Engineering Thermodynamics

| L | T | P | Credit |
|---|---|---|---|
| 4 | 1 | 0 | 05 |

## ME201

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## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Relate the thermodynamic laws to engineering systems and processes. |
| CO2 | Solve thermodynamic problems using Mollier diagram, steam and gas tables/charts. |
| CO3 | Apply the second law of thermodynamics and entropy concepts in analyzing performance of heat pump and refrigerator |
| CO4 | Explain the method of improving performance of a system by reducing irreversibility. |
| CO5 | Analyse performance of various steam power cycle in context to power plant. |
| CO6 | Classify various steam generators |

## 2. Syllabus

- **INTRODUCTION** **(02 Hours)**

- **PROPERTIES OF PURE SUBSTANCE** **(08 Hours)**
  Definition of pure substance, Phases of a pure substance, P-V-T behavior of a pure substance, Critical & triple point of a pure substance, Mollier diagram, steam table & dryness fraction of steam, Measurement of dryness fraction of steam.

- **PROPERTIES OF GAS AND GAS MIXTURE** **(05 Hours)**
  Equation of state for ideal gas, Change in entropy, internal energy, enthalpy of gas in various thermodynamics processes, Dalton's law of partial pressure & properties of gas mixture.

- **SECOND LAW OF THERMODYNAMICS** **(07 Hours)**
  Statements of second law of thermodynamics. - The Carnot cycle & Carnot's theorem, Corollary of Carnot's theorem, Efficiency of reversible engine, Causes of irreversibility, C.O.P. of heat pump & refrigerator.

- **ENTROPY** **(08 Hours)**
  Inequality of Clausius theorem, Entropy as a property, Change in entropy in reversible and irreversible processes, Principle of increase of entropy, Entropy change of an ideal gas in various thermodynamics processes, Second law of thermodynamics for steady flow process & its application

- **AVAILABILITY AND IRREVERSIBILITY** **(10 Hours)**
  Basic concepts, Available and unavailable energy for a cycle, Different form of Exergy, Exergy balance for closed system and open system, Decrease of Exergy principle, Difference between first law & second law efficiency, Second law efficiency for steady flow devices.

- **THERMODYNAMIC RELATIONS & EQUILIBRIUM** **(08 Hours)**
  The Maxwell relations, Clausis –clapeyron equation, Joule –Thomson coefficient, Relationships involving specific heats, enthalpy, entropy.

- **STEAM GENERATIORS** **(08 Hours)**
  Types of steam generators like natural circulation and forced circulation. Heat recovery steam generators (HRSG) with LP and HP evaporators, economizers, super heaters and air preheaters. High pressure boilers such as La Mont, Loeffler, Benson, Schmidt, Velox Boiler. Performance of boilers.

**(Total Lecture Hours: 56)**

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## 3. Books Recommended:


1. W. Van, R.E. Sonnetag and C. Borgnakke, Fundamental of Classical Thermodynamics, John Wiley & sons, 2005.
2. P K Nag, Engineering Thermodynamics, McGraw Hill Education Private Limited, 2013.
3. Y.A. Cengel and M.A. Boles, Thermodynamics, Tata McGraw Hill, 2004.
4. C.P. Kothandaraman, P.R. Khajuria and S. Domkundrar, A Course in Thermal Engineering, Dhanpat Rai & Sons,2004.
5. P.L. Ballaney, Thermal Engineering, Khanna Publishers, 2000.

**Theory of Machines**

**ME203**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 1 | 2 | 05 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Calculate the degree of freedom of mechanisms. |
| CO2 | Apply the kinematic analyses in existing or real life mechanisms. |
| CO3 | Analyze the kinematic requirements and shape of the cam and follower mechanism. |
| CO4 | Analyze the given gears and gear trains for specific applications. |
| CO5 | Calculate the required length and size of the belt, rope and chain drives considering required power transmission and centrifugal effect |

## 2. Syllabus

- **MACHINES AND MECHANISMS (06 Hours)**
  Introduction, Mechanism and machine, Rigid and resistant body, Link, Kinematic pair, Types of motion, Degrees of freedom (mobility), Classification of kinematic pairs, Kinematic chain, Linkage, Mechanisms, Kinematic inversion, Inversions of slider crank chain, Double slider-crank chain

- **VELOCITY ANALYSIS (08 Hours)**
  Trace the Loci of points in simple mechanisms, Absolute and Relative motions, Vectors, Addition and Subtraction of vectors, Motion of a link, Angular velocity, Rotation of a rigid body, Translation and rotation of a rigid body, Velocity analysis of mechanisms by relative velocity method (graphical), Instantaneous centre, Kennedy's Theorem, Locating I- centres, Velocity analysis by instantaneous centers, Centrode.

- **ACCELERATION ANALYSIS (09Hours)**
  Definition of acceleration, Angular acceleration, A general case of acceleration, Radial and transverse components of acceleration, The coriolis component of acceleration, Acceleration analysis of mechanisms, Acceleration diagrams, Coriolis Acceleration component, Kinematic analysis of mechanisms with computer assisted software: Modeling and assembly of the linkages, joints and constraints, motion animation of the mechanism, Kinematic analysis of the existing or real life mechanism.

- **BELTS, ROPES AND CHAINS (06 Hours)**
  Introduction, Belt and rope drives, Open and crossed belt drives, Velocity ratio, Slip, Materials for belt and ropes, Law of belting, Length of belt, Ratio of friction tensions, Power transmitted, Centrifugal effect on belts, Maximum power transmitted by a belt, Initial tension, Creep, Chains, Cha in length, Angular speed ratio, Classification of chains

- **GEARS AND GEAR TRAINS (07 Hours)**
  Introduction, Classification of gears, Gear terminology, Law of gearing, Velocity of sliding, Forms of teeth, Cycloidal profile teeth, Involute profile Teeth, Comparison of cycloidal and involute tooth forms, Birth of contact, Arc of contact, number of pairs of teeth in contact, Interference in involute gears, Minimum number of teeth, Interference between rack and pinion, Undercutting, Introduction

to helical, Spiral, Worm, Worm gear and bevel gears. Types of Gear trains. Kinematic analysis of gear trains, Differential of an Automobile.

- **CAMS** **(06 Hours)**
  Introduction, Types of cams, Types of followers, Cam terminology, Displacement diagrams, Motions of the follower, Graphical construction of cam profile.

**(Total Lecture Hours: 42)**

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## 3. Practicals:

1. To study and demonstrate various types of mechanisms and their inversions.
2. To draw velocity diagram of a mechanisms using instantaneous centre method.
3. To draw velocity and acceleration diagrams for mechanisms.
4. To draw velocity and acceleration diagram of a mechanism involving coriolis component of acceleration.
5. Kinematic analysis of existing or real life mechanisms with computer assisted software – I
6. Kinematic analysis of existing or real life mechanisms with computer assisted software – II
7. To study and demonstrate various types of cams and followers.
8. To draw the layout of cam profile for a reciprocating radial knife edge follower to provide constant velocity to the follower
9. To draw the layout of cam profile for an offset reciprocating roller follower to provide constant acceleration and retardation motion to the follower
10. To draw the layout cam profile for a flat faced reciprocating follower to provide SHM motion to the follower
11. To draw the layout of cam profile for an oscillating follower to provide cycloidal motion to the follower

## 4. Books Recommended:


1. S. S. Rattan, Theory of machines. Tata McGraw-Hill Education, 2014.
2. J. J. Uicker, G. R. Pennock and J.E. Shigley, Theory of Machines and Mechanisms, 3 rd Edition, Oxford University Press, 2011.
3. J.S., Rao and R.V. Dukkipati, Mechanism and Machine Theory, New edge international publishers, 2007.
4. A. Ghosh, and A.K. Mallik, Theory of mechanisms and machines, Affiliated East-West Press Private Limited, 2002.
5. A. G. Ambekar, Mechanism and Machine Theory, Prentice Hall of India Private Limited, 2007.

# Metallurgy

**ME205**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 2 | 04 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Describe the importance of metallurgical industries and explain the basic principles of metallography and extraction of metallic elements. |
| CO2 | Explain the microstructure of ferrous and non-ferrous alloys and correlate the same with their properties and applications. |
| CO3 | Analyze solidification mechanisms of metals and apply the same for control of structure of engineering products |
| CO4 | Describe strengthening mechanisms of metallic materials, and explain the elastic/plastic deformation of metallic materials. |
| CO5 | Explain the phase-equilibria in binary alloys and analyze phase diagrams for binary alloys. |
| CO6 | Explain the principle, procedure and application of heat-treatments of ferrous and non-ferrous alloys. |
| CO7 | Explain the principles, procedures, advantages and limitations of non-destructive testing techniques. |

## 2. Syllabus:

- **INTRODUCTION AND SCOPE (04 Hours)**
  Various fields of metallurgical engineering, Status of metallurgical industry in India, Sources of metals, Basic outline of the principles of production of iron and steel, copper, aluminum. Basic concepts of metallography.

- **STRUCTURE-PROPERTY CORRELATIONSHIP IN METALS (06 Hours)**
  Ferrous: Allotropic forms of Iron, Wrought Iron, Cast Irons - Grey, White, Malleable and Spheroidal Graphite, Steel - Plain carbon steel, Alloying of steels, Stainless steels, Tool steels, Maraging steels.
  Non-ferrous: Copper & Copper alloys - Brass, Bronze, Cupro-Nickel; Aluminum and Aluminum alloys, Titanium alloys, Nickel based super alloys.

- **SOLIDIFICATION OF METALS (04 Hours)**
  Solidification of pure metals, Nucleation, Growth, Applications of controlled Nucleation & controlled growth.

- **DEFORMATION OF METALS (06 Hours)**
  Elastic & plastic deformation of metals, Strengthening mechanisms, Importance of grain size, directional properties, Recovery, Recrystallization and grain growth

- **EQUILIBRIUM PHASE DIAGRAMS (08 Hours)**
  Objectives & classification, Basic terms - system, phases & structural constituent, Phase systems - Isomorphous, Eutectic. Eutectoid, Peritectic. Interpretation of phase diagrams - Lever rule, Gibb's phase rule, Equilibrium phase diagram of Fe-$Fe_3C$ system, Equilibrium phase diagrams of non-ferrous alloys.

- **HEAT TREATMENT** **(08 Hours)**
  Purpose, Definition and Classification of heat-treatment processes for steels, Heat treatments for bulk materials - Annealing, Normalizing, Hardening, Tempering, Isothermal cooling transformation diagram (ICT/TTT) and Continuous cooling transformation (CCT) diagrams for steels, Various surface hardening heat-treatment of steels; Heat-treatment of Al alloys - Solution treatment, Solution quenching & Precipitation hardening.

- **NON-DESTRUCTIVE TESTING TECHNIQUES** **(06 Hours)**
  Importance, principle, procedure, equipments, advantages & limitations of various non-destructive techniques - visual inspection, radiography, ultrasonic testing, magnetic particle inspection, liquid penetrant inspection, eddy current testing

**(Total Lecture Hours: 42)**

## 3. Practicals:

1. To study construction and working of metallurgical microscope.
2. To preparation specimen for microscopic observation
3. To study structure, properties and applications of ferrous alloys.
4. To study Fe-$Fe_3C$ equilibrium phase diagram and its applications.
5. To Study structure, properties and applications of non-ferrous alloys.
6. To study T-T-T & C-C-T diagram of steels.
7. To estimate effect of severity of quenching media in hardening heat-treatment of steels.
8. To determine hardenablility of steel using Jominy end quench test.

## 4. Books Recommended:


1. R. Balasubramanian, Callister's Materials Science and Engineering, John Wiley & Sons, 2014.
2. D. R. Askland, P. P. Fulay, W. J. Wright, The Science and Engineering of Materials, Cengage Learning, 2015.
3. S. H. Avner, Introduction to Physical Metallurgy, McGraw-Hill, 2017.
4. O. P. Khanna, A Text book of Materials Science And Metallurgy, Dhanpat Rai Publications.
5. W. Smith, J. Hashemi, R. Prakash, Materials Science & Engineering, McGraw Hill, 2014.

**Measurements And Instrumentation**

**ME207**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 1 | 2 | 04 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Draw block diagram of different measurement instruments. |
| CO2 | Describe basic concepts of mechanical measurement, errors in measurements and uncertainty. |
| CO3 | Identify the type of measurement instruments and their relevant specification etc. which can be used in a particular process parameter measurement selection. |
| CO4 | Explain the theory of stress & strain, force and torque measurements. |
| CO5 | Explain control systems used in industry. |
| CO6 | Analyze and characterize the behavior of a control system in terms of different system and performance parameters. |

## 2. Syllabus

- **BASIC CONCEPTS & IMPORTANCE OF MEASUREMENTS: (07 hours)**
  Aim of measurement, methods of measurement, generalized measurement systems, Instruments & its classifications, performance characteristics of instruments, Statistic & dynamic characteristics, analysis of experimental data, Regression analysis, correlation, estimation of uncertainty and presentation of data, design of experiments, Errors in measurements.

- **TEMPERATURE MEASUREMENTS: (06 Hours)**
  Temperature scales, Ideal gas, Temperature measuring devices, Thermometer, Bi- metallic strip, Electrical resistance thermometer, Thermistors and thermocouples, Laws of thermocouples and their applications, Construction and calibration of thermocouples, Radiation pyrometers, total radiation pyrometers

- **PRESSURE MEASUREMENT: (07 hours)**
  Definition of pressure, Units, Types of pressure measurement devices, Manometers, Dead weight tester, Bourdon tube pressure gauge, Diaphragms and bellows, Low pressure measurement, Mcleod gauge, Pirani thermal conductivity gauge, Knudsen gauge, Ionization gauge, Piezo electric transducer Selection of pressure measuring devices for specific applications, Calibration of pressure measuring devices.

- **FLOW MEASUREMENTS**: **(07 hours)**
  Types of flow measuring devices, Constructional features, Obstruction meters like orifice, Venturi nozzle and their calibration, Flow measurement by drag effects (rotameter), Pitot tube, Hot wire anemometers, Magnetic flow Meters, Flow visualization Techniques, Shadowgraph, Interferometer, Laser Doppler, Ultra sonic flow meter.

- **MEASUREMENT OF FORCE, TORQUE AND STRAIN: (6 hours)**
  load cells, cantilever beams, proving rings, differential transformers. Measurement of torque: Torque measurement on rotating shaft, Proney brake and eddy current dynamometer. Measurement of strain:

Mechanical strain gauges, electrical strain gauges, strain gauge: materials, gauge factors, theory of strain gauges and method of measurement, Rosettes, bridge arrangement, temperature compensation.

- **DISPLACEMENT, VELOCITY, SPEED AND ACCELERATION MEASUREMENTS**: **(5 hours)**

  Working principal of Resistive Potentiometer, Linear variable differential transducers, Electro Magnetic Transducers, Mechanical, Electrical and Photoelectric Tachometers, Piezoelectric Accelerometer, Seismic Accelerometer.

- **CONTROL SYSTEMS:** **(04 hours)**

  Basic concepts of control systems, classifications of control system, close loop control systems, open loop control system, automatic control systems, servo mechanism, regulator, representation through model, analogous system, block diagram, mathematical block diagram, signal flow graph, time response of control systems stability, frequency response, Industrial controllers pneumatic and hydraulic control systems, micro controller

**(Total Lecture Hours: 42)**

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## 3. Practicals:

1. To calibrate the thermocouples.
2. To demonstrate temperature by using RTD & thermistor
3. To determine the fluid flow velocity through orifice meter, venturimeter,
4. To determine the fluid flow velocity through rotameter and magnetic flow meter.
5. To demonstrate temperature of forceby using strain gauge.
6. To demonstrate temperature pressure measurement through dead weight tester.
7. To demonstrate temperature measurements of speed of machine elements.
8. To demonstrate temperature measurement of temperature by using optical pyrometer.

## 4. Books Recommended:


1. O. E. Doeblin and D. N. Manik, Measurements System, 7th Edition, McGraw Hill, 2019
2. Richard S. Figiliola,Theory and Design for Mechanical Measurements; 6thEdition, Wiley India, 2015
3. D. S. Kumar, Mechanical Measurement and control,5th edition, Metropolitan Book Co. (P) Ltd., (2015)
4. A. K. Sawhney and Puneet Sawhney, A Course in Mechanical Measurements and Instrumentation and Control, Dhanpat Rai & Co., 2017
5. R. K. Rajput, Mechanical Measurements and Instrumentation, Kataria and sons, 2013

# Teaching Scheme: B. Tech. (Mechanical Engineering) II Year

**SEMESTER - IV**

| Sr. No. | Subject | Code | Scheme | Exam Scheme | | | | Total | Credit |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Tuto. | Pract. | | |
| | | | | Hrs. | Marks | Marks | Marks | | |
| 1. | Fluid Mechanics | ME202 | 3 – 1 – 2 | 3 | 100 | 25 | 50 | 175 | 05 |
| 2. | Heat Transfer | ME204 | 3 – 1 – 2 | 3 | 100 | 25 | 50 | 175 | 05 |
| 3. | Machine Design and Drawing | ME206 | 4 – 0 – 4 | 3 | 100 | - | 100 | 200 | 06 |
| 4. | Dynamics of Machines | ME208 | 3 – 1 – 2 | 3 | 100 | 25 | 50 | 175 | 05 |
| 5. | Industrial Engineering | ME212 | 3 – 0 – 0 | 3 | 100 | - | - | 100 | 03 |
| | | Total | 16 – 3 – 10 | 15 | 500 | 75 | 250 | 825 | 24 |

**Fluid Mechanics**

**ME202**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 1 | 2 | 05 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Predict the performance of prototype using dimensionless numbers. |
| CO2 | Apply continuity equation in Cartesian and cylindrical coordinate system. |
| CO3 | Compute local velocity and acceleration of complex fluid flow domain. |
| CO4 | Solve fluid dynamic problems applying Navier-Stoke's equation and its reduced form |
| CO5 | Evaluate fluid flow properties for laminar/turbulent flow through pipes and parallel plates |
| CO6 | Design piping system for water distribution |

## 2. Syllabus

- **FLUID KINEMATICS** **(12 Hours)**
  Velocity Field, Steady and unsteady Flows, One, Two and Three Dimensional Flows, Uniform and non-uniform flows, Steam Lines and Stream Tubes, Path Lines and Streak Lines, Euler and Lagrangian Methods, Substantial Derivative and Acceleration, Translation, Rotation and Deformations, Vorticity , Rotational and Irrotational flows, Circulation, Velocity Potential function, Equation of Continuity in differential form for Cartesian and cylindrical coordinate system, Equation of Stream Line, Discharge in Terms of Steam Function, Stream Function and Velocity Potential function, Laplace Equation in terms of Stream Function and Velocity Potential function, Boundary Conditions, Flow Nets, Differential and Integral Approach Applied to Conservation of Mass, Momentum and Energy Principles..

- **FLUID DYNAMICS** **(10 Hours)**
  Newton's Laws of Motion, Reynold's Transport Theorem, Euler's Equation, Bernoulli's Equation, Flow Through Confined Passages, Navier-Stokes Equation, Exact solution of Navier-Stokes Equation for simple flows. Vortex flow, Free vortex flow and forced vortex flow.

- **DIMENSIONAL ANALYSIS** **(04 Hours)**
  Dimensions, Dimensional Homogeneity, Buckingham-π Theorem, Dimensional Grouping, Non - Dimensional Numbers, Geometrical, Kinematics and Dynamic Similarity.

- **LAMINAR AND TURBULENT FLOWS** **(06 Hours)**
  Concepts of Laminar an Turbulent Flows, Laminar Flow Through Round Pipes, Laminar Flow between Parallel Plates for Moving and Stationary plates, Measurement of Viscosity. Concept of Eddy Viscosity, Prandtle's Mixing Length Theory, Viscous Sub layer, Smooth and Rough Pipe s, Nickuradse Experiment, Moody's Chart.

- **PIPE SYSTEMS** **(05 Hours)**
  Major and Minor losses in pipes, Losses in Fittings, Power Transmission Through Pipes, Pipes connected in Series and Parallel, Branched Pipes, Total Energy line and Hydraulic Gradient Lines. Water distribution system.

- **BOUNDARY LAYER THEORY** **(05 Hours)**

Concept of Boundary Layer, Boundary Layer over Flat Plates and Tubes, Boundary Layer Parameters, Boundary Layer Thickness, Momentum Thickness, Displacement Thickness, Von - Karman Momentum Integral Equation, Boundary Layer Separation and Control, Concept of Drag, Streamlined and Bluff Bodies.

**(Total Lecture Hours: 42)**

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## 3. Practicals:

1. Flow of an Incompressible Fluid through an Orifice meter and its calibration for measurement of discharge.
2. Flow of an Incompressible Fluid through a Nozzle meter and its calibration it for measurement of discharge.
3. Flow of an Incompressible Fluid through a Venturi Meter and its Calibration for measurement of discharge.
4. Flow of an Incompressible Fluid through a Centrifugal Head Meter and its Calibration for measurement of discharge.
5. Forced Vortex flow of water in the vessel.
6. Variation of friction factor with Reynolds number for Laminar flow through circular pipe
7. Variation of friction factor with Reynolds number for Turbulent flow through circular pipe
8. Determination of the velocity distribution in circular pipe.
9. Study of types of Pipes, Pipe symbols, Pipe Fittings and Valves.

## 4. Books Recommended:


1. F. M. White, Fluids Mechanics, McGraw -Hill Inc., 2015.
2. V. L. Streeter, E. B. Wylie, Fluid Mechanics, McGraw -Hill Book Co. Inc., 2001.
3. A. K. Mohanty, Fluid Mechanics, Prentice -Hall India Private Ltd., 2004.
4. J. F. Douglas, J. M. Gasiorek, J. A. Swaffield, Fluid Mechanics, Pearson Education Pvt. Ltd., 2001.
5. S. K. Som, G. Biswas, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill Co. Pvt. Ltd., 2017.

**Heat Transfer**

**ME204**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 1 | 2 | 05 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Apply appropriate mode of heat transfer while analysing complex engineering problems. |
| CO2 | Compute steady state and transient heat conduction problems in slab, cylindrical and spherical systems. |
| CO3 | Explore various Nusselt number correlations for forced and free convection systems. |
| CO4 | Calculate surface to surface radiative heat transfer in engineering systems. |
| CO5 | Investigate the performance of heat exchanger using LMTD and NTU-effectiveness methods. |

## 2. Syllabus

- **INTRODUCTION** **(01 Hours)**
  Modes of heat transfer, conduction, convection and radiation.

- **CONDUCTION** **(14 Hours)**
  Fourier's law. General three-dimensional heat conduction equation in Cartesian, cylindrical and spherical co -ordinates. One-dimensional steady conduction through plane wall, cylinder and sphere. Contact Resistance. Critical radius of insulation. Heat source systems in plane wall and cylinder. Heat conduction through extended surface. Effectiveness and fin efficiency. Derivation of governing differential equation (GDE) for pin fin. Solution GDE of pin fin subjected to different boundary conditions. Heat flow rate from finned system. One-dimensional unsteady state heat conduction. Lumped heat capacity analysis. Analysis of system with considerable temperature gradient. Heisler and Grober charts.

- **CONVECTION** **(14 Hours)**
  Forced Convection: Governing Differential Equation, Dimensionless number and their physical significance, Internal forced convection, External forced convection, Flow over tube banks, Reynolds analogy and Colburn analogy. Free Convection: Governing Differential Equation, Dimensionless number and their physical significance, Empirical relations for plate and cylinder and their use. Combined natural and forced convection. Fundamentals of boiling & condensation heat transfer.

- **RADIATION** **(07 Hours)**
  Thermal radiation, monochromatic and total emissive power. Basic laws of radiation. Radiation shape factors, black and grey surfaces, heat transfer in presence of re-radiating surfaces.

- **HEAT EXCHANGERS** **(06 Hours)**
  Basic types of heat exchangers, fouling factors, LMTD, Effectiveness – NTU methods of design**.**

**(Total Lecture Hours: 42)**

## 3. Practicals:

1. To calibrate copper constantan of thermocouple.
2. To plot temperature distribution and analyse heat transfer through composite wall.
3. To determine thermal conductivity of insulating powder.
4. To find and compare heat transfer coefficient in natural convection
5. To assess emissivity of circular surface
6. To determine and compare heat transfer coefficient in internal forced convection phenomena.
7. To compute Stefan Boltzmen constant value
8. To determine pin-fin efficiency in natural and forced convection.
9. To calculate the overall heat transfer coefficient in shell and tube heat exchanger.

## 4. Books Recommended:


1. S. P. Sukhatme, Heat Transfer, Universities Press, 20012.
2. J. P. Holman, Heat Transfer, McGraw Hill, 2017.
3. Y. A. Cengel, A. J.Ghajar, Heat and Mass Transfer, McGraw Hill, 2017.
4. N. V. Suryanarayana, Engineering Heat Transfer, Penram International Publishing, 2015.
5. R. C. Sachdeva, Fundamentals of Heat and Mass Transfer, New Age International Publications, 2012.

## Machine Design and Drawing

## ME206

| L | T | P | Credit |
|---|---|---|---|
| 4 | 0 | 4 | 06 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Describe the theories of stress and strain |
| CO2 | Explain the basic principles of machine design and drawing considerations. |
| CO3 | Design machine elements for dynamic considerations. |
| CO4 | Design screws, fasteners, riveted, bolted and welded joints. |
| CO5 | Design mechanical springs, shafts and shaft components |

## 2. Syllabus

- **THEORIES OF STRESS AND STRAIN** **(10 Hours)**
  Concept of stress and strain and their relationships, equilibrium equations, strain displacement relation, simple beams, bending moments, shear forces and stresses in beams. torsion, energy methods.

- **COMBINE LOADING AND THEORIES OF FAILURE** **(10 Hours)**
  Combined stresses, mohr's circle diagram for stress and strain rosettes. theories of failure, stresses in thin and thick cylinders.

- **DESIGN CONSIDERATIONS** **(05 Hours)**
  Introduction to design procedure, design requirements and material selection, review of force analysis concepts, factor of safety concepts, concept and mitigation of stress concentration.

- **DYNAMIC LOADING** **(05 Hours)**
  Cyclic loading, endurance limit, fatigue and thermal stresses, creep.

- **DESIGN OF MECHANICAL ELEMENTS**
  **Screws, Fasteners, and Design of Joints** **(12 Hours)**
  Threaded fasteners and power screws, design of welded, riveted and bolted joints, knuckle and cotter joints.
  **Shafts and Shaft Components** **(07 Hours)**
  Design of keys, splines, shafts and shaft couplings.
  **Mechanical Springs** **(07 Hours)**
  Stresses in helical springs, curvature effect, deflection of helical springs, spring materials, helical compression spring design for static service, fatigue loading, extension and leaf springs.

**(Total Lecture Hours: 56)**

## 3. Practicals:

**Machine Drawing Practice**

1. DETACHABLE FASTENERS: Specifications of screw threads and threaded fasteners, foundation bolts; shaft couplings, knuckle and cotter joints.
2. PERMANENT FASTENINGS: Rivets and riveted joints, types of welds and welded joints, and representation of welds on drawings.
3. ASSEMBLY DRAWINGS: Review of sheet preparation: boundary lines, zones, title block, revision panel, parts list, numbering of components and associated detail drawings; assembly drawing practices, exposure to CAD software.
4. COMPONENTS DRAWING: Use of tolerances, tolerance dimensioning, general tolerances; Surface quality symbols: Terminology and representation on drawings, correlation of tolerances and surface quality with manufacturing techniques, detail drawing practices: I.C. Engine parts, boiler mounting accessories.

## 4. Books Recommended:


1. S. P. Timoshenko and D. H. Young, Elements of Strength of Materials, 5th Edition, East-West Press Pvt. Ltd., 2009.
2. R. G. Budynas and K. Nisbett, Shigley's Mechanical Engineering Design, $11^{th}$ Edition, McGraw Hill, 2020.
3. V. B. Bhandari, Design of Machine Elements, $4^{th}$ Edition, Tata McGraw Hill, 2016.
4. R. L. Norton, Machine Design, $5^{th}$ Edition, Pearson Education India Ltd., 2014.
5. N. D. Bhatt and V. M. Panchal, Machine Drawing, $48^{th}$ Edition, Charotar Publishing House, 2013.

**Dynamics of Machines**

**ME208**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 1 | 2 | 05 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Understand the conditions of the static equilibrium and free body diagrams and analyse different types of governors. |
| CO2 | Apply the knowledge of static and dynamic force analysis in existing mechanisms |
| CO3 | Apply the concept of balancing for rotating and reciprocating unbalanced masses |
| CO4 | Analyze the stability of automobile, naval ship and other related devices considering gyroscopic effect. |
| CO5 | Design and analysis of the flywheel considering turning moment diagram, |

## 2. Syllabus

- **INTRODUCTION** **(09 Hours)**
  Forces, couples, conditions of static equilibrium, free body diagrams, analysis of mechanisms, spur gears, worm gears.

- **STATIC AND DYNAMIC FORCE ANALYSIS** **(11 Hours)**
  Inertia forces, analysis of a floating link, rotation, method of virtual work. Dynamic analysis of Four-link mechanism, combined static and inertia force analysis of different mechanisms, Turning moment diagrams, fluctuation of speed and energy, flywheels, Inertia force analysis of simple mechanisms.

- **BALANCING** **(09Hours)**
  Introduction, static balancing, dynamic balancing of several masses in different planes. Balancing of inline engines, V-engines, radial engines, balancing machines.

- **GOVERNORS** **(08 Hours)**
  Introduction, types of governors, sensitiveness of a governor, hunting, isochronisms, stability, effort and power of a governor, controlling force.

- **GYROSCOPE** **(05 Hours)**
  Angular velocity, angular acceleration, gyroscopic couple, gyroscopic effect on naval ships, stability of an automobile, stability of a two wheel vehicle.

**(Total Lecture Hours: 42)**

## 3. Practicals:

1. To determine mass moment of inertia of connecting rod by compound pendulum mentioned.
2. To determine mass moment of inertia of connecting rod by bifiller method.
3. To determine mass moment of inertia of connecting rod by trifiller method.

4. To balance multi-rotor system by experimental and validation with analytical and graphical method.
5. To prepare the performance characteristic curves on Porter governor.
6. To prepare the performance characteristic curves on Proell governor.
7. To prepare the performance characteristic curves on Watt governor.
8. To find the gyroscopic couple acting on rotating disc.

## 4. Books Recommended:


1. S. S. Rattan, Theory of Machines, McGraw Hill Education (India) Private Limited, 2009.
2. J.E. Shigley, J. J. Uicker and G. R. Pennock, Theory of Machines and Mechanisms, 3 rd Edition, Oxford University Press, 2005.
3. R. S. Khurmi and J. K. Gupta, Theory of Machines, S. Chand and Company Ltd., 2003.
4. J.S. Rao, and R.V. Dukkipati, Mechanism and Machine Theory, Wiley Eastern Ltd.,1989
5. A. Ghosh and A. K. Malick, Theory of Mechanisms and Machines, 3rd Edition, East West Press Pvt. Ltd., 2000.

## Industrial Engineering

## ME212

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs)

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain the basics of industrial engineering, identify the factors influencing productivity and evaluate the productivity. |
| CO2 | Apply the tools of method study and time study for creating the improved process and timing for doing a job. |
| CO3 | Explain and analyse the factors affecting the plant layout and location decisions. |
| CO4 | Apply qualitative and quantitative techniques for solving the problems of forecasting. |
| CO5 | Apply deterministic and probabilistic inventory control models for evaluating the inventory level. |
| CO6 | Explain the production systems and functions of production planning and control. |

## 2. Syllabus

- **INDUSTRIAL ENGINEERING AND PRODUCTIVITY** (**04 Hours**)
  Introduction, history, objectives, organization structure, scope, Productivity, factors influencing productivity, Productivity measurement, causes of low productivity and techniques of their elimination, Introduction to advance industrial engineering techniques.
- **WORK STUDY AND ERGONOMICS** (**10 Hours**)
  History, Scope, Objectives, Overview, Method study Objectives and procedure, Micro motion study, Method study tools, Time study procedure, Performance rating, Allowances, Predetermined Motion Time Systems (PMTS), Work Sampling, Ergonomics, Work science, Design factors, Effect of environment, Man-Machine System, Workload and Fatigues.
- **PLANT LOCATION AND LAYOUT** **(07 Hours)**
  Factors affecting location decisions, Methods of evaluating location alternative, Layout types, Work cells, Repetitive and product oriented layout, Computerized layout design procedure
- **FORECASTING** **(06 Hours)**
  Steps, qualitative and quantitative approaches, Monitoring and controlling forecast, Forecasting in service sector
- **INVENTORY CONTROL** **(07 Hours)**
  Managing inventory, Inventory models for independent demand, Probabilistic models and safety stock, Single period model, Fixed period model
- **PRODUCTION PLANNING AND CONTROL (PPC)** **(04 Hours)**
  Production Systems, Job, Batch, Mass and Continuous production system, Objectives of PPC, Functions of PPC

- **HUMAN RESOURCE MANAGEMENT** **(04 Hours)**

  Functions of Human Resource Manager, Training and development, Job evaluation and Merit rating, Wage and Wage Incentives, Grievance handling, Discipline and welfare

**(Total Lecture Hours: 42)**

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## 3. Books Recommended:


1. J. Heizer, B. Render, C. Munson, and A.Sachan, Operations Management, 12th Edition, Pearson Education, 2017.
2. E. S. Buffa and R. K. Sarin, Modern Production/ Operations Management, 8th Edition, John Wiley & Sons, 1987.
3. S. Eilon, Elements of Production Planning and Control, 3rd Edition, Universal Publishing Corporation, 1991.
4. N.V. S. Raju, Industrial Engineering and Management, 1st Edition, Cengage Learning, 2013.
5. M. Mahajan, Industrial Engineering and Production Management, 1st Edition, Dhanpat Rai & Co. (P) Limited, 2015.

# Teaching Scheme: B. Tech. (Mechanical Engineering) III Year

**SEMESTER - V**

| Sr. No. | Subject | Code | Scheme | Exam Scheme | | | | Total | Credit |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Tuto. | Pract. | | |
| | | | | Hrs. | Marks | Marks | Marks | | |
| 1. | Fluid Machines | ME301 | 4 – 0 – 2 | 3 | 100 | - | 50 | 150 | 05 |
| 2. | Design of Machine Components | ME303 | 3 – 1 – 2 | 3 | 100 | 25 | 50 | 175 | 05 |
| 3. | Machining Processes | ME305 | 3 – 1 – 2 | 3 | 100 | 25 | 50 | 175 | 05 |
| 4. | Institute Elective –1 | ME3XX | 3 – 0 – 0 | 3 | 100 | - | 00 | 100 | 03 |
| 5. | Core Elective – 1 | ME3AA | 3 – 0 – 0 | 3 | 100 | - | - | 100 | 03 |
| 6. | Seminar | ME307 | 0 – 0 – 2 | 0 | - | - | 50 | 50 | 01 |
| | | Total | 16 – 2 – 8 | 15 | 500 | 50 | 200 | 750 | 22 |

**Institute Elective – 1 (ME3XX)**

1. Plastic and Ceramics: ME361
2. Theory and Application of Fluid Machinery*: ME363
3. Mechatronics: ME365
4. Control System: ME367
5. Engineering Estimation and Costing: ME369

*Except MED students

**Core Elective – 1 (ME3AA)**

1. Computational Fluid Dynamics: M321
2. Maintenance & Safety Engineering:ME323
3. Powder Processing Techniques: ME325
4. Mechanics of Materials: ME327
5. Additive Manufacturing Process:ME329

**Fluid Machines**

**ME301**

| L | T | P | Credit |
|---|---|---|---|
| 4 | 0 | 2 | 05 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Illustrate selection and application of various hydraulic and steam turbines |
| CO2 | Explain the working principles of hydraulic pumps, and predict performance curves |
| CO3 | Describe the working principles of steam power cycles |
| CO4 | Explain working principles of steam nozzle |
| CO5 | Explore various steam condenser, and cooling towers |
| CO6 | Describe basic principles of pumps, fans, blowers and compressors |

## 2. Syllabus

- **FUNDAMENTALS OF FLUID MACHINES** **(04 Hours)**
  Classification of fluid machines, Impulse momentum principle, Basic equation of energy transfer in a fluid machines.

- **HYDRAULIC TURBINES** **(12 Hours)**
  Classification, Pelton, Francis, Kaplan, Propeller turbines, Velocity triangles, power and efficiency calculations, draft tube, cavitation, Thoma's cavitation factors

- **HYDRAULIC PUMPS** **(12 Hours)**
  Classification of different type of pump, principle of dynamic action & positive displacement type of pump, various parts of centrifugal pump & their function, theoretical analysis of energy transfer between fluid & rotor, losses, various efficiencies of the pump, performance characteristics, matching of pump & system characteristics, model analysis of centrifugal pump & specific speed, cavitation in pump & maximum suction lift.

- **STEAM POWER CYCLES** **(05 Hours)**
  Simple steam power cycle, Rankine cycle, Rankine cycle efficiency, Comparison of Rankine & Carnot cycles. Reheat cycle, Regenerative cycle, Reheat -regenerative cycle, Cogeneration.

- **STEAM NOZZLES** **(05 Hours)**
  Introduction, Types of Nozzles, Flow of steam through nozzles, Expansion of steam considering friction, Nozzle efficiency, Super-saturated flow through nozzle, Examples.

- **STEAM TURBINES** **(08 Hours)**
  Introduction of steam and water turbine, Classification and general constructional features, Compounding of turbine. Impulse Turbine: Working principle, Forces on blades, Velocity diagrams, efficiency of multi stage turbine, Specific speed and performance characteristic curves for water turbine. Impulse Reaction Turbine: Working principle, Degree of reaction, Parson's reaction turbine, height of blade, Cavitation and performance characteristic curves for water turbine.

- **STEAM CONDENSOR AND COOLING TOWER** **(04 Hours)**

Introduction, Elements of steam condensing plant, Types of steam condensers, Thermodynamic analysis of condenser, Cooling towers.

- **FANS, BLOWERS AND COMPRESSORS (06 Hours)**
  Construction and classification, governing equation, losses, performance curves, Positive displacement, Centrifugal and axial flow compressor, Components & their functions, velocity triangle, Performance, Slip factor, pre whirl, Choking, Surging & stalling, Degree of reaction.

**(Total Lecture Hours: 56)**

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## 3. Practicals:

1. Study of Modern Steam Power Plant.
2. Estimation of power output & efficiency of a steam turbine.
3. Study of condenser and cooling tower.
4. Impact of jet on vanes.
5. Performance test on gear pump.
6. Performance test on jet pump.
7. Performance test on centrifugal pump.
8. Study and performance of water turbines.
9. Study of compressors.

## 4. Books Recommended:


1. S. Domkundwar, C.P. Kothandaraman and A.V. Domkundwar, A Course in Thermal Engineering, Dhanpat Rai and Co, 2018
2. J. Lal, Hydraulic Machines including Fluidics, Dhanpat Rai & Co, 2016.
3. S. K. Som, G. Biswas, S. Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, McGraw Hill, 2017
4. P.K. Nag, Power Plant Engineering, Tata McGraw Hill Publications, 2017
5. S.M.Yahya, Turbines, Compressors and Fans, Tata McGraw Hill, 2017.

## Design of Machine Components

| L | T | P | Credit |
|---|---|---|---|
| 3 | 1 | 2 | 05 |

**ME303**

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Apply the statistical considerations in machine design. |
| CO2 | Design and analysis of power transmission elements. |
| CO3 | Design of different types of clutches and brakes. |
| CO4 | Design of different types of bearings and I. C. Engine components. |
| CO5 | Design of miscellaneous machine elements. |

## 2. Syllabus

- **STATISTICAL CONSIDERATIONS IN MACHINE DESIGN (03 Hours)**
  Probabilistic approach to design, statistical analysis of tolerances, reliability, statistical factor of safety, MTBF, reliability of systems in series and parallel.

- **DESIGN OF POWER TRANSMISSION ELEMENTS (17 Hours)**
  Design of belt drives, selection of flat and V- belts, design of pulleys and flywheels, design of gear drives – spur, helical, bevel and worm gear drives, design of single and multistage speed reducers. Design of gear boxes: Types of gear boxes, design of machine tool gear boxes using preferred numbers.

- **DESIGN OF CLUTCHES AND BRAKES (05 Hours)**
  Types of clutches, design of single and multiple plate clutches, cone and centrifugal clutch, design of block brake, pivoted shoe brake, long shoe brake, internal shoe brake, simple and differential band brake.

- **DESIGN OF BEARINGS (08 Hours)**
  Design of hydrodynamic journal bearings, classification, material selection, Sommerfeld number and use of charts for the estimation of minimum film thickness, temperature rise, flow quantity etc. design of pressure fed and self-contained bearings, rolling contact bearings, classification, selection factors affecting bearing life, bearing assembly and lubrication.

- **MISCELLANEOUS MACHINE ELEMENTS (05 Hours)**
  Selection of steel wire rope for hoists and cranes, crane hooks, design of pressure vessels: thin and thick cylinder, stresses and types of failures.

- **DESIGN OF I.C. ENGINE COMPONENTS (04 Hours)**
  Piston, cylinder and connecting rod.

**(Total Lecture Hours: 42)**

## 3. Practicals:

1. Drawing of involute gear profile.
2. Design of spur gear.
3. Design of helical gear.
4. Design of journal bearing.
5. Design of two stage speed reducer gear box with its kinematic arrangement.
6. Design and drawing of automobile clutch of any of the following:
    a. Plate clutch,
    b. Centrifugal clutch,
    c. Multi-plate clutch.
7. Design and drawing of the any of the brake from following:
    a. External expanding brake,
    b. Internal expanding brake,
    c. Differential band brake.
8. Design and drawing of hook block.
9. Selection and mounting of rolling element bearing.
10. Design of bevel gear.

## 4. Books Recommended:


1. R. G. Budynas and K. Nisbett, Shigley's Mechanical Engineering Design, 11th Edition, McGraw Hill, 2020.
2. V. B. Bhandari, Design of Machine Elements, 4th Edition, Tata McGraw Hill, 2016.
3. R. L. Norton, Machine Design, 5th Edition, Pearson Education India Ltd., 2014.
4. M. F. Spotts, Design of Machine Elements, Pearson Education India Ltd., 2004.
5. R. C. Juvinall and K. M. Marshek, Fundamentals of Machine Component Design, 6th Edition, Wiley, 2017.

**Machining Processes**

**ME305**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 1 | 2 | 05 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain mechanics of chip formation and types of chips. |
| CO2 | Explain relationship between chip formation and generation of stress, strain, force and wear. |
| CO3 | Describe conventional machining processes, geometry of cutting tools, and mechanism of conventional machine tools. |
| CO4 | Select machining process(es), cutting tool(s) and machine tool(s) to produce a given part. |
| CO5 | Calculate machining time incurred in machining a part if machining parameters and part dimensions are given. |
| CO6 | Explain working principle and machine setup of unconventional machining processes. |

## 2. Syllabus

- **MECHANICS OF MACHINING (10 Hours)**
  Mechanism of chip formation, types of chips, chip breakers, Marchant circle diagram, cutting forces and power, tool wear and tool life; machinability; economics of machining; cutting tool materials; types of tools.

- **CONVENTIONAL MACHINING PROCESSES (16 Hours)**
  Introduction to Turning, shaping, planning, milling, drilling, broaching processes; types of machines and operations; different mechanisms on the machine; tool and work holding devices; special attachments; capstan and turret machine; automats; machining time calculations.

- **FINISHING PROCESSES (06 Hours)**
  Introduction to grinding, types of machines and operations, dressing and trueing, glazing, designating system, selection of grinding wheel, lapping, honing, super finishing processes.

- **THREAD AND GEAR MANUFACTURING PROCESSES (05 Hours)**
  Thread manufacturing by thread milling and thread grinding. Gear milling, hobbing and finishing.

- **INTRODUCTION TO UNCONVENTIONAL MACHINING PROCESSES (05 Hours)**

**(Total Lecture Hours: 42 Hours)**

## 3. Practicals:

1. Machining Practices on lathe for step turning, taper turning, grooving, thread cutting operations.
2. Machining practices on shaping and drilling machine.
3. Machining practices on milling machine to cut spur or helical gear.

4. Calculation of shear plane angle under different machining conditions.
5. Measurement of chip tool interface temperature under different machining conditions.
6. Grinding Practice of single point cutting tool and measure tool angles.
7. Demonstration of Capstan lathe.
8. Demonstration of EDM process.

## 4. Books Recommended:


1. H.M.T., Production Technology, Tata McGraw-Hill Education, 2004.
2. S. K. Hajra Choudhury, Element of Workshop Technology, Vol. 2, 14th Edition, Media Promoters and publishers Pvt., 2010.
3. V. K. Jain, Advanced machining processes. Allied publishers, 2009.
4. A. B. Chattopadhyay, Machining and Machine Tools, 2nd Edition, John Wiley & Sons, 2017.
5. S. Kalpakjian, S. R. Schmid, Manufacturing Engineering and Technology, 7th Edition, Pearson, 2018

**Plastics and Ceramics**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

**ME361**

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Describe fundamentals of plastic and ceramic materials. |
| CO2 | Identify the importance of manufacturing processes used to manufacture plastic and ceramic products. |
| CO3 | Establish design guidelines and testing associated with production of plastic products. |
| CO4 | Analyze plastic recycling and waste management practices. |
| CO5 | Distinguish sintering mechanisms considered for ceramic materials. |
| CO6 | Compile properties of various plastic and ceramic materials and its comparison with other classes of materials. |

## 2. Syllabus

- **INTRODUCTION (06 Hours)**
  Classification of materials, history of plastic materials, comparison of plastics with other engineering materials. Classification of plastics, thermoplastic, thermoset plastics, elastomers and polymers. Polymer structures, polymerization, properties of polymers, additive methods to modify polymers. National and International organizations dealing with plastic materials.

- **PROCESSING OF PLASTICS (10 Hours)**
  Injection molding, extrusion molding, blow molding, rotational molding, vacuum molding, thermoforming, compression molding, resin transfer molding, calendaring process, etc. Secondary processes for plastics i.e. machining, joining, painting, etc. Defects during processing of plastic products.

- **DESIGN AND TESTING OF PLASTICS PRODUCTS (06 Hours)**
  Commodity plastics, engineering plastics, speciality plastics. Design guidelines for products, design guidelines for various processes, importance of mold making. Concept of testing, specification and standards. Overview of various tests, significance of important thermal and mechanical properties of plastic materials.

- **PLASTICS RECYCLING AND WASTE MANAGEMENT (05 Hours)**
  Applicability and statistics of plastics in various sectors. Issues and challenges with plastics. Impact of plastics on environment and its remedies. Utility of plastics wastes, waste management practices, plastic recycling processes. Case studies for recycling and waste management.

- **CERAMIC MATERIALS (06 Hours)**
  Introduction to ceramic materials, history of ceramic materials, comparison of ceramics with other engineering materials. National and International organizations dealing with ceramics. Atomic bonding and crystal structures in ceramics, traditional and engineering ceramics, classification of ceramics based on properties and applications. Factors affecting properties of ceramics.

- **PROCESSING OF CERAMICS (09 Hours)**
  Material selection. Powder making processes. Processing of ceramic materials i.e. slip casting process, ceramic injection molding, tape casting process, etc. Significance of sintering in

ceramics, sintering mechanisms, stages during sintering, Importance of phase equilibrium diagrams, Gibbs phase rule, silica phase diagram, phase diagrams for other ceramics.

**(Total Lecture Hours: 42)**

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## 3. Books Recommended:


1. T. L. Szabo, Plastics – Inside Out, 3rd Edition, Elsevier Butterworth-Heinemann, 2005.
2. R. J. Crawford and P. J. Martin, Plastics Engineering, 4th Edition, Elsevier Butterworth-Heinemann, 2020.
3. J. R. Fried, Polymer Science and Technology, 3rd Edition, Prentice Hall, 2014.
4. M.W. Barsoum, Fundamentals of Ceramics, 2nd Edition, CRC Press, 2019.
5. M. N. Rahaman, Ceramic Processing and Sintering, 2nd Edition, CRC Press, 2003.

**Theory and Applications of Fluid Machinery**

**ME363**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Classify fluid machines and explain the concept and performance parameters of fluid machines |
| CO2 | Explain the construction and working of fan and blowers and select the appropriate machines for different applications |
| CO3 | Identify types of compressors, calculate various performance parameters and analyze the performance characteristics |
| CO4 | Compare the working of different types of pumps and evaluate the performance of pumps, Select the appropriate pump for suitable application |
| CO5 | Classify hydraulic turbines, investigate velocity triangles and analyze the function of various components and cavitation phenomena |
| CO6 | Identify measuring and performance parameters, Calculate the performance parameters, Evaluate the performance of fluid machines |

## 2. Syllabus

- **INTRODUCTION TO FLUID MACHINES (08 Hours)**
  Classification of fluid machines: Positive displacement type and dynamic type machinery; Impulse type and reaction type machinery; reciprocating, radial, mixed and axial flow machines, Basic fluid mechanics of fluid machines, The torque momentum and head momentum equations; one dimensional theory and its limitations, specific work and its representation on T-s and h-s diagrams; losses and efficiencies; energy transfer in fluid machines

- **FANS AND BLOWER (06 Hours)**
  Classification and Construction; performance analysis: Power required, pressure rise, efficiency calculations; characteristic curves and selection, fan drives and fan noise. Applications in boilers, cooling towers, and other industrial applications

- **COMPRESSORS (06 Hours)**
  Centrifugal Compressors: Construction and working, Types, performance: work done and pressure rise; Slip; Compressibility effects; Surging and choking of compressors; Compressor characteristics and applications.
  Axial Flow Compressors: Working, performance parameters: Stage pressure rise; polytrophic efficiency, degree of reaction; Surging and stalling of compressors; Compressor performance and characteristic curves, Off design performance and applications.

- **PUMPS (08 Hours)**
  Main elements and their functions, Various types and classification, Pressure changes in a pump - suction, delivery and manometric heads, head-capacity relationships, losses, pump output and efficiency, Minimum starting speed, Priming and priming devices, Multistage pumps - series and parallel arrangement; submersible pumps, Axial and mixed flow pumps: Construction and operation, NPSH and cavitation in pump.

- **HYDRAULIC TURBINES** **(08 Hours)**
  Classification, Pelton, Francis, Kaplan, Propeller turbines, Velocity triangles, power and efficiency calculations, draft tube, cavitation, Thoma's cavitation factors

- **PERFORMANCE CHARACTERISTICS OF FLUID MACHINES** **(06 Hours)**
  Pressure, temperature, velocity, head, capacity, and power measurement, model testing, similarity laws, unit quantities, specific quantities, main operating and constant efficiency curve.

**(Total Lecture Hours: 42)**

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## 3. Books Recommended:


1. S. R. Gorla Rama, A.A. Khan, Turbomachinery Design and Theory, CRC Press- Taylor and Francis Group, 2011.
2. S. Ramachandran, R. Devaraj, Y.V.S. Karthick, Fluid Machinery, Airwalk Publications, 2017.
3. S.M.Yahya, Turbines, Compressors and Fans, Tata McGraw Hill, 2017.
4. A.T. Sayers, Hydraulic and compressible flow turbomachines. McGraw-Hill Publishing Co., 1990.
5. V. Kadambi and M. Prasad, An introduction to energy conversion, New Age International Private Limited, 2011.

**Mechatronics**

**ME365**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain the basic elements of mechatronics system. |
| CO2 | Analyze the functioning of sensors, transducers and actuators. |
| CO3 | Analyze and evaluate the electronic elements such as digital circuits, AD convertors, etc. |
| CO4 | Explain the basics of PLC programming |
| CO5 | Develop a mechatronic system using the gained knowledge. |

## 2. Syllabus

- **INTRODUCTION TO MECHATRONICS (01 Hour)**

- **MECHATRONIC SYSTEM ELEMENTS (04 Hours)**
  Measurement system, Control system, Microprocessor based controllers & its applications, other applications with mechatronic approach, Building blocks of mechatronic system.

- **SENSORS & TRANSDUCERS (09 Hours)**
  Classification, Performance terminologies, Displacement, Position & proximity sensors, Photo detectors, Optical encoders, Pneumatic sensor, Hall effect sensor, Velocity & motion sensors: Incremental encoder, Tachogenerator, Piezo electric sensors, Tactile sensors, Flow & temperature sensors: Ultrasonic sensors, Light sensors, Selection of sensors, Interference & noise in measurement.

- **ACTUATION SYSTEMS (10 Hours)**
  Pneumatic & hydraulic actuation systems: System configuration, Control System & its elements, Linear actuators, Rotary actuators. Mechanical actuation: System types & its configuration, fixed ratio type, Invariant motion profile type, variator etc. Electrical actuation system types & configurations, Mechanical switches, Solid state switches, Solenoids.

- **DIGITAL CIRCUITS (08 Hours)**
  Boolean algebra combinational circuits. (Adders, Subtractors, encoders, decoders, multiplexers, de – multiplexers, memory units: RAM, ROM, EPROM etc.), Sequential circuits (Latches, Flip-flops, Counters, Registers).

- **ANALOG SIGNAL PROCESSING (06 Hours)**
  Amplifiers, Operational amplifiers, Ideal model for operational amplification, Inverting amplifier, Non-inverting amplifier, Summer, Difference amplifier, Instrumentation amplifier, Integrator, Differentiator, Sample & hold circuit, Comparator, Basics of filters, Types of filters, Introduction to A/D and D/A converters.

- **ELECTRONIC SYSTEM DESIGN (04 Hours)**
  Introduction to MPU & MCU, Assembly programming, Interfacing, Introduction to PLC & basics of PLC programming.

**(Total Lecture Hours: 42)**

## 3. Books Recommended:


1. D. Shetty, A. R. Kolk, Mechatronic System Design, 2nd Edition, PWS Publicity Boston, 2010.
2. W. Bolton, Mechatronics, 4th Edition, Pearson Education (India), 2011.
3. HMT Ltd., Mechatronics, 1st Edition, Tata McGraw Hill Publication, 2002
4. D. Necsulescu, Mechatronics, Pearson Education (Singapore), 2002.
5. M. Mano, Digital Logic & Computer Design, 4th Edition, Pearson, 2016.

**Control Systems**

**ME367**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain the theory and applications of control systems and draw block diagrams techniques, signal flow graphs of linear systems and their controlling actions. |
| CO2 | Apply the knowledge of control systems components for hydraulic and pneumatic applications. |
| CO3 | Apply the concept of standard test signals and transient response of first and second order systems, evaluate the sources of static and dynamic error constant. |
| CO4 | Analyze the stability criteria for frequency response. |
| CO5 | Analyze the behavior of closed loop systems using tools such as root locus, Routh Hurwitz, Bode, Nyquist, and Matlab. |
| CO6 | Describe the control system design, Fuzzy logic, fuzzy set and fuzzy control, PLC |

## 2. Syllabus

- **BASIC COMPONENTS OF CONTROL SYSTEM** **(08 Hours)**
  Open loop and Closed loop system – Automatic Control System. Mathematical Modeling, Analogous Models – Mathematical modelling of fluid system and thermal systems – Transfer Function – Block diagram reduction Techniques, signal flow graphs.

- **REPRESENTATION OF PHYSICAL SYSTEM** **(06 Hours)**
  Linear approximation of nonlinear System – position Control system – Stepper motor – Hydraulic systems – pneumatic systems – Inertial navigation system – Applications.

- **MODES OF CONTROLS** **(06 Hours)**
  Proportional, Integral, Derivative – proportional plus integral – proportional plus Derivative– proportional Plus integral plus derivative controls – examples from Mechanical system.

- **TIME DOMAIN ANALYSIS OF CONTROL SYSTEMS** **(08 Hours)**
  Classifications of time response, systems time response, analysis of steady state error, Standard test signals and transient response of first and second order systems**.** Sources of errors, static and dynamic error constants, Routh Hurwitz Stability Criteria.

- **FREQUENCY RESPONSE** **(06 Hours)**
  Bode Plot – Polar Plot. Stability Analysis – Relative stability

- **DESIGN PRINCIPLES** **(08 Hours)**
  An outline of Control System Design - Control of the A/F ratio in an Automotive Engine – Control of Read/Write Head Assembly of a Hard Disk. Introduction to Fuzzy logic – Fuzzy set – Fuzzy Control – PLC

**(Total Lecture Hours: 42)**

## 3. Books Recommended:


1. G. F. Franklin, Feedback control of Dynamic Systems, 7th Edition, Pearson Education Asia, 2014
2. I. J. Nagrath and M.Gopal, Control System Engineering, 6th Edition, New Age International Pvt Ltd, 2018
3. K. Ogata, Modern Control Engineering, 5th Edition, Pearson Education India, 2015.
4. F. H. Raven, Automatic Control Engineering, 5th Edition, McGraw Hill, 1995
5. J. W. Webb & R. A. Reis, Programmable Logic Controllers: Principles and Applications, 5th Ed, PHI Learning, New Delhi, 2002
6. S. Gosh, Theory & application of control systems, Person Education, 2010

## Engineering Estimation and Costing

**ME369**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Analyze the concept of estimation for various industrial applications.. |
| CO2 | Analyze the concept of cost accounting and control. |
| CO2 | Apply engineering economics and analyze the breakeven point for single and multiple product production cases. |
| CO3 | Demonstrate the effects of depreciation and replacement policy in engineering economic analysis problems. |
| CO4 | Explain the concepts of financial management and accounting. |

## 2. Syllabus

- **ESTIMATING** **(06 Hours)**

  Objectives of estimating –constituents of estimate, mechanical estimating – costing and cost estimation, functions of estimation organization and prerequisites of estimation, estimating such as design and drafting period, time & motion studies, time allowances etc., estimation of material, labour cost, production estimate sheet, advantages & elements of costing, classification of cost elements.

- **COST ACCOUNTING AND CONTROL** (**06 Hours**)

  Cost accounting, elements of cost, factors affecting selling price, fixed cost, variable cost, computation of actual cost, nature of cost, type of cost and cost control

- **ENGINEERING ECONOMICS & BREAK EVEN ANALYSIS** (**10 Hours**)

  Introduction, time value of money, cash flows, taxation concept, tools for engineering economics, models, operation research, value engineering, make and buy decisions, economic batch size, locational economics, benefits cost ratio, break even analysis, analytical and graphical methods, single products and multiple product cases

- **DEPRECIATION AND REPLACEMENT ANALYSIS** **(10 Hours)**

  Concepts, classification, methods of depreciation, comparison of different depreciation method, selection of depreciation methods, obsolescence, reasons for replacement of equipment, development of systematic replacement programme/policy, replacement models, sudden failure, failure tress.

- **FINANCIAL MANAGEMENT AND ACCOUNTING** **(10 Hours)**

  Definitions and functions of financial management, sources of funds, capitals and its classification, capitalization, sourcing of funds, shares, debentures, trade credits, pubic deposits, banking, foreign exchange and trade, nature of accounting, accounting terminology and types, rules for debit and credit, financial ratios, budget and budgetary control

**(Total Lecture Hours: 42)**

## 3. Books recommended:


1. J. Heizer, B. Render, C. Munson, and A. Sachan, Operations Management, 12th Edition, Pearson Education, 2017.
2. M. Mahajan, Industrial Engineering and Production Management, 1st Edition, DhanpatRai & Co. (P) Limited, 2015.
3. B.P. Sinha, Mechanical Estimating and Costing, 1st Edition, Tata McGraw Hill Publishing Co. Ltd., 1995.
4. T.R. Banga and S. C. Sharma, Industrial Organization and Engineering Economics, 24th Edition, Khanna Publishers, 2013.
5. S. K. Sharma and S. Sharma, Industrial Engineering &Organization management, Reprint Edition, S K Kataria and Sons, 2013.

**Computational Fluid Dynamics**

**ME321**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Develop mathematical model for fluid flow and associated transport processes |
| CO2 | Discretize the fundamental equations of flow and other transport processes using finite difference method |
| CO3 | Apply finite volume method for numerical modeling of fluid flow modeling |
| CO4 | Solve two-dimensional incompressible viscous flow problems using stream function-vorticity formulation |
| CO5 | Solve Navier-Stokes equations for incompressible flows using semi-explicit and semi-implicit algorithms |

## 2. Syllabus

- **GOVERNING EQUATIONS FOR FLUID FLOW AND HEAT TRANSFER (06 Hours)**
  Conservation of Mass, Newton's Second Law of Motion, Expanded Forms of Navier stokes equations, Conservation of Energy Principle, Special Forms of the Navier Stokes Equations, Classification of Second order Partial Differential Equations, Initial and Boundary Conditions, Governing Equations in Generalized Coordinates.

- **FINITE DIFFERENCE, DISCRETIZATISON, CONSISTENCY, STABILITY (06 Hours)**
  Elementary Finite Difference Quotients, Basic Aspects of Finite Difference Equations, Errors and Stability Analysis, Some Nontrivial Problems with Discretized Equations

- **FINITE VOLUME METHOD FOR FLUID FLOW MODELING (12 hours)**
  Integral Approach, Discretization of Unsteady, Diffusion, Advection and Source Terms, Advection Schemes: Central Difference Scheme, First Order Upwind Scheme, Second Order Upwind Scheme, QUICK scheme and Other Higher Order Schemes, Finite Volume Solution of Unsteady Advection, Diffusion Problems with Source Term.

- **SOLUTION OF VISCOUS INCOMPRESSIBLE FLOWS BY STREAM FUNCTION – VORTICITY FORMULATION (08 Hours)**
  Two Dimensional Incompressible Viscous Flow, Incorporation of Upwind Scheme, Estimation of Discretization Error, Application to Curvilinear Geometries, Derivation of Surface Pressure and Drag.

- **SOLUTION OF NAVIER -STOKES EQUATIONS FOR INCOMPRESSIBLE FLOWS USING SEMI-EXPLICIT AND SEMI-IMPLICIT ALGORITHMS (10 Hours)**
  Collocated and Staggered Grid, Solution of Unsteady Navier-Stokes Equations using Semi-explicit method, for Collocated and Staggered grid, Momentum Interpolation, SIMPLE Algorithm, Formulation of Coupled Flow with Heat Transfer and Other Scalar Transport.

**(Total Lecture Hours: 42)**

## 3. Books Recommended:


1. D.A. Anderson, Tannehill J.C., Pletcher R.H., Computational Fluid Mechanics and Heat Transfer, CRC Press, 2012.
2. K. Murlidhar, T. Sunderarajan, Computational Fluid Flow and Heat Transfer, Narosa Publisher, 2013
3. J.D. Anderson, Computational Fluid Dynamics, McGraw Hill, 2017.
4. S.V. Patanankar, Numerical Heat Transfer and Flow, Hemispehre Publ. Corporation, 2017.
5. H. K. Versteag, and W. Malalsekara, An Introduction to Computational Fluid Dynamics, Pearson, 2008

**Maintenance and Safety Engineering**

**ME323**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain the principles, functions and practices adapted in industry for the successful management of maintenance activities. |
| CO2 | Apply the knowledge of Predictive maintenance and conditioning monitoring concepts for industrial applications. |
| CO3 | Apply the concept of failure pattern, system reliability: Series, Parallel and Mixed configurations. |
| CO4 | Explain the safety engineering aspects in industry. |
| CO5 | Explain the safety codes and standards. |

## 2. Syllabus

- **OBJECTIVE OF MAINTENANCE** **(09 Hours)**
  Types of maintenance – Breakdown, preventive and predictive maintenance - Repair cycle - Repair Complexity, Lubrication and Lubricants. Maintenance of Mechanical transmission systems and process plants.

- **PREDECTIVE MAINTENANCE** **(09 Hours)**
  Vibration and noise as maintenance tool - wear debris analysis - Condition monitoring concepts applied to industries - Total Productive Maintenance (TPM) - Economics of Maintenance- Computer aided maintenance

- **RELIABILITY** **(09 Hours)**
  Definition, concept of reliability based design, failure rate, MTTF, MTBF, failure pattern, system reliability: Series, Parallel and Mixed configurations - Availability and Maintainability concepts- Applications.

- **SAFETY AND PRODUCTIVITY** **(08 Hours)**
  Causes of accidents in industries – accident reporting and investigation - measuring safety performance - Safety organizations and functions - Factories act and rules.

- **SAFETY CODES AND STANDARDS** **(07 Hours)**
  General Safety considerations in Material Handling equipment - Machine Shop machineries-pressure vessels and pressurized pipelines – welding equipment – operation and inspection of extinguishers – prevention and spread of fire–emergency exit facilities.

**(Total Lecture Hours: 42)**

## 3. Books Recommended:


1. P. Gopalakrishnan, Maintenance and Spare Parts Management, 2nd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2013
2. L. S. Srinath, Reliability Engineering, Affiliated East West press, 2005
3. Rolland P. Blake, Industrial Safety, 3rd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2003.
4. R. C. Mishra and K. Pathak, Maintenance Engineering and Management, 2nd Edition, Prentice Hall of India Pvt.Ltd.,New Delhi, 2012.
5. E. Balagurusamy, Reliability Engineering, McGraw Hill Education, 2017
6. H. P. Garg, Industrial Maintenance, S. Chand & Co Ltd., New Delhi, 2010

**Powder Processing Techniques**

**ME325**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

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## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain the importance of powder processing route of manufacturing process, and compare powder metallurgy products with cast & wrought products. |
| CO2 | Compare different techniques of production, testing and characterization of ceramic and metal powders. |
| CO3 | Describe different methods of conditioning of powders and analyze various techniques of compactions of powder products. |
| CO4 | Describe mechanism of sintering of green powder compacts and secondary & finishing operations in powder processing. |
| CO5 | Explain detailed procedure of manufacturing of selected products by powder processing. |

## 1. Syllabus:

- **INTRODUCTION (06 Hours)**
  History, Basic terms related to powder processing, principle and outline of powder processing techniques, advantages and limitations of powder processing, General characteristics of ceramic and metal powders. Comparison of powder processed parts with cast and wrought products, Design considerations in powder metallurgy.

- **PRODUCTION OF POWDERS (06 Hours)**
  Atomization, variants of atomization, Chemical reduction, Carbonyls, Electrolytic deposition, Mechanical pulverization methods - crushing, milling etc.; vapour condensation, precipitation from chemical solution, high temperature extractive metallurgy processes, production of nano powders, Microencapsulated powders.

- **TESTING & CHARACTERIZATION OF POWDERS (06 Hours)**
  Physical characterization related to powder particles - shapes, size, mesh number, size distribution, surface area, porosity; flow rate, tap density, apparent density, true density, compressibility and friction; chemical characterization related to chemical compositions, phase composition and surface characterization.

- **POWDER CONDITIONING AND HEAT TREATMENT (03 Hours)**
  Alloying, sintering aids, lubricants, plasticizers and binders, mixing and blending, granulation; Equipment for powder conditioning, Heat treatments of powders.

- **COMPACTION OF POWDER PRODUCTS (07 Hours)**
  Conventional die pressing, pressure distribution during conventional die pressing, cold iso-static pressing, powder rolling, powder extrusion, injection moulding, hot iso-static pressing, spray deposition (Osprey process), pressureless compaction, compaction using ceramic molds.

- **SINTERING & SECONDARY OPERATIONS (10 Hours)**

Defects and defect chemistry; Solid state sintering, atomic mechanisms, coarsening, densification, sintering kinetics: sintering stages, coarsening and grain growth growth kinetics; Liquid phase sintering: introduction, the different stages, controlling kinetics and thermodynamic factors; Sintering furnaces and their classifications, batch furnace, continuous furnaces, sintering atmosphere, vacuum sintering. Finishing, machining, infiltration, Repressing, Resizing, Impregnation.

- **SELECTED POWDER PRODUCTS** **(04 Hours)**
  Sintered carbides and carbide tools; Cermets; Dispersion strengthened materials; Automotive-engine bearing cap, Electrical contact materials; Self-lubricating bearings & gears, Filters, Friction materials.

**(Total Lecture Hours: 42)**

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## 3. Books Recommended:


1. R. M. German, Powder Metallurgy and Particulate Materials Processing, MPIF, 2005.
2. K. Hingashitani, H. Makino, S. Matsusaka, Powder Technology Handbook, CRC Press, 2019.
3. A. Upadhyaya, G. S. Upadhyaya, Powder Metallurgy - Science, Technology & Materials, Universities Press, Taylor & Fracis, 2018.
4. P. C. Angelo, R. Subramanian, Powder metallurgy - Science, Technology and Applications, PHI Learning Pvt. Ltd., 2008.
5. B. K. Datta, Powder Metallurgy: An Advanced Technique of Processing Engineering Materials, 2014.

**Mechanics of Materials**

**ME327**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain the mechanical properties of materials |
| CO2 | Illustrate the theoretical basis about the stress, strain and elastic modulus in components. |
| CO3 | Analyze members under uni-axial and axi-symmetric loads. |
| CO4 | Analyze members under torsional and flexural loads. |
| CO5 | Analyze elastic stability of columns |

## 2. Syllabus

- **ANALYSIS OF STRESS AND STRAIN (10 Hours)**
  Introduction: Stress and strain: stress at a point, Cauchy stress tensor, analysis of deformation and definition of strain component, principal stresses and strain, stress and strain invariant, Mohr's circle representation. Hooke's law and its application to isotropic materials, elastic constants and their relationships, plane stress and plain strain conditions.

- **MECHANICAL PROPERTIES (03 Hours)**
  Uniaxial tension test to determine yield and ultimate strength of materials, stress-strain diagram, proof stress, ductile and brittle materials, hardness and impact strength, conditions affecting mechanical behaviour of engineering materials.

- **MEMBERS IN UNI-AXIAL STATE OF STRESS (04 Hours)**
  Uniform cross-section and tapered bars subjected to uniaxial tension and compression, composite bars and statically indeterminate bars, thermal stresses; Introduction to plasticity; Strain energy under axial loading.

- **MEMBERS SUBJECTED TO AXI-SYMMETRIC LOADS (03 Hours)**
  Stresses and strains in thin cylindrical shells and spheres under internal pressure, stresses in thin rotating rings.

- **MEMBERS SUBJECTED TO TORSIONAL LOADS (04 Hours)**
  Torsion of solid and hollow circular shafts, stepped and composting shafts, Shafts subjected to combined bending, torsion and axial thrust, Strain energy in torsion.

- **MEMBERS SUBJECTED TO FLEXURAL LOADS (13 Hours)**
  Statically determinate beams, support reactions, relationship between load, shear force and bending moment, shear force and bending moment diagrams; theory of flexure for initially straight beams, distribution of bending stresses across the beam cross-section, principal stresses in beams; equation of elastic curve for the loaded beam, relationship between bending moment, slope and deflection; calculation of deflection by integration, moment area and unit-load methods, Strain energy in flexure.

- **ELASTIC STABILITY OF COLUMNS** **(05 Hours)**
  Euler's theory of initially straight columns, critical loads for different end condition of columns, eccentric loading, columns with small initial curvature, empirical formulae, Short struts subjected to eccentric loads. Energy methods: principle of virtual work, minimum potential energy, Introduction to theory of photo-elasticity.

**(Total Lecture Hours: 42)**

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## 3. Books Recommended:


1. F. P. Beer, E. R. Johnston, Jr., J. T. Dewolf and D. E. Mazureu, Mechanics of Materials, 5th Edition, McGraw Hill, 2009.
2. S. P. Timoshenko and D. H. Young, Elements of Strength of Materials, 5th Edition, East-West Press Pvt. Ltd., 2009.
3. S. Ramamurtham, Strength of Materials, Dhanpat Rai Publications, 2005.
4. E. P. Popov, Engineering Mechanics of Solids, Prentice-Hall, 1999.
5. L. S. Srinath, Advanced Mechanics of Solids, 3rd Edition, Tata McGraw Hill, 2009.

**Additive Manufacturing Processes**

**ME329**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Compare and distinguish various additive manufacturing processes. |
| CO2 | Explain the process chain for selected additive manufacturing process. |
| CO3 | Compare and recommend suitable additive manufacturing process for a given material and application. |
| CO4 | Identify defects in model and reframe in standard format. |
| CO5 | Integrate design concepts with CAD or reverse engineering for geometry preparation for additive manufacturing of part. |

## 2. Syllabus

- **INTRODUCTION** **(06 Hours)**
  Definition, classification, stages of generic additive manufacturing process, benefits, applications, process selection, evaluation, benchmarking, future growth and opportunities

- **LIQUID BASED PROCESSES** **(08 Hours)**
  Photo polymerization, principle and working of stereo lithography apparatus, scanning techniques, curing processes, typical materials and applications.

- **POWDER BASED PROCESSES** **(08 Hours)**
  Powder fusion mechanism, powder handling and recycling, Principle and working of Selective Laser Sintering, Laser Engineering Net Shaping process, Electron Beam Melting, process parameters, typical materials and applications.

- **SOLID BASED PROCESSES** **(08 Hours)**
  Basic principle and working of fused deposition modelling process, liquification, solidification and bonding, bio extrusion, Laminated Object Manufacturing process, Multi jet process, typical materials and applications

- **SOFTWARE ISSUES IN ADDITIVE MANUFACTURING** **(06 Hours)**
  Preparation of CAD models and STL files, STL file problems and repair, slicing, newly proposed formats, standards, softwares to assist additive manufacturing, role of reverse engineering.

- **DESIGN FOR ADDITIVE MANUFACTURING** **(06 Hours)**
  Core concepts and objectives, unique capabilities of Additive Manufacturing, exploring design freedom, design tools.

**(Total Lecture Hours: 42)**

## 3. Books Recommended:


1. I. Gibson, D. Rosen, B. Stucker, Additive Manufacturing Technologies, Springer Publisher, 2010.
2. C. K. Chua, K. F. Leong, C. S. Lim, Rapid Prototyping – Principles and Applications, World Scientific, 3rd Edition, 2010.
3. R. Noorani, 3D printing technology, applications and selection, CRC Press, 2017.
4. M. W. M. Cunico, 3D Printers and Additive Manufacturing: the rise of the Industry 4.0, Concept 3D, 2019
5. A. Bandyopadhyay and S. Bose, Additive Manufacturing, CRC Press, 2015

# Teaching Scheme: B. Tech. (Mechanical Engineering) III Year

**SEMESTER - VI**

| Sr. No. | Subject | Code | Scheme | Exam Scheme | | | | Total | Credit |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Tuto. | Pract. | | |
| | | | | Hrs. | Marks | Marks | Marks | | |
| 1. | Professional Ethics, Economics and Management | HU308 | 4 – 0 – 0 | 3 | 100 | - | - | 100 | 04 |
| 2. | Tribology and Mechanical Vibration | ME302 | 3 – 1 – 2 | 3 | 100 | 25 | 50 | 175 | 05 |
| 3. | Production Technology | ME304 | 3– 0 – 2 | 3 | 100 | - | 50 | 150 | 04 |
| 4. | Applied Thermal Engineering | ME306 | 4 – 0 – 2 | 3 | 100 | - | 50 | 150 | 05 |
| 5. | Institute Elective – 2 | ME3YY | 3 – 0 – 0 | 3 | 100 | - | - | 100 | 03 |
| 6. | Core Elective - 2 | ME3BB | 3 – 0 – 0 | 3 | 100 | - | - | 100 | 03 |
| | | Total | 20 – 1 – 6 | 18 | 600 | 25 | 150 | 775 | 24 |

**Institute Elective – 2 (ME3YY)**

1. Corrosion Engineering: ME362
2. Energy Efficiencies in Industrial Utilities[#]: ME364
3. Product Design and Development: ME366
4. Lubrication Technology: ME368
5. Plant Layout and Material Handling: ME372
6. Risk, Reliability and Life Testing: ME374
7. Materials Management: ME376

# Except ECED and CoED students

**Core Elective – 2 (ME3BB)**

1. Advance Engineering Materials: ME322
2. Energy and Exergy Analysis of Thermal Systems: ME324
3. Machine Tool Design: ME326
4. Micro Hydro Power Plant: ME328
5. Micro- and Nano-Manufacturing: ME332
6. Finite Element Methods: ME334

## Professional Ethics, Economics and Business Management

## HU308

| L | T | P | Credit |
|---|---|---|---|
| 4 | 0 | 0 | 04 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Identify application of ethics in society and development of understanding regarding Professional ethical issues related to Mechanical engineering |
| CO2 | Develop managerial skills to become future engineering managers |
| CO3 | Develop skills related to various functional areas of management (Marketing Management, Financial Management, Operations Management, Personnel Management etc.) |
| CO4 | Build knowledge about modern management concepts (ERP, SCM, e-CRM, etc.) |
| CO5 | Develop experiential learning through Management games, Case study discussion, Group discussion etc. |
| CO6 | Apply knowledge of Economics and Business management aspects in Mechanical engineering |

## 2. Syllabus:

- **PROFESSIONAL ETHICS** **(14 Hours)**

  Introduction, Approaches to Ethics, Meaning of Ethics, Major attributes of Ethics, Business Ethics, Factors influencing Ethics, Importance of Ethics, Ethics in Management, Organizational Ethics, Ethical aspects in Marketing, Mass communication and Ethics - Television, Whistle blowing, Education – Ethics and New Professional, Intellectual Properties and Ethics, Introduction to Professional Ethics, Engineering Ethics, Ethical issues related to Mechanical Engineering

- **ECONOMICS** **(08 Hours)**

  Introduction To Economics, Micro & Macro Economics, Applications & Scopes Of Economics, Demand Analysis, Demand Forecasting, Factors Of Production, Types Of Cost, Market Structures, Break Even Analysis

- **MANAGEMENT** **(12 Hours)**

  Introduction to Management, Features Of Management, Nature Of Management, Development of Management Thoughts – Scientific Management By Taylor & Contribution of Henry Fayol, Coordination & Functions Of Management, Centralization & Decentralization, Decision Making; Fundamentals of Planning; Objectives & MBO; Types of Business Organizations: Private Sector, Public Sector & Joint Sector; Organizational Behavior: Theories of Motivation, Individual & Group Behavior, Perception, Value, Attitude, Leadership

- **FUNCTIONAL MANAGEMENT** **(18 Hours)**

  Marketing Management: Core Concepts Of Marketing, Marketing Mix (4p), Segmentation – Targeting – Positioning, Marketing Research, Marketing Information System, Concept of International Marketing, Difference Between Domestic Marketing & International Marketing;

Operations Management: Introduction to Operations Management, Types of Operation Systems, Types of Layouts, Material Handling, Purchasing & Store System, Inventory Management; Personnel Management: Roles & Functions of Personnel Manager, Recruitment, Selection, Training, Industrial Dispute, Collective Bargaining; Financial Management: Goal of Financial Management, Key Activities In Financial Management, Organization of Financial Management, Financial Institutions, Financial Instruments, Sources of Finance

- **MODERN MANAGEMENT ASPECTS** **(04 Hours)**

  Introduction to ERP, e – CRM, SCM, RE – Engineering, WTO, IPR Etc.

(**Total Lecture Hours: 56)**

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## 3. Books Recommended:


1. V. Balachandran and Chandrasekaran, Corporate Governance, Ethics and Social Responsibility, PHI, 2nd Edition, 2011
2. L.M. Prasad, Principles & Practice of Management, Sultan Chand & Sons, 8th Edition,2015
3. T. R. Banga & S.C. Shrama, Industrial Organisation & Engineering Economics, Khanna Publishers, 25th Edition, 2015
4. Everett E. Adam, Ronald J. Ebert, Production and Operations Management, Prentice Hall of India, 5th edition, 2012
5. P. Kotler P., K. L. Keller, A. Koshi & M. Jha, Marketing Management – A South Asian Perspective, Pearson, 14th Edition, 2014
6. P.C. Tripathi, Personnel Management & Industrial Relations, Sultan Chand & sons, 21st Edition, 2013
7. P. Chandra, Financial Management, Tata McGraw Hill, 9th Edition, 2015


## Further Reading:


1. A. Crane & D. Matten, Business Ethics: Managing Corporate Citizenship and Sustainability in the Age of Globalisation, Oxford University, 2010
2. D. J. Fritzsche, Business Ethics: A Global and Managerial Perspectives, McGraw Hill Irwin, Singapore, 2004
3. S.K. Mandal, Ethics in Business and Corporate Governance, Tata McGraw Hill, 2011

## Tribology And Mechanical Vibrations

## ME302

| L | T | P | Credit |
|---|---|---|---|
| 3 | 1 | 2 | 05 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain the fundamentals of tribology and its engineering importance |
| CO2 | Explain the friction and wear theories in engineering applications. |
| CO3 | Analyze different lubrication theories |
| CO4 | Model single degree of freedom vibrating system using Newton's Law of motion and energy methods. |
| CO5 | Derive equation of motion and determine the natural frequency for single degree of freedom system |
| CO6 | Formulate governing differential equation and solution for force vibration |

## 2. Syllabus

- **INTRODUCTION** **(05 Hours)**
  Definition of tribology, friction, wear and lubrication, importance of the Tribological studies. Surface Topography: Methods of assessment, measurement of surface roughness-different statistical parameters (Ra, Rz, Rmax, etc.), contact between surfaces, deformation between single and multiple asperity contact, contact theories involved

- **FRICTION** **(05 Hours)**
  Coulomb and Amontons laws of friction, its applicability and limitations, comparison between static, rolling and kinetic friction, friction theories, mechanical interlocking, molecular attraction, electrostatic forces and welding, shearing and ploughing, models for asperity deformation.

- **LUBRICATION** **(06 Hours)**
  Types of lubrication, viscosity, characteristics of fluids as lubricant, hydrodynamic lubrication, Reynold's equation, elastohydrodynamic lubrication- partial and mixed, boundary lubrication, various additives, solid lubrication.

- **WEAR** **(06 Hours)**
  Sliding wear: Abrasion, adhesion and galling, testing methods pin-on-disc, block-on ring, etc., theory of sliding wear, un-lubricated wear of metals, lubricated wear of metals, fretting wear of metals, wear of ceramics and polymers. Wearing by plastic deformation and brittle fracture. Wear by hard particles: Two-body abrasive wear, three-body abrasive wear, erosion, effects of hardness shape and size of particles.

- **FUNDAMENTALS OF VIBRATIONS** **(03 Hours)**
  Introduction, definition, SHM, beats phenomenon, complex method of representing harmonic vibrations

- **UNDAMPED FREE VIBRATIONS OF SINGLE DEGREE OF FREEDOM SYSTEM**
  Introduction, deviation of differential equations and resolution, equivalent stiffness of spring combinations, Newton's method and energy method for problem solutions. **(04 Hours)**

- **DAMPED FREE VIBRATIONS OF SINGLE DEGREE OF FREEDOM SYSTEM**
  Different types of damping, free vibrations with viscous dampers **(05 Hours)**

- **FORCED VIBRATION OF SINGLE DEGREE OF FREEDOM SYSTEMS (05 Hours)**
  Forced vibration with constant harmonic excitation, with rotating and reciprocating unbalance, due to the support, vibration isolation and transmissibility, measuring instruments, displacement, velocity, acceleration, frequency measuring instruments.

- **CRITICAL SPEED OF SHAFTS (03Hours)**
  Introduction, critical speed of shaft having single and multiple disc

**(Total Lecture Hours: 42)**

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## 3. Practicals:

1. Tuned rectilinear vibration absorber
2. Rectilinear vibration of cantilever beam
3. Free damped vibration
4. Fixed free three rotor system
5. To determine the viscosity using falling ball viscometer
6. Demonstrate friction and wear measurement on pin on disc apparatus
7. Demonstrate the coefficient of friction measurement on reciprocation motion
8. Performance of Journal bearing test rig
9. To measure the surface roughness using profile-meter

## 4. Books Recommended:


1. R. D. Arnell, P. Davies, J. Halling, and Terence Whomes, Tribology: Principles and Design Applications: Principles and Design Applications, Macmillan International Higher Education, 1991.
2. B. C Majmudar, Introduction to Tribology of Bearings, S Chand & Company, 2010.
3. B. Bhushan, Introduction to Tribology, 2nd Edition, Wiley-Blackwell, 2013.
4. S. S. Rao, Mechanical Vibrations, Pearson Education, 6th Edition, 2018.
5. G. K. Grover, Mechanical Vibrations, Nem Chand & Bros, 2009.

## Production Technology

## ME304

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 2 | 04 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain the terms related to metrology |
| CO2 | Apply measurement techniques for measuring length, angle and taper, screw thread parameters, gear parameters, and surface roughness. |
| CO3 | Design limit gauges for checking internal and external dimensions of components. |
| CO4 | Illustrate mechanism and state applications of metal forming processes. |
| CO5 | Analyze metal forming processes such as rolling, extrusion, wire-drawing, and forging, and identify probable defects and their remedies. |

## 2. Syllabus

- **INTRODUCTION TO METROLOGY** **(04 Hours)**
  Definition of metrology, important terms such as error, zero error, accuracy, precision, sensitivity, true value, Classification of methods of measurement, Uncertainty of measurement.

- **LIMITS, FITS, AND GAUGES** **(08 Hours)**
  Limit, Fit, Types of fit, Tolerance, Tolerance analysis, Interchangeability, Types of gauges, Design of limit gauges.

- **MEASUREMENT** **(08 Hours)**
  Measurement of length, angle and taper; Screw thread measurement, Gear measurement, Surface roughness measurement, Geometrical Dimensioning and Tolerancing (GD & T).

- **INTRODUCTION TO METAL FORMING** **(04 Hours)**
  Plastic deformation and yield criteria, Material behavior in metal forming processes, Role of temperature in in forming processes, Classification of metal forming processes.

- **MECHANISM OF METAL FORMING PROCESSES** **(10 Hours)**
  Mechanism of bulk deformation processes (rolling, forging, wire drawing, and extrusion) and sheet metal forming processes, Applications of metal forming processes, Mechanism and applications of high energy rate forming processes,

- **ANALYSIS OF BULK DEFORMATION PROCESSES** **(08 Hours)**
  Analysis of forging, rolling, drawing, and extrusion process

**(Total Lecture Hours: 42)**

## 3. Practicals:

1. To calibrate given indicating micrometer/micrometer.
2. To find angle of V-block, dovetails, taper, and radius of circular arc.
3. To calibrate given gear tooth vernier, find the tooth thickness and module
4. To find the pitch, effective diameter, best wire size of the given screw threads,
5. To find the angle of external taper, taper of tapered hole, taper of tapered ring.
6. To draw stress-strain behavior for model material.
7. To measure the force required in extrusion.
8. To find flow stress of the given material and to plot a graph of forging ratio vs flow stress

## 4. Books Recommended:


1. A. K. Bewoor and V. A. Kulkarni, Engineering metrology and measurements, Tata McGraw Hill Education, 2017.
2. N. V. Raghavendra, L. Krishnamurthy, Engineering Metrology and Measurements, Oxford publishers, 2013.
3. R. K. Jain, Engineering Metrology, Khanna Publishers, 1997.
4. S. Kalpakjian, S. R. Schmid, Manufacturing Engineering and Technology, 7th Edition, Pearson, 2018
5. A. Ghosh and A. K. Mallik, Manufacturing Science, East West Press New Delhi, 2010.

## Applied Thermal Engineering

## ME306

| L | T | P | Credit |
|---|---|---|---|
| 4 | 0 | 2 | 05 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Correlate the suitability of particular fuel for SI/CI engines. |
| CO2 | Compare the working and performance of CI and SI engines. |
| CO3 | Prepare heat balance sheet and calculate SI/CI engine efficiencies. |
| CO4 | Evaluate the refrigeration systems for various applications. |
| CO5 | Determine the properties of moist air and present air conditioning processes on psychometric chart. |
| CO6 | Compute cooling/heating loads for designing air conditioning systems, cold storage plants. |

## 2. Syllabus

- **INTRODUCTION TO INTERNAL COMBUSTION ENGINES (03 Hours)**
  Historical Development in IC Engines, General Specifications of I C Engines being used for Two Wheeler, Three Wheeler, Four Wheeler segment.

- **FUEL AIR CYCLE AND ACTUAL CYCLE ANALYSIS (05 Hours)**
  Significance of cycle analysis. Effect of variation in specific heat of gases, Dissociation effect, Time burning Loss and other losses affecting the performance of engine cycle. Comparison of air standard cycle-fuel air cycle and actual cycle analysis.

- **COMBUSTION IN SI AND CI ENGINE (12 Hours)**
  Stages of combustion in SI Engine, Factors affecting various stages of combustion in SI Engine, Stages of combustion in CI Engine, delay period, factors affecting stages of combustion in C I Engine, Difference of Ignition Delay and ignition lag, Abnormal combustion phenomenon in SI and CI engine and its prevention. Knocking/detonation and its effects, Comparison of normal and abnormal combustion in SI and CI Engines.

- **ENGINE EMISSION AND CONTROL (05 Hours)**
  Pollutant - Sources and types – Effect on environment and human health - formation of NOx - Hydrocarbon Emission Mechanism - Carbon Monoxide Formation - Particulate emissions - Methods of controlling Emissions - Catalytic converters and Particulate Traps - Selective Catalytic Reduction(SCR) - Diesel Oxidation Catalyst (DOC). - Emission Norms and Driving cycles - Indian and Euro norms.

- **GAS TURBINE POWER PLANT (03 Hours)**
  Introduction to Gas Turbine, Site Selection, Components and Layout, Performance analysis of Brayton Cycle; open cycle and closed cycle gas turbine power plant.

- **AIR REFRIGERATION (04 Hours)**
  Reversed Carnot cycle, Bell Coleman cycle, Aircraft refrigeration cycle, Boot strap system, Actual cycle, Ramming, Compression and Turbine efficiencies, Coefficient of performance.

- **VAPOUR COMPRESSION REFRIGERATION (07 Hours)**
  Simple vapour compression cycle, Analysis of vapour compression cycle, Modifications and performance improvements to simple vapour compression system, Multistage vapour compression system, properties of refrigerants.

- **VAPPOUR ABSORPTION REFRIGERATION (03 Hours)**
  Comparison between vapour absorption and vapour compression system, Aqua-Ammonia and Lithium Bromide absorption system.

- **PSYCHROMETRY OF AIR CONDITIONING PROCESSES (14 Hours)**
  Psychrometric properties, Preparation of psychrometric charts, Psychrometric Processes - Mixing process, Sensible heating, Sensible cooling, Humidification, Dehumidification, Cooling and Dehumidification, Heating and humidification, Bypass factor, Apparatus dew point, Sensible heat factor, Air washer, evaporative cooling, Adiabatic humidification, Efficiency of humidification, Summer and Winter air conditioning system, Load calculations, comfort conditions, Central air conditioning plant, Pressure drop in air ducts.

**(Total Lecture Hours: 56)**

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## 3. Practicals: (Any 5 Practical from S. No. 1 to 7; and other 5 Practical from S. No. 8 to 14)

1. Study of Valve Timing/Port Timing Diagram for Engine System
2. Performance test of 4 stroke Petrol Engine.
3. Performance test of 4 stroke Diesel Engine.
4. Heat Balance Preparation for 4 stroke Diesel Engine.
5. Heat Balance Preparation for 4 stroke Petrol Engine
6. Determination of friction power of multi cylinder petrol engine using Morse Test Method.
7. Determination of friction power of single/multi cylinder petrol engine using Willan's Line Method.
8. To conduct performance test on vapour compression refrigeration system.
9. To study tools and instruments used in refrigeration and air conditioning
10. To determine psychrometric properties of air.
11. To conduct performance test on air conditioning system
12. To conduct performance test on Ice plant.
13. To conduct performance test on vapour absorption system - Electrolux- Domestic type.
14. To conduct performance test on desert cooler.

## 4. Books Recommended:


1. V. Ganesan, Internal Combustion Engine, Fourth Edition, Tata Mc-Graw Hill, 2017.
2. M.L. Mathur and R.P. Sharma, Internal Combustion Engine, Dhanpat Rai Publications, 2010.
3. R. Stone, Introduction to Internal Combustion Engines, Fourth edition, Palgrave Macmillan, 2012.
4. R. J. Dossat, Principles of Refrigeration, Pearson Education India, 2002.
5. C. P. Arora, Refrigeration and Air conditioning, Tata McGraw Hill, 2017.

## Corrosion Engineering

## ME362

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Describe importance of corrosion and various terminology associated with corrosion. |
| CO2 | Identify various types of corrosion, significance, causes and remedies. |
| CO3 | Interpret corrosion issues of various grades of materials. |
| CO4 | Analyze effect of different environments and conditions on corrosion behavior. |
| CO5 | Predict and test corrosion rate of materials from available data. |
| CO6 | Explain design guidelines and preventive methods to minimize corrosion of materials. |

## 2. Syllabus

- **INTRODUCTION TO CORROSION (04 Hours)**
  Definition, corrosion damage, statistics/summary of losses due to corrosion, importance of corrosion control, corrosion rate expressions, standards/societies related to corrosion, NACE terminology, origin of Pourbaix diagram.
- **TYPES OF CORROSION (07 Hours)**
  General corrosion, galvanic corrosion, crevice corrosion, pitting corrosion, intergranular corrosion, selective leaching, erosion corrosion, stress corrosion, overview of hydrogen cracking, high temperature corrosion. Case studies of failures due to various types of corrosion.
- **CORROSION OF VARIOUS MATERIALS (08 Hours)**
  Corrosion of carbon steels, stainless steels and alloy steels. Corrosion issues of aluminium, magnesium, copper, nickel, titanium, etc. and its alloys. Corrosion issues of composite materials and its control.
- **CORROSION IN SELECTED ENVIRONMENTS AND ITS CONTROL (09 Hours)**
  Atmospheric corrosion, corrosion due to sea water, microbiologically induced corrosion, overview of corrosion in human body, overview of corrosion in automobiles, overview of corrosion in aircraft, corrosion of steel in concrete, corrosion in petrochemical industry, corrosion in paper and pulp industry and its control.
- **CORROSION TESTING (08 Hours)**
  Purpose of testing, importance of testing, laboratory, semi-plant and field tests, ASTM standards for testing, material selection and sample preparation, sequential procedure for laboratory and on-site corrosion investigations. Various tests like immersion tests, cabinet tests, Huey test, Streicher test, Warren test, slow strain rate test, electrochemical tests, high temperature and pressure test, paint test, etc. Testing of stress corrosion cracking and pitting. Cases studies for failure analysis related to surface degradation.
- **CORROSION PREVENTION (06 Hours)**
  Purification and alloying of metal, material selection, alteration of environment, design modifications, cathodic and anodic protection, coatings (metallic, inorganic, non-metallic and organic)

**(Total Lecture Hours: 42)**

## 3. Books Recommended:


1. M. G. Fontana, Corrosion Engineering, 3rd Edition, Tata McGraw-Hill, 2005.
2. R. W. Revie and H. H. Uhlig, Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering, 4th Edition, Wiley Publication, 2008.
3. R. Baboian, Corrosion Tests and Standards: Application and Interpretation, 2nd Edition, ASTM International, 2005.
4. E. Bardal, Corrosion and Protection, 1st Edition, Springer-Verlag London Ltd., 2004.
5. A. J. McEvily and J. Kasivitamnuay, Metal Failures: Mechanisms, Analysis, Prevention, 2nd Edition, Wiley Publication, 2013.

**Energy Efficiency and Industrial Utilities**

**ME364**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Apply various energy conservation techniques to estimate energy saving potential |
| CO2 | Compare various appliances/utilities based on their stars and labelling, benchmarking values |
| CO3 | Calculate the usage of energy for a given industrial utility and suggest suitable way to minimize energy bill |
| CO4 | Relate the significance of energy usage in buildings and understand the ways to reduce energy bill |
| CO5 | Compute various performance parameters of HVAC systems and suggest suitable ways for improving energy efficiency |

## 2. Syllabus

- **GLOBAL AND NATIONAL ENERGY SCENARIO (05 Hours)**
  Energy consumption in various sectors, Energy resources like Coal, Oil and Natural Gas –their demand and supply management, Indian energy scenario, Indian Coal & LPG scenario, Primary and Secondary Sources of Energy, Commercial and Non Commercial Sources, India's installed energy capacity, per capita energy consumption, General aspects of Energy conservation and management, Roles of energy auditors, Roles of energy manager, Energy policy of industry, Energy Conservation Act and its amendments

- **ENERGY EFFICIENCY IN BOILER, STEAM AND FURNACE SYSTEM UTILITIES (10 Hours)**
  Energy conservation opportunities in boiler systems, retrofitting of FBC in conventional boilers, Steam line distribution standard practices including sizing and layouts, selection, operation and maintenance of steam traps, energy saving opportunities in steam systems
  **Energy Efficiency in Furnaces**: Sankey diagram, Fuel economy measures in furnaces
  **Insulation and Refractories**: Types of insulations, Economic thickness of insulation, Typical refractories for industrial applications

- **COGENERATION (03 Hours)**
  Principle of cogeneration, Technical options for cogeneration, Factors influencing cogeneration choice, Important technical parameters for cogeneration, case study on savings with and without cogeneration

- **FANS, BLOWERS AND COMPRESSORS AND PUMP SYSTEMS (12 Hours)**
  Energy saving opportunities, performance evaluation and efficient system operation.
  Compressed Air Systems: Efficient operation of compressed air system, Leakage tests.
  Pumps and Pumping Systems: Pump curves, factors affecting pump performance, Energy loss in throttling, Effects of impeller diameter change, Flow control strategy, Variable speed drives, Energy conservation opportunities.

- **ENERGY EFFICIENCY IN HVAC AND REFRIGERATION UNITS (04 Hours)**
  Performance assessment of refrigeration units, Factors affecting energy efficiency in refrigeration plants, Energy saving opportunities in cold storage systems, Heat Pumps and Applications, Standards and Labelling of Room Air-conditioners.

- **COOLING TOWERS (02 Hours)**
  Performance evaluation and assessment, Efficient system operation, Energy saving opportunities.

- **LIGHTING SYSTEMS (02 Hours)**
  Light source and Lamp types, Illuminance level for various tasks, Energy efficient lighting controls, standards and labelling programs in lamps.

- **ENERGY CONSERVATION IN BUILDINGS (04 Hours)**
  Energy Conservation Building Codes, ECBC Guidelines on Building Envelops, service hot water, lighting, water pumping, electrical power, escalators and elevators, Star Ratings of buildings.

**(Total Lecture Hours: 42)**

## 3. Books Recommended:


1. General Aspects of Energy Conservation, Management and Audit: Guide Book for Energy Managers and Energy Auditors; Bureau of Energy Efficiency, Ministry of Power
2. Energy Efficiency in Electrical Utilities: Guide Book for Energy Managers and Energy Auditors; Bureau of Energy Efficiency, Ministry of Power
3. Energy Efficiency in Thermal Utilities: Guide Book for Energy Managers and Energy Auditors; Bureau of Energy Efficiency, Ministry of Power
4. S. A. Roosa, Energy Management Handbook, Fairmont Press, 2018
5. A. Thumann, Handbook of Enegry Audits, Fairmont Press, 2012

## Product Design and Development

## ME366

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain the fundamental requirement of product design |
| CO2 | Describe the concepts of design and intellectual rights for innovation |
| CO3 | Explain the concepts of design for manufacturing and industrial design aspects |
| CO4 | Design and model the product |
| CO5 | Apply the concept of product life cycle and management to design product |

## 2. Syllabus

- **MOTIVATION/OBJECTIVE OF PRODUCT DEVELOPMENT (14 Hours)**

  Customers' need analysis, Market research & feasibility study, New Product Development (NPD) or improving the existing product, Product Design Specifications (PDS), Quality Function Deployment (QFD) technique

- **DESIGN ENGINEERING (18 Hours)**

  Conceptual design; concept generation, selection, and testing. Creating design ideas & Problem solutions. Methodologies; brain storming, lateral thinking, Theory of Inventive Problem Solving (TRIZ), Use of available products and literature (patents & copy rights),

  Preliminary design; design considerations, product architecture, functional dimensions and useful life for the application. Concept of reverse engineering, Design for X (DfX), manufacturing, assembly, material selection, reliability & value engineering, Industrial design (human factors); ergonomics safety, aesthetics,

  Detail design & documentation; parts and assembly drawings, design and review reports. Modeling/Prototyping and performance testing.

- **LAUNCHING AND LIFE CYCLE MANAGEMENT (10 Hours)**

  Reaching out to customers; Marketing, advertising, promoting, servicing etc, Product life cycle and management.

**(Total Lecture Hours: 42)**

## 3. Books Recommended:


1. K. T. Ulrich, S. D. Eppinger, and M. C. Yang , Product Design & Development, , 7th Edition, McGraw Hill, 2019.
2. G. Pahl, W. Beitz, J. Feldhusen and K. Grote, Engineering Design - A Systematic Approach, 3rd Edition Springer, 2007.
3. L. C. Schmidt and G. Dieter, Engineering Design, 4th Edition, Mc Graw Hill, 2017.
4. Y. Haik, Engineering Design Process, 2nd edition, CL Engineering, 2011.
5. J. G. Bralla, Hand book of Product Design for Manufacturing, 2nd edition, McGraw Hill, 1996.

## Lubrication Technology

## ME368

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain basics of lubricants, primary roles, their types, performance properties and evaluation methods. |
| CO2 | Apply the conceptual selection criteria of lubricants in the industrial applications. |
| CO3 | Identify oil degradation; role of various additives ; selection criteria for lubricants in various situations; various regimes of lubrication and Striback curve |
| CO4 | Explain the theory of lubrication in industrial applications. |
| CO5 | Explain the general safety considerations for lubrication storage and handling of the plants. |

## 2. Syllabus

- **INTRODUCTION** **(08 Hours)**

Introduction: friction, wear and lubrication, Historical background, Purpose of lubrication, Lubrication regimes, Characteristics of lubricants - viscosity, viscosity index, oxidation stability, flash point and fire point, pour point and cloud point, carbon residue, ash content, iodine value, neutralization number, dielectric strength.

- **LUBRICANTS** **(08 Hours)**

Classification of lubricating oils, properties of lubricating oils, tests on lubricants. Grease classification, properties, tests. Specific requirements for automotive lubricants, oxidation, deterioration and degradation of lubricants, additives, synthetic lubricants.

- **PROPERTIES AND ADDITIVES** **(10 Hours)**

Composition and classification of lubricants, lubricating oils – oil refining, types, categories, grading, Grease - composition, function, characteristics, thickeners and additives, soap and its complexes, selection and its practices, solid lubricants, Functional additives – surface, performance enhancing, lubricant protective.

- **THEORY OF LUBRICANTS** **(10 Hours)**

Engine friction - introduction, total engine friction, effect of engine variables on friction, hydrodynamic lubrication, elastohydrodynamic lubrication, boundary lubrication, bearing lubrication, functions of the lubrication system, introduction to design of a lubricating system.

- **LUBRICANTS APPLICATIONS** **(06 Hours)**

Tribological components and industrial machinery, Lubricants testing and test methods, Organization and management of lubrication, lubricant storage and handling, Safety and health hazards, Environmental regulations.

**(Total Lecture Hours: 42)**

## 3. Books Recommended:


1. Hand Book of Lubrication and Tribology, Vol. I – Vol. III, CRC Press Inc., 2006
2. D. D. Fuller, Theory and practice of lubrication for engineers,2nd Edition, John Wiley & sons., 1984
3. A. Cameron, Basic Lubrication Theory, Prentice Hall Press, 1971
4. Raymond G. Gunther, Lubrication, Chipton Book Co., 1971
5. A. R. Lansdown, Lubrication &Lubricants selection, 3rd Edition, ASME Press, 2003

## Plant Layout and Material Handling

## ME372

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Demonstrate the capabilities of selecting suitable plant location considering various criteria. |
| CO2 | Demonstrate the knowledge of factory buildings used in industries and its importance. |
| CO3 | Analyze various types of plant layouts used in industries and solve the related problem using various evaluation techniques. |
| CO4 | Evaluate the optimum layouts using optimization techniques. |
| CO5 | Analyze and identify suitable material handling equipment used in industries as per the requirement. |

## 2. Syllabus

- **INTRODUCTION** (**04 Hours**)

  Need of plant layout; basic objectives of plant layout; types of plant layouts; types of production systems.

- **PLANT LOCATION** (**06 Hours**)

  Introduction to plant location, Influence of location on plant layout, plant location selection factors, Models for the plant location selection: median model, gravity model; plant location selection

- **INDUSTRIAL BUILDING** (**04 Hours**)

  Relationship between the building and layout, considerations in industrial building design; types of factory buildings: single storey/horizontal buildings and multi storey buildings.

- **PLANT LAYOUT** (**06 Hours**)

  Definitions of plant layout, types of plant layouts: product Layout, process layout/functional type layout, fixed position layout, group technology layout/cellular layout; advantages and disadvantages.

- **EVALUATION OF LAYOUTS** (**15 Hours**)

  Product layout/assembly line evaluation algorithms: largest candidate rule; Kilbridge and Wester method; ranked positional weights method. Process layout evaluation: qualitative and quantitative factors; layout cost evaluation; comparing two layout layout; computerized relative allocation of facilities technique (CRAFT); equal area and unequal area facility layout problems. Assignment model for addition of new facilities/machine to the existing layout. Group technology layout evaluation: part families and machine cells; rank order clustering technique.

- **MATERIAL HANDLING** **(07 Hours)**

  Principles of material handling, Factors considered for material handling equipment selection, Types of material handling equipment: load formation equipment, positioning equipment,

conveyers, cranes and hoists, industrial trucks, elevators, storage equipment, etc.; material handling equipment selection.

**(Total Lecture Hours: 42)**

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## 3. Books Recommended


1. M. P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, 5th Edition, Pearson, 2018.
2. R. Panneerselvam, Production and Operations Management, 3rd Edition, Prentice Hall India, 2012.
3. T. H. Allegri, Material Handling, Principles and Practice, CBS Publishers, New Delhi, 2017.
4. P.B. Mahapatra, Computer Aided Production Management, 1st Edition, Prentice Hall India, 2004.
5. S. Roy, Introduction to Material Handling, 2nd Edition, New Age International (P) Ltd, 2017.

**Risk, Reliability and Life Testing**

**ME374**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Examine the reliability of any product or system which ultimately maintains the customers' base of any industry. |
| CO2 | Explain the components and systems through its life cycle. |
| CO3 | Evaluate the probabilistic time analysis of products' successes and failures. |
| CO4 | Predict reliability of any component or system which is essential before we put it into any use. |
| CO5 | Estimate the life of a system and their components with concepts of highly accelerated life testing. |

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## 2. Syllabus

- **BASIC CONCEPTS IN RELIABILITY (08 Hours)**
  Risk and Reliability, introduction and fundamentals of risk management and reliability engineering, bath tub curve, failure mechanism of mechanical components: causes, modes, function of mechanical elements, failure theories.

- **COMPONENT RELIABILITY (06 Hours)**
  Failure data analysis, reliability function, hazard rate, failure rate, and their relationship, MTTF, mean failure rate, MTBF.

- **SYSTEM RELIABILITY (06 Hours)**
  Series, parallel, mixed configuration, r-out of-n structure, solving complex systems, Reliability Logic Diagrams (RLD), techniques of reliability estimation: fault tree analysis, tie sets and cutsets, boolean algebra.

- **SYSTEM RELIABILITY IMPROVEMENT (08 Hours)**
  Use of better components, simplification, derating, redundancy, working environment control, maintenance, etc. redundancy techniques: introduction, component vs unit redundancy, weakest link technique, mixed redundancy, standby redundancy, redundancy optimization, double failure and redundancy.

- **CASE APPLICATION OF COMPLEX SYSTEM (04 Hours)**
  Marine power plant, computer system, nuclear power plant, combats aircraft, etc.

- **RELIABILITY TESTING (08 Hours)**
  Introduction, objectives, assumptions, different types of test. life testing in practice: methodology, problems and difficulties. economics of reliability engineering.

- **ACCELERATED LIFE TESTING (10 Hours)**
  Introduction, basic concepts, data qualification. accusations faster, stress combination methods, limitations, Accelerated Stress Testing (AST), step stress method for AST, various AST models,

recent development recommended approach. Highly Accelerated Life Testing (HALT), Highly Accelerated Stress Screening (HASS).

**(Total Lecture Hours: 42)**

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## 3. Books Recommended:


1. L. S. Srinath, Mechanical Reliability, East-West Press Pvt. Ltd, New Delhi, 2002
2. L. S. Srinath, Reliability Engineering, 4th edition, East-West Press Pvt. Ltd, New Delhi, 2005
3. V. N. A. Naikan, Reliability Engineering and Life Testing, PHI Learning Pvt. Ltd. New Delhi, 2008
4. E. Balagurusamy, Reliability Engineering, TMH, New Delhi, 2017
5. D. T. Patrick, Practical Reliability Engineering, 4th edition, Wiley Publishing company, 2008


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**Materials Management**

**ME376**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Describe the role and scope of materials management in organization. |
| CO2 | Apply the concepts of classification, codification, specification, standardization and variety reduction for proper store management. |
| CO3 | Apply deterministic and probabilistic inventory control models and selective inventory control to insure a steady supply of materials to meet the needs of the organization |
| CO4 | Evaluate the budget and material requirement plan to insure a steady supply of materials to meet the needs of the organization |
| CO5 | Explain the key characteristics of fundamental and specialized purchasing aspects, store keeping, the public and international purchase. |

## 2. Syllabus

- **MATERIALS MANAGEMENT** (**04Hours**)

  Functions, Objectives, Activities, Cost, advantages, Desirable qualities of purchasing and materials manager

- **CLASSIFICATION, CODIFICATION & SPECIFICATION** **(05 Hours)**

  Need for classification and identifications of materials. Classification of Materials, Codification: Nature, process, merits and demerits, Codification Systems, Stores Vocabulary, Marking of Stores, Objective of specifications, Specification Categories and development

- **STANDARDISATION AND VARIETY REDUCTION** **(05 Hours)**

  Standard, Dimensions, Different levels of standards, Scope, Various foreign standards used in India, Procedure for evolving Indian standards, Benefits, Standardization and variety reduction in products, Techniques of variety reduction, Three S's- Standardization, Simplification and Specialization

- **INVENTORY CONTROL AND MANAGEMENT** **(07 Hours)**

  Classification, Inventory Models (Deterministic and Probabilistic), P and Q Systems in Practice, Selective Inventory Control, Two dimensional Classification, Music 3-D Model, A-B-C analysis for always better control.

- **BUDGETING AND MATERIAL RESOURCE PLANNING** **(07 Hours)**

  Budgetary control, Types, advantages, Material Requirement Planning (MRP) structures, Management, Lot sizing techniques

- **STORE AND STORE KEEPING** **(04 Hours)**

  Objectives, Functions of storekeeper, Benefits of store keeping, Features of successful store keeping, Stores Organization, Location and layout of stores, Types of stores, Stock taking

- **PURCHASING** **(10 Hours)**

  Purchasing Process, purchasing terms and conditions, Principles, Objectives, Methods, Vendor/Supplier rating, e-Procurement, Vendor/Supplier performance evaluation, negotiation, make or buy, outsourcing, and buy commodities, capital goods, Director general of Supplies and Disposals (DGS&D), Supplier registration, Government e-Market place (GeM), tendering, Central Public Procurement Portal (CPPP), Director general of foreign trade (DGFT), Importers, Criteria of Licencing, Negative list, Import procedure

**(Total Lecture Hours: 42)**

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## 3. Books Recommended:


1. J. R. T. Arnold, S. N. Chapman and L. M. Clive, Introduction to Materials Management, 7th Edition,Pearson Education, 2010.
2. A. K. Chitale and R. C. Gupta, Materials Management: A Supply Chain Perspective, 3rd Edition, PHI learning Private Limited, 2014.
3. J. Heizer, B. Render, C. Munson and A. Sachan, Operations Management, 12th Edition, Pearson Education, 2017.
4. P. Gopalakrishnan and A. Haleem, Handbook of Materials Management, 2nd Edition, Prentice Hall India Learning Private Limited, 2015.
5. P. Gopalakrishnan and M. Sundaresan, Materials Management: An Integrated Approach by Gopalakrishanan, 1st Edition, Prentice Hall India Learning Private Limited, 1977.

**Advanced Engineering Materials**

**ME322**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain major types of special steels, their properties and applications |
| CO2 | Find out metals that can be used for high temperature applications |
| CO3 | Select cast-irons for specific engineering applications |
| CO4 | Correlate metallurgical aspects and application of light metals |
| CO5 | Select nanomaterials for different industrial applications |
| CO6 | Describe material properties and select the suitable material for biological, space and cryogenic service applications |

## 2. Syllabus:

- **INTRODUCTION** **(01 Hour)**
  The urge for advancements in material development and processing.

- **SPECIAL STEELS** **(08 Hours)**
  Metallurgical aspects, Composition, Properties and applications of: different types of Stainless steels, Dual phase steels, TRIP steels, Maraging steels, High speed steels, Hadfield steels, Free cutting steels, Ausformed steels, Tool Steels, manganese steels, chrome steels, electrical steels, bearing steels, spring steels, heat resistant steels, creep steels, HSLA steels, materials in nuclear field, materials used in space

- **SPECIAL AND HIGH TEMPERATURE ALLOYS** **(06 Hours)**
  Ti alloys: physical and mechanical properties, thermomechanical treatment of Ti-alloys, Ti shape memory alloys, Fe based super alloys, Ni based alloys, Co based alloys, Strengthening mechanism, Composition, Properties and their applications. engineering applications at elevated temperatures.

- **ALLOY CAST IRON** **(05 Hours)**
  Austempered ductile iron; alloy cast irons, Ni hard, high silicon cast irons, heat resistant cast irons- high chrome cast iron- structure, property and engineering applications.

- **LIGHT METALS AND THEIR ALLOYS** **(04 Hours)**
  Aluminium, magnesium and titanium alloys: Metallurgical aspects, Properties and applications.

- **NANO MATERIALS** **(04 Hours)**
  Definition, Types, Properties and applications, Carbon nano tubes, Methods of production.

- **SMART MATERIALS AND BIOMATERIALS** **(06 Hours)**

Shape memory alloys, Piezoelectric materials, Electro-rheological fluid, Magneto-rheological fluids,biocompatibility, bio functionality, Important bio metallic alloys like: Ni-Ti alloy and Co-Cr-Mo alloys. Applications.

- **COMPOSITE MATERIALS** **(04 Hours)**
  PMC, CMC, MMC, processing and typical application**,** Special High Temperature High performance Carbon-Carbon composites.

- **MISCELLANEOUS ADVANCED MATERIALS** **(04 Hours)**
  Magnetic materials, aerospace materials, cryogenic materials, semi-conducting and superconducting materials.

**(Total Lecture Hours: 42)**

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## 3. Books Recommended:


1. J. F. Shackelford, B. R. W. Alexander, Materials Science and Engineering Handbook, CRC Press, LLC, 2001.
2. K. G. Budinski, M K Budinski, Engineering Materials: Properties and Selection, General Motors Corporation, Pearson, 2010.
3. I. J. Polmear, Light alloys: Metallurgy of Light Metals, Arnold, 1995.
4. Z. Abdullaeva, Nano and Biomaterials: Compounds, Properties, Characterization and Applications, Wiley-VCH Verlag, 2017.
5. K K Chawla, Composite Material Science and Engineering, Springer, 2012.

## Energy and Exergy Analysis of Thermal Systems

## ME324

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain the importance of the exergy and its difference from energy analysis |
| CO2 | Apply the first law and second law of thermodynamics to various thermal systems |
| CO3 | Determine the physical and chemical exergy of a given system |
| CO4 | Illustrate pictorial representation of exergy balance |
| CO5 | Perform exergy analysis of different thermal systems |

## 2. Syllabus

- **Introduction** **(05 Hours)**
  Fundamentals of mass, energy and entropy balance, and requirement of exergy analysis

- **Basics of exergy analysis** **(10 Hours)**
  Energy and exergy analysis, Exergy classifications, Exergy of closed systems, Exergy of flows, Exergy consumption, Procedure for energy and exergy analysis, reference environment, Exergy analysis implications

- **Exergy analysis of thermodynamic processes** **(10 Hours)**
  Mixing and separation process, heat transfer across a finite temperature difference, expansion and compression processes, Chemical process in combustion.

- **Elements of plant analysis** **(05 Hours)**
  Control mass analysis, control region analysis, Criteria of performance, Pictorial representation of exergy balance, Energy and exergy properties diagram

- **Exergy analysis of thermal power plants** **(12 Hours)**
  Gas turbine power plant with external and internal irreversibility, regeneration, cogeneration, reheater, and intercooler, combined steam and gas turbine power plant, Brayton cycle steam turbine power plants with external and internal irreversibility, super heater, reheater, vacuum condenser, regenerative feed water heating, combined feed water heating and reheating. Combined power plants

**(Total Lecture Hours: 42)**

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## 3. Books Recommended:


1. A. Bejan, G. Tsatsaronis, M. J. Moran, M. Moran, Thermal Design and Optimization, John Wiley & Sons, Inc.. 1996
2. I. Dincer Marc A. Rosen, Exergy, Energy, Environment and Sustainable Development, Elsevier Science, 2013
3. A. Bejan, Advanced Engineering Thermodynamics, John Wiley & Sons, Inc., New York. 2016
4. T. J. Kotas, The exergy Method of Thermal Plant Analysis, Butterworth-Heinemann, 2013
5. M. J. Moran, Availability Analysis – A Guide to Efficient Energy Use, ASME, 1989

**MACHINE TOOL DESIGN**

**ME326**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain the general requirements of machine tools. |
| CO2 | Design mechanical and hydraulic transmission elements. |
| CO3 | Analyze the kinematics of machine elements |
| CO4 | Explain machine tool control systems. |
| CO5 | Design the column, table and guide ways of machine tools. |

## 2. Syllabus

- **INTRODUCTION** **(03 Hours)**
  General requirements to machine tools, Machine tool design recommendations, Classification of motions to shape surface, Machine tool drives for rectilinear motion, Periodic motion, reversing motion etc.

- **KINEMATICS OF MACHINE TOOLS** **(05 Hours)**
  Kinematics or gearing diagram of Lathe, Drilling Machine, Milling Machine etc. machine tool drive, principles specification of machine tool.

- **DESIGN OF KINEMATICS** **(05 Hours)**
  Methods to determine transmission ratios for drives, Mechanical transmission and its elements, hydraulic transmission and its elements.

- **SPEED AND FEED BOXES** **(05 Hours)**
  General requirement, Design of gear trains, speed box es types, speed changing devices, feed boxes, characteristics of feed mechanism, types of rapid traverse mechanisms, variable devices

- **SPINDLE DESIGN AND SPINDLE BEARING** **(08 Hours)**
  Main requirement, Materials and details of spindle design, Spindle bearings, bearings, types of bearings and their selections, Bearing Materials

- **COLUMNS, TABLES AND WAYS** **(08 Hours)**
  Materials, typical constructions and design, basic design procedure of machine tool structure, design of columns, function and types of guide ways, design criteria and calculation of slide ways.

- **MACHINE TOOLS CONTROL SYSTEMS** **(08 Hours)**
  Requirement of control system selection and construction of control systems Mechanical control system, predilection control, remote control safety devices

**(Total Lecture Hours: 42)**

## 3. Books Recommended:


1. N. K.Mehta, Machine Tool Design, 3re Edition, Tata McGraw Hill, 2017
2. S. K.Basu and D. K.Pal, Design of Machine Tools, 5th Edition, Ox ford and IBH, 2005
3. N. Achertan, Machine Tool Design, University Press of the Pacific, 2000
4. F. Koenigsberger, Design Principles of Metal Cutting Machine Tools, Pergamon Press, 2013
5. G. C.Sen and A.Bhattacharyya, Principles of Machine Tools, 2nd Edition, New Central Book Agency,2009

**Micro-Hydro Power Plant**

**ME328**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain the concepts of hydro-electric power plant and classify different hydro-electric and micro hydro-electric power plant |
| CO2 | Analyze flow prediction methods and evaluate flow transfer systems required based on site conditions |
| CO3 | Identify different types of turbines and analyze the performance characteristics of various turbines |
| CO4 | Explain the working of different components of governing systems, and select the appropriate governing and drive for suitable application |
| CO5 | Compare the working of different electrical power sources |
| CO6 | Prepare maintenance schedule of components of micro hydro plant and carry out fault diagnosis |

## 2. Syllabus

- **INTRODUCTION** **(06 Hours)**
  Classification of Hydro-Electric Power Plant, micro hydro power plant overview and components.

- **HYDROLOGY, SITE SURVEY AND CIVIL WORKS** **(10 Hours)**
  Introduction, flow prediction, head measurements, site measurements of flow, civil works, system layout, Weir, spillways, channel, penstocks.

- **TURBINES** **(10 Hours)**
  Introduction, types: impulse, Pelton, Turgo, Cross flow, Reaction, Francis, Propeller, Kaplan and reverse pump: selection of turbine.

- **GOVERNING AND DRIVE SYSTEM** **(06 Hours)**
  Purpose of governing, approaches to the governing, direct couple drives: components.

- **ELECTRICAL POWER** **(06 Hours)**
  Basic electricity, choosing the supply, generators, synchronization

- **OPERATION AND MAINTENANCE** **(04 Hours)**
  Maintenance of components of micro hydro plant, fault diagnosis.

**(Total Lecture Hours: 42)**

## 3. Books Recommended:

1. P. Fraenkel, O. Parish, V. Bolkalders, A. Harvey, Micro-hydro Power: A guide for development workers, ITDG Publishing,1991.

2. L. Kindberg, Micro-Hydro Power: A Beginners Guide to Design and Installation, National Center for Appropriate Technology, 2014.
3. A. Harvey, Micro-Hydro Design Manual: A Guide to Small-Scale Water Power Schemes, Intermediate Technology Publications, 1993.
4. V. Schnitzer, Micro hydro Power scout guide. Hydro Power GTZ, 2009.
5. J.M. Chapallaz, P. Eichenberger, G. Fischer. Manual on pumps used as turbines, Vieweg, 1992.

**Micro- and Nano- Manufacturing**

**ME332**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Categorize and describe micro- and nano- manufacturing processes based on given application. |
| CO2 | Explain and select suitable micro machining/ micro forming/ MEMS processes based on given parameters and constraints. |
| CO3 | Distinguish between the requirements for micro and nano manufacturing processes |
| CO4 | Recommend a suitable nano- manufacturing process for a given application |
| CO5 | Propose suitable metrological technique for measuring micro and nano features |

## 2. Syllabus

- **INTODUCTION (02 Hours)**
  Introduction to miniaturization, scaling laws, micro products and design considerations, classification, applications.

- **MICRO MACHINING PROCESSES (14 Hours)**
  Principle of mechanical micromachining, micro turning, micro milling, ultrasonic micro machining, abrasive jet micro machining, micro electro discharge machining, micro electro chemical machining, micro grinding, laser micro machining.

- **MICRO FORMING PROCESSES (08 Hours)**
  Micro scale plastic deformation, size effect, micro deep drawing, micro extrusion, micro punching, micro blanking, micro fabrication using bulk metallic glasses, flow induced defects.

- **MEMS TECHNIQUES (06 Hours)**
  Classification, principle and working, photo lithography, chemical etching, LIGA, materials.

- **INTRODUCTION TO NANO MANUFACTURING (08 Hours)**
  Transition from nano technology to nano manufacturing; diamond turn machining; nano joining, nano soldering, nano welding, mechanical bonding, fastening; chemical vapor deposition, scanning tunneling microscopy, nano lithography.

- **MICRO AND NANO METROLOGY (04 Hours)**
  Scanning electron Microscopy, optical microscopy, scanning white light interferometry, scanning probe microscopy, computed tomography, digital volumetric imaging, molecular measuring machine.

**(Total Lecture Hours: 42)**

## 3. Books Recommended:


1. M. Jackson, Micro and Nano Manufacturing, Springer Science media, 2007.
2. W. Ahmed and M. J. Jackson, Emerging Nano Technologies for Manufacturing, Elsevier, 2nd edition, 2015.
3. I. Fassi and D. Shipley, Micro Manufacturing Technologies and their Applications, Springer, 2017.
4. N. Maluf and K. Williams, Introduction to MEMS Engineering, 2nd edition, Artech house, 2004.
5. K. Gupta, Micro and Precision Manufacturing, Springer, 2018

**Finite Element Method**

**ME334**

| L | T | P | Credit |
|---|---|---|---|
| 3 | 0 | 0 | 03 |

## 1. Course Outcomes (COs):

At the end of the course the students will be able to:

| | |
|---|---|
| CO1 | Explain the fundamental concepts of the theory of the finite element method |
| CO2 | Develop element characteristic equation and generation of global equation. |
| CO3 | Apply suitable boundary conditions to a global equation for bars, trusses and beams |
| CO4 | Evaluate the governing FE equations for solving 1D and 2D problems |
| CO5 | Apply the FE method for thermal, potential flow and transient problems |

## 2. Syllabus

- **INTRODUCTION (07 Hours)**
  Basic concepts of FEM, Matrix notations, Exact solution, Approximate solution, general procedure for finite element analysis, various approximate methods, types of elements, Interpolation and shape functions.

- **STIFFNESS (DISPLACEMENT) METHOD (07 Hours)**
  Introduction to Stiffness matrix, stiffness matrix for spring element, Global stiffness matrix, application of boundary conditions and forces, essential and natural boundary conditions, elimination method, penalty methods, element stresses and strains, Potential Energy approach to derive spring element Equations.

- **TRUSS STRUCTURES (07 Hours)**
  Stiffness Matrix for Bar Element, Global stiffness matrix for bar elements, computation of stress and strain for bar. Other residual method for one dimensional (1-D) bar problems.

- **FLEXURE ELEMENTS (07 Hours)**
  Beam theory, Beam stiffness matrix, Global beam stiffness matrix, equivalence load for various distributed loads, potential energy and Galerkin's method for beam elemental equation. .

- **FINITE ELEMENTS FOR TWO-DIMENSIONS (06 Hours)**
  Introduction to plane stress and plane strain, constant – strain triangle (CST) stiffness matrix, body and surface force for two-dimensional element, finite element solution of plane stress problem.

- **APPLICATIONS OF FEA IN ENGINEERING (08 Hours)**
  Plane elasticity, Heat conduction, Potential flow, Transient problems and Computer implementation.

**(Total Lecture Hours: 42)**

## 3. Books Recommended:


1. R.D. Cook, Concepts and Applications of Finite Element Analysis, 4th Edition, John Wiley & Sons, 2007.
2. D.L. Logan, A first course in the finite element method, 5th Edition, Cenage Learning, 2012.
3. J.N. Reddy, an Introduction to the Finite Element Method, 5th edition, McGraw Hill, x 2017.
4. T.R. Chandrupatla & A.D Belagundu, Finite Elements in Engineering, 4th Edition, Pearson, 2015.
5. O.C. Zienkiewicz, R.L Taylor and J.Z Zhu, The finite element method its basis and fundamentals, 7th edition, Elsevier,2013