Bansilal Ramnath Agarwal Charitable Trust's

# Vishwakarma Institute of Information Technology, Pune-48

(An Autonomous Institute affiliated to Savitribai Phule Pune University)


## Curriculum for

# S. Y. B. Tech.

# (Mechanical Engineering)

# Department of Mechanical Engineering

# VISION

Excellence in Mechanical Engineering for Global Acceptance

# MISSION

- Make spirited mechanical engineers with morals, values and principles for sustainable development of society.
- Strive continuously to impart knowledge and skills of the highest standards.
- Our engineers will respond to the current and future needs of the industry, higher studies as well as research.

## Program Educational Objectives:

1. Graduates of the program will become competent engineers suitable for the mechanical engineering based industry and higher education.
2. Graduates of the program will acquire the necessary foundation in fundamental mechanical engineering subjects for development of mathematical and analytical abilities.
3. Graduates of the program will acquire the knowledge and skills in mechanical engineering to provide technological solutions.
4. Graduates of the program will learn managerial, financial and ethical practices such as, project and financial management skills, multidisciplinary approach and soft skills.
5. Graduates of the program will respond to growing demands of society through lifelong learning.

## Program Outcomes:

At the end of the program, a student will be able to

1. **Engineering knowledge-** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis-** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
3. **Design/development of solutions-** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
4. **Conduct investigations of complex problems-** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage-** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society-** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability-** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics-** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work-** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication-** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance-** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning-** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

## Program Specific Outcomes-

At the end of the mechanical engineering program, a student will be able to-

1. Identify, automate and apply manufacturing processes for production of mechanical components considering effective use of man, machines, and material resources.
2. Design, formulate, develop and analyze mechanical components and systems using design engineering principles and modern CAD/CAE tools
3. Specify, analyze, evaluate, audit, design and build thermal and fluid systems using modern engineering tools

## Second Year B. Tech. Mechanical Engineering (SYBT) - Semester I (Pattern 2017)

| Course Code | Course | Course Type | Teaching Scheme | | | Examination Scheme | | | | | Total | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Formative Assessment | | | Summative Assessment | | | |
| | | | L | T | P | ISE T1 | ISE T2 | CE | ESE | PR/ OR | | |
| MEUA21171 | Engineering Mathematics – III | TH | 4 | - | - | 15 | 15 | 20 | 50 | - | 100 | 4 |
| MEUA21172 | Mathematics Practice – III | CE | - | 1 | - | - | - | 50 | - | - | 50 | 1 |
| MEUA21173 | Manufacturing Processes | TH | 3 | 1 | - | 15 | 15 | 20 | 50 | - | 100 | 4 |
| MEUA21174 | Strength of materials* | TH | 3 | - | - | 15 | 15 | 20 | 50 | - | 100 | 3 |
| MEUA21175 | Thermodynamics* | TH | 3 | - | - | 15 | 15 | 20 | 50 | - | 100 | 3 |
| MEUA21176 | Material science and Engineering metallurgy* | TH | 3 | - | - | 15 | 15 | 20 | 50 | - | 100 | 3 |
| MEUA21177 | Lab Practice - I | CE PR/OR | - | - | 6 | - | - | 50 | - | 50 | 100 | 3 |
| MEUA21178 | Skill Development (Computer Aided Machine Drawing) | CE | - | - | 2 | - | - | 50 | - | - | 50 | 1 |
| MEUA21179 | Environmental Studies | CE | 1 | - | 2 | - | - | 50 | - | - | 50 | 2 |
| A2 | Audit Course | - | - | - | - | - | - | - | - | - | - | - |
| | Total | - | **17** | **2** | **10** | **75** | **75** | **300** | **250** | **50** | **750** | **24** |

*Courses have lab practice component of 2 hrs. /week each under Lab practice head.
L: 1Hr. = 1 Credit, P: 2 Hrs. = 1 Credit, #T: 1 hr. = 1 Credit, Audit Course: No Credits

**Audit Courses:** Professional Ethics; Cyber Security; Value Engineering and Human Rights; Legislative Procedures; Technical Writing/Documentation; Sports/Yoga; Performing Art such as music, dance, and drama etc.; Languages; Online certification course (minimum two weeks); Participation in intercollegiate co-curricular and extra-curricular activities.

BoS Chairman Dean Academics Director

## Second Year B. Tech. Mechanical Engineering (SYBT) - Semester II (Pattern 2017)

| Course Code | Course | Course Type | Teaching Scheme | | | Examination Scheme | | | | | Total | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Formative Assessment | | | Summative Assessment | | | |
| | | | | | | ISE | | CE | ESE | PR/ OR | | |
| | | | L | T | P | T1 | T2 | | | | | |
| MEUA22171 | Kinematics of Machinery | TH | 4 | - | - | 15 | 15 | 20 | 50 | - | 100 | 4 |
| MEUA22172 | Kinematics of Machinery- Practice | CE | - | 1 | - | - | - | 50 | - | - | 50 | 1 |
| MEUA22173 | Internal Combustion Engines* | TH | 3 | - | - | 15 | 15 | 20 | 50 | - | 100 | 3 |
| MEUA22174 | Fluid Mechanics* | TH | 3 | - | - | 15 | 15 | 20 | 50 | - | 100 | 3 |
| MEUA22175 | Mechatronics* | TH | 3 | - | - | 15 | 15 | 20 | 50 | - | 100 | 3 |
| MEUA22176 | Industrial Psychology | TH | 3 | - | - | 15 | 15 | 20 | 50 | - | 100 | 3 |
| MEUA22177 | Lab Practice –II | CE PR/OR | - | - | 6 | - | - | 50 | - | 50 | 100 | 3 |
| MEUA22178 | Skill Development (Workshop Practice –II) | CE | - | - | 2 | - | - | 50 | - | - | 50 | 1 |
| MEUA22179 | Project Management | CE | 2 | - | - | - | - | 50 | - | - | 50 | 2 |
| A2 | Audit Course | - | - | - | - | - | - | - | - | - | - | - |
| | Total | - | **18** | **1** | **8** | **75** | **75** | **300** | **250** | **50** | **750** | **23** |

*Courses have lab practice component of 2 hrs./ week each under Lab practice head.
L: 1Hr. = 1 Credit, P: 2 Hrs. = 1 Credit, #T: 1 hr. = 1 Credit, Audit Course: No Credits

**Audit Courses:** Professional Ethics; Cyber Security; Value Engineering and Human Rights; Legislative Procedures; Technical Writing/Documentation; Sports/Yoga; Performing Art such as music, dance, and drama etc.; Languages; Online certification course (minimum two weeks); Participation in intercollegiate co-curricular and extra-curricular activities.

BoS Chairman Dean Academics Director

## INDEX

# Semester – I

# Engineering Mathematics – III (MEUA21171)

**Teaching Scheme**
Credits: 4
Lectures: 4Hrs./week

**Examination Scheme**
Formative Assessment : 50 Marks
Summative Assessment: 50 Marks

**Prerequisite:** Basics of Derivatives, Integration, Trigonometry, Vector Algebra & Partial differentiation.

**Course objectives:**

- To introduce higher order Linear Differential Equations and modelling of mass spring systems, free and forced damped and undamped systems.
- To introduce Fourier Transform and Applications
- To know Statistical technique to analyse the data.
- To introduce Vector Differentiation.
- To introduce Vector Integration.
- To introduce Partial Differential Equations

**Course Outcomes:**

After successful completion of the course, student will be able to:

1. Solve the Linear Differential equations, modelling of mass spring systems, free and forced damped and undamped systems.
2. Analyze continuous and discrete system using the knowledge of Fourier Transform.
3. Apply Statistical techniques in Engineering fields
4. Solve vector differential calculus that includes physical phenomenon viz gradient, divergence, curl, etc.
5. Describe the applications of vector integral calculus viz work done, electric flux etc
6. Develop the modeling of boundary value problems.

**Unit I - Linear Differential Equations**

LDE of nth order with constant coefficients, Method of Variation of Parameters, Cauchy's & Legendre's DE, Solution of Simultaneous and Symmetric Simultaneous DE, Modelling of mass spring system.

**Unit II –Transforms**

Fourier Transform (FT) : Complex Exponential form of Fourier Series, Fourier Integral Theorem , Sine and Cosine Integrals, Fourier Transform ,Fourier Sine and Cosine Transform and their Inverses, Laplace Transforms(LT):- Definition of LT, Properties and Theorems ,LT of standard functions ,Inverse LT

**Unit III - Statistics**

Moments, Skewness and Kurtosis, Correlation and Regression, Probability Distribution:- Binomial, Poisson and Normal Distributions, -Sampling Distributions, t-distribution, Chi-Square distribution

**Unit IV-Vector differential Calculus**

Physical interpretation of Vector differentiation, Vector differential operator, Gradient, Divergence and Curl, Directional derivative, Solenoidal, Irrotational and Conservative fields, Scalar Potential,Vector identities

| **Unit V-Vector Integral Calculus& Applications** |
|---|
| Line, Surface and Volume integrals, Work-done, Green's Lemma, Gauss's Divergence theorem, Stoke's theorem, Applications to problems in Fluid Mechanics. |
| **Unit VI - Partial Differential Equations & Applications** |
| Formation of PDE, Methods to solve the first order PDE (Type- 1-4), and Applications of PDE: Modelling of Vibrating string, Wave equation, One and two dimensional heat flow equations. |

**Text Books:**

1. A Text book of Applied Mathematics by P.N. Wartikar, U.N.Wartikar (Pune Vidyarthi Griha Prakashan ,Pune) (Volume II-ISBN 81-85825-07-6)((Volume III-ISBN 81-85825-01-7)
2. Advanced Engineering Mathematics by Erwin Kreyszig (Wiley Eastern Ltd.).(*ISBN* 978-0-470-45836-5.)

**Reference books:**

1. Higher Engineering Mathematics by B.S.Grewal (KhannaPublication,Delhi) (ISBN-13. 978-81-7409-195-5. *ISBN*-10. 81-7409-195-5)
2. Advanced Engineering Mathematics by Wylie C.R &Barrett L.C.(McGraw-Hill,INC)(*ISBN* 0 - 07 -463841 – 6)
3. Advanced Engineering Mathematics by Peter V.O'Neiol(ISBN-13: 9781111427429 / ISBN-10: 1111427429)

**Course Coordinator:** Mrs. P. U. Belhekar

**BoS Member:**

**BoS Chairman:**

# Mathematics Practice – III (MEUA21172)

**Teaching Scheme**
Credit: 1
Tutorial work: 1 Hr./week

**Examination Scheme**
Formative Assessment : 50 Marks
Summative Assessment : NA

**Course Objectives:**

- To introduce and practice the various types of problems based on proposed topics of syllabus.
- To introduce application based example.

**Course Outcomes:**

After successful completion of the course, student will be able to:

1. Solve the Linear Differential equations, modelling of mass spring systems, free and forced damped and undamped systems.
2. Analyze continuous and discrete system using the knowledge of Fourier Transform.
3. Apply Statistical techniques in Engineering fields
4. Solve vector differential calculus that includes physical phenomenon viz gradient, divergence, curl, etc.
5. Describe the applications of vector integral calculus viz work done, electric flux etc.
6. Develop the modeling of boundary value problems.

**Tutorial (Assignments):**

1. Practice Problems on Complimentary Functions& Particular Integral.
2. Practice Problems on Method of Variation of Parameters, Cauchy's & Legendre's differential equations.
3. Practice Problems on Fourier Transform (FT) and Laplace Transform(LT)
4. Practice Problems on Applications of Fourier Transforms in Heat equation.
5. Practice Problems on Statistical methods.
6. Practice Problems on Probability.
7. Practice Problems on Vector Differentiation, Gradient, Divergence and Curl, Directional derivative.
8. Practice Problems on Solenoidal, Irrotational and Conservative Fields, Scalar Potential, vector identities.
9. Practice Problems on Line integral, Greens Theorem, Gauss divergence Theorem. Stokes theorem.
10. Practice Problems on Partial Differential Equations.

**Course coordinator:** Mrs. P. U. Belhekar

**BoS Member:**

**BoS Chairman:**

# Manufacturing Processes (MEUA21173)

**Teaching Scheme**
Credits: 4
Lectures: 3 Hrs./week
Tutorial : 1Hr./week

**Examination Scheme**
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

**Prerequisite:** Basic Mechanical Engineering, Engineering Physics, Engineering Chemistry, Engineering Mathematics, Workshop Practice I.

**Course objectives:**

- To familiarize students with major manufacturing processes
- To correlate the material type with the possible fabrication processes
- To describe the operations and tools for major manufacturing processes
- To interpret the knowledge about manufacturing processes, parameters and their effects on performance.

**Course Outcomes:**

By the end of the course, students will be able to

1. Describe fundamentals of metal casting processes, casting defects and product design considerations.
2. Explain material behavior, temperature, and analysis of metal forming processes.
3. Calculate punch and die dimensions and press capacity for sheet metal processes.
4. Describe various material forming and shaping processes for plastics, composites and rubber.
5. List various joining and assembly processes, their applications and design considerations for welding and assembly.
6. Explain different machining operations with power and energy relationships.

**Unit I - Metal Casting Processes**

Fundamentals of metal casting, heating and pouring, solidification and cooling, sand casting: Patterns and cores, Moulds and mould making, other expandable and permanent-mould casting processes, Furnaces, Pouring, cleaning and heat treatment, casting defects, metals for casting, product design considerations (allowances).

**Unit II - Metal Forming**

Bulk deformation processes, Material behavior and temperature in metal forming, Rolling, Forging, Other deformation processes related to Rolling and Forging, Extrusion and Wire drawing. Analysis of Rolling, Forging, Extrusion and Wire drawing.

**Unit III - Sheet Metalworking**

Sheet metal working: cutting and bending operations, drawing, Dies and presses for sheet metal processes, Engineering analysis of sheet-metal cutting, bending and drawing, Stretch forming, Roll bending and forming, Spinning and High-energy rate forming.

**Unit IV- Plastics and Composite Materials**

Extrusion, Production of sheet, film, Injection moulding, Compression and transfer moulding, Blow moulding, Thermoforming, Overview of Polymer Matrix Composites (PMC) and Rubber processing, Open and closed mould processes, Rubber processing and shaping, Manufacturing of tires and other rubber products.

**Unit V- Joining and Assembly processes**

Physics of welding, Features of a fusion welded joint, Arc welding, Resistance welding, Oxyfuel gas welding, Other fusion welding processes, Solid state welding, Weld quality, Weldability, Design considerations in welding, Brazing, soldering, Adhesive Bonding, Mechanical Assembly: Threaded fasteners, rivets and Eyelets.

**Unit VI– Machining Processes**

Theory of chip formation in metal machining, Force relationships and the Merchant equation, power and energy relationships in machining, Cutting temperature, Machining operations and machine tools: Turning, drilling, milling and related operations, Machining Centers and Turning centers, Broaching and Sawing operations, Machining of screw threads and gears, Tool life, Tool materials, Tool geometry, Cutting fluids, Selection of cutting conditions.

**Tutorial**

List of Tutorials:

1. Fundamentals of metal casting: Calculations related to heating and pouring the molten metal, shrinkage, solidification time, buoyancy force, G-factor in Centrifugal casting.
2. Calculation of flow stress, average flow stress, analysis of rolling, forging, extrusion and drawing in terms of forming process and deformation.
3. Calculation of punch and die sizes and tonnage requirement for blanking and punching operations.
4. Calculation of blank size, bend allowance, bending force for bending operation and calculation of drawing ratio, reduction, drawing force and blank-holder force.
5. Numerical on shaping processes for plastics such as extrusion and injection moulding.
6. Numerical on Arc welding, Resistance welding, Oxyfuel welding, threaded fasteners and Interference fits.
7. Numerical on chip formation, forces, power, energy and cutting temperature in machining, machinability and machining economics.
8. Numerical on turning and related operations, drilling, milling and machining and turning centers.
9. Study of milling cutter, twist drill and single point turning tool nomenclature.
10. Numerical on tool life, machining of screw threads and gears .

**Text Books:**

1. Hajara Choudhari, Bose S.K. – Elements of workshop Technology Vol. I &II , Asian Publishing House, ISBN 0713136227
2. M.P Grover – Fundamentals of modern manufacturing: Materials and systems, John Wiley & Sons, Inc, New Jersey, 2010, ISBN 978-0470-467008.
3. R. K. Jain, Production Technology, Khanna Publishers, 16th Edition, 2003.

**Reference Books:**

1. B. Ravi – Metal Casting – Computer Aided design and analysis- Prentice Hall of India ISBN: 8120327268, 9788120327269
2. Reikher – Casting: An analytical approach – Springer ISBN 9781846288494
3. Materials and Processes in Manufacturing, DeGarmo, Black, and Kohser, John Wiley & Sons, Inc,New York, 2011.

4. Kalpakjian and Schmid - Manufacturing Engineering and Technology, Prentice Hall, New Jersey, 2013

**Course Coordinator:** Mr. M. G. Gadge

**BoS Member:**

**BoS Chairman:**

# Strength of Materials (MEUA21174)

**Teaching Scheme**
Credits: 3
Lectures: 3 Hrs./week

**Examination Scheme**
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

**Prerequisite:** Engineering Mathematics, Engineering Mechanics.

**Course Objectives:**

- Mechanical behavior of the body by determining the stresses, strains and deflections produced by the loads up to the elastic limit.
- Fundamental concepts related to deformation, strain energy, moment of inertia, load carrying capacity, slope an deflection of beams, shear forces, bending moments, torsional moments, column and struts, principal stresses and strains.

**Course Outcomes:**

After successful completion of the course, the students will be able to

1. Apply knowledge of Shear force diagram and Bending moment diagram in Engineering application.
2. Understand the various types of stresses.
3. Compute and analyze different stresses induced in beams.
4. Estimate the Slope and Deflection in determinate beams.
5. Understand the concept of Torsion and Buckling.
6. Identify the Principal planes and compute principal stresses for different combination of loads.

**Unit I - Shear Force and Bending Moment Diagrams**

Types of beams, shear forces & bending moment diagrams (Cantilever, Simply supported and Overhang beams) subjected to concentrated loads, uniformly distributed loads, uniformly varying loads & couples, Relationship between rate of loading, shear force and bending moment. Maximum bending moment & positions of points of contraflexure.

**Unit II - Simple Stresses and Strains**

Concept of stress and strain (linear, lateral, shear and volumetric), stress strain diagram for ductile and brittle material, Hooke's law, Modulus of Elasticity, Modulus of Rigidity, Bulk Modulus, Poisson's ratio, relationship between elastic constants, Factor of Safety.
Stresses, strains and deformation in determinate and indeterminate (homogeneous and composite) bars under concentrated loads, Deformation due to self-weight, Temperature stresses in simple members.

**Unit III - Principal Stresses and Strains**

Definition of principal planes & principal stresses, Stresses on oblique plane, planes of maximum shear, Mohr's circle for representation of principal stresses, theories of failure.

**Unit IV - Stresses in Beams**

**Bending stresses:** Theory of simple bending, assumptions, flexural formula, moment of resistance, section modulus, bending stresses in symmetrical sections. Bending stress distribution diagram (rectangular, I,T).
**Shear stresses:** Concept, derivation of shear stress distribution formula, shear stress distribution diagram for common symmetrical sections, maximum and average shear stress.

| **Unit V - Slope and Deflection of Beams** |
|---|
| Relation between BM and slope, slope and deflection of determinate beams, derivation of formula for slope & deflection for standard cases, Macaulay's method.<br>**Strain Energy:** Resilience, proof Resilience, strain energy stored in the member due to gradually applied load, suddenly applied load, impact load. |
| **Unit VI- Torsion and Buckling** |
| **Torsion:** Theory of torsion & assumptions, derivation of torsion equation, polar modulus, stresses in solid and hollow circular shaft, Strength and rigidity criterion for design of shaft, power transmitted solid and hollow circular shaft.<br>**Buckling of columns:** Concept of buckling of columns, Expression for crippling load for various end conditions of column, Limitations of Euler's formula, Rankine's formula, safe load on columns |
| **Text Books:** |
| 1. S. Ramamurtham and R. Narayanan, "Strength of Materials", 18th Edition, Dhanpat Rai Publication, ISBN: 81-87433-54-X.<br>2. S.S. Rattan, "Strength of Material", 2nd Edition, Tata McGraw Hill Publication Co. Ltd., ISBN: 978-0-07-107256-4<br>3. R. K Bansal, "Strength of Materials", 6th Edition, Laxmi Publication, ISBN: 978-81-318-0814-6.<br>4. S.S. Bhavikatti, "Strength of Materials", Vikas Publishing, 4th Edition ISBN: 9789325971578.<br>5. Rajput R. K., "Strength of Materials", S. Chand Publication. ISBN-10 : 8188458104 |
| **Reference Books :** |
| 1. Ferdinand Beer, Jr., E. Russell Johnston, John DeWolf, David Mazurek, 6th Edition, "Mechanics of Materials", Tata McGraw Hill Publication Co. Ltd., ISBN-13: 978-0073380285<br>2. Timoshenko S. P. and Young D. N., "Strength of Materials", Affiliated East-West Press PVT. LTD. New Delhi, 2006, ISBN: 8176710199.<br>3. Singer and Pytel, "Strength of Materials", Addison Wesley Publishing Corporation, 1999, ISBN 0 321 04541 6. |

**Course Coordinator:** Dr. D. N. Kamble

**BoS Member:**

**BoS Chairman:**

# Thermodynamics (MEUA21175)

**Teaching Scheme**
Credits: 3
Lectures: 3 Hrs/week

**Examination Scheme**
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

**Prerequisite:** Engineering Mathematics – I, Engineering Physics, Engineering Chemistry.

**Course Objective:**
To apply thermodynamics laws to power producing and power absorbing devices in order to understand their functioning and improve their performance.

**Course Outcomes:**
By the end of the course, students will able to

1. Apply the first law of thermodynamics to analyze thermodynamic device and ideal gas processes.
2. Describe second law of thermodynamics and concept reversibility and irreversibility.
3. Calculate entropy change during processes.
4. Evaluate various properties of steam using the steam table.
5. Explain fuel calorific value, steam generator and its performance calculations.
6. Explain theory and performance calculation of compressors.

**Unit I - First Law of Thermodynamics**

Review of basic terms and definitions, Microscopic and Macroscopic approach, Thermodynamic equilibrium, Point and path function, Heat and work, Perfect gas laws, PMM I, SFEE (Pump, compressor, turbine, boiler, condenser, evaporator, nozzle).
Applications of first law to non-flow processes (Constant Pressure, Constant Volume, Isothermal, Adiabatic, and Polytrophic), Calculations of heat transfer, work done, internal energy and enthalpy.

**Unit II - Second Law of Thermodynamics**

Limitations of First law, Clausius and Kelvin Plank Statement and their equivalence, PMM II, Reversibility and irreversibility, causes of reversibility, Conditions for reversibility.
Carnot cycle for heat engine, heat pump and refrigerator, Carnot theorem, Clausius inequality.

**Unit III - Entropy**

Concept of entropy, entropy changes for an ideal gas during reversible process, entropy of isolated system, principle of entropy increase, available and unavailable energy.

**Unit IV - Properties of Steam**

Formation of steam, phase changes, properties of steam, P-V, T-S and Mollier diagram for steam, dryness fraction and its determination, steam calorimeters (Barrel, Separating, Throttling and combined) Non-flow and Steady flow vapour processes, change of properties, work and heat transfer.
Thermodynamic Vapor Cycle, Rankine and modified Rankine cycle, work done and efficiency, Specific steam consumption, comparison of Rankine and Carnot cycle.

**Unit V - Steam Generators**

Boiler mounting and accessories, boiler draught (natural and artificial draught),boiler performance calculations, equivalent evaporation, boiler efficiency, Energy balance and IBR Act.

| |
|---|
| Classification of fuels, calorific value of fuel, Bomb calorimeter, Junker gas calorimeter. |
| **Unit VI - Reciprocating Air Compressor** |
| Classification of compressor, Reciprocating compressor-Single stage compressor – computation of work done, isothermal efficiency, effect of clearance volume, volumetric efficiency, Free air delivery, Theoretical and actual indicator diagram.<br>Multistaging of compressor- Computation of work done, volumetric efficiency, condition for maximum efficiency, Inter-cooling and after cooling. |
| **Text Books** |
| 1. Y. Cengel & Boles: Thermodynamics – An Engineering Approach, Tata McGraw Hill Publications, ISBN 13:9780072884951<br>2. R. K. Rajput, Engineering Thermodynamics, EVSS Thermo Laxmi Publications, ISBN: 978-81-318-0058-4<br>3.P. K. Nag, Engineering Thermodynamics, Tata McGraw Hill Publications, ISBN-13: 978-1-25-906256-8 |
| **Reference Books** |
| 1. P. L Ballany: Thermal Engineering, Khanna Publishers, ISBN-13: 978-81-7409-031-2<br>2. C.P. Arora: Engineering Thermodynamics, Tata McGraw Hill Publications, ISBN – 9780074620144 |

**Course Coordinator:** Mrs. H. Y. Kolekar

**BoS Member:**

**BoS Chairman:**

# Material Science and Engineering Metallurgy (MEUA21176)

**Teaching Scheme**
Credits: 3
Lectures: 3 Hrs/week

**Examination Scheme**
Formative Assessment : 50 Marks
Summative Assessment: 50 Marks

**Prerequisite:** Engineering Physics, Engineering Chemistry, Basic Mechanical Engineering.

**Course objective:**
To Describe importance of crystal structure and importance phase diagram and co-relation of different phases with different mechanical properties. Perform various heat treatments tests for material properties and characterization of industrial samples.

**Course Outcomes :**
After successful completion of the course, student will be able to

1. Apply the basic concepts of crystal structure and structure of metal.
2. Explain the plastic deformation of different metals and non- destructive testing.
3. Apply the fundamentals of metallography in material science the importance of equilibrium diagrams.
4. Apply the fundamentals of different types of steels from basics of material science and the importance of Iron Carbon equilibrium diagram.
5. Summarize the difference between alloy steels and cast iron.
6. Describe different heat treatments, their importance and non- ferrous materials.

**Unit I - Structure of Materials**

Crystal structures, indexing of lattice planes, indexing of lattice directions, no. of atoms per unit cell, atomic packing factor imperfections in crystals - point defects, line defects, surface , mechanism of plastic deformation and effect on mechanical properties , deformation of single crystal by slip

**Unit II -Deformation Mechanisms and Introduction to NDT**

Plastic deformation of polycrystalline materials with slip and Twining Annealing and its stages, fatigue test, creep test. Introduction to different Non-destructive test

**Unit III - Metallographic and Introduction to Equilibrium diagrams**

Microscopy, specimen mounting, study of metallurgical microscope macros copy, specimen preparation, sulphur printing, flow line observations. Importance of Equilibrium diagram with basic terms. Hume Rotheyr's rule of solid solubility, allotropy and polymorphism, study of eutectic system.

**Unit IV - Equilibrium Diagrams**

Plotting of Iron-iron carbide equilibrium diagram, critical temperatures and application of lever rule for finding out different phases and its percentage in slowly cooled steels, Classification and application of plain carbon steels specification of steels.

**Unit V - Alloy Steels and cast Irons**

Introduction to tool steel, Introduction to cast Iron and its basic types, non-equilibrium cooling of steels, transformation products of austenite, time temperature transformation diagrams, critical cooling rate.

**Unit VI - Heat- treatment of Steels and Introductions to Non ferrous Materials**

Heat treatment of steels like Annealing, normalizing, hardening & tempering, retention of austenite: effects of retained austenite, elimination of retained austenite, Introduction to non ferrous materials ( basics about brass and bronz).

**Text Books:**

1. Dr. V.D. Kodgire & S. V. Kodgire, "Material Science & Metallurgy For Engineers", Everest Publication 2008 , ISBN 81-86314-00-8.
2. K. Bhargava, C.P. Sharma "Mechanical Behavior & Testing Of Materials",. P H I Learning Private ltd.., ISBN: 978-81-203-4250-7

**Reference books:**

1. Smith W.F., "Principles of Material Science and Engineering", McGraw Hill Book Co., 2002.ISBN: 0070591695
2. Donald R. Askland, Phule P. P., "Science and engineering of materials", Thomson Learning, 2003.ISBN: 053455396
3. Callister W. D, "Materials Science and Engineering", John Wiley, ISBN 9780470419977
4. Higgins R. A., "Engineering Metallurgy", Viva books Pvt. Ltd., 2000, ISBN 0340568305
5. Raghvan V. "Material Science &Engg.", Prentice Hall of India , New Delhi. 2003
6. Avner, S.H. Introduction to Physical Metallurgy, Tata McGraw-Hill, 1997. ISBN 10: 0074630067
7. Dieter, G.E, Mechanical Metallurgy, McGraw-Hill, 1988, ISBN 0-521-64684-7
8. U. C. Jindal, Material Science and Metallurgy, , Pearson Edu., 2012, ISBN:9788131759110
9. T.E. Reed-Hill and R. Abbaschian, Physical Metallurgy Principles, Thomson, 3rd edition,2003,
   ISBN- 978-0-495-08254-
10. Murthy, "Structure and properties engineering materials", Tata McGraw Hill 2003.ISBN: 007048287XG. S. Sawhney, " Fundamentals of fluid mechanics" , I. K. International Publishing House Pvt. Ltd. New Delhi
11. G.F. Carter and D.E. Paul, Materials Science and Engineering, ASM International, 3rd edition, 2000, ISBN: 9780871703996

**Course Coordinator:** Mrs. S. V. Dravid

**BoS Member:**

**BoS Chairman:**

# Lab Practice –I (MEUA21177)

**Teaching Scheme**
Credits: 3
Lectures: -- Hrs/week
Laboratory Work: 6 Hrs. /week

**Examination Scheme**
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

**Course Objectives:**

- To offer hands-on experience with the operation of a various thermal systems like Steam generator, Air compressor, Steam calorimeters and fuel calorimeters.
- To offer hands-on experience with various tests on Universal Testing machine and experimental verification for cantilever and simply supported beams.
- To offer hands on experience with hardness tests, impact test and provide the knowledge of metallurgical microstructure and heat treatment of steel.

**Course Outcomes:**

At the end of the course the students will able to,

1. Conduct various tests and can obtain various material properties.
2. Design structural elements, machine parts and perform engineering work in accordance economic constraints.
3. Operate and analyze various thermal systems in detail to determine its performance parameters.
4. Determine operating and performance parameters of a given system using any suitable programming tool.
5. Conduct various hardness tests to determine hardness of materials.
6. Explain the metallurgical microscope, microstructure of steel and cast iron and heat treatment of plain carbon steel.

**A] Lab Practice - Strength of Materials (MEUA21174)**

Lab Practice shall consist of the following :

1. Shear test of ductile material on Universal Testing Machine
2. Tensile test on ductile and brittle materials on Universal Testing Machine
3. Experimental verification of flexural formula in bending for cantilever beam
4. Experimental verification of flexural formula in bending for simply supported beam
5. Torsion test on circular bar
6. Impact test on metals
7. Shear force and bending moment diagrams with different end conditions
8. Slope and deflection
9. Buckling of columns
10. Principal stresses through graphical and analytical method

**B] Lab Practice – Thermodynamics (MEUA21175)**

The lab Practice consist of the following :

1. Demonstration and study of Boiler Mountings.
2. Demonstration and study of Boiler Accessories.
3. Determination of dryness fraction of steam.

4. Trial on boiler to determine boiler efficiency, equivalent evaporation and Energy Balance.
5. Industrial visit to any processing unit having boiler.
6. Determination of calorific value using Gas calorimeter.
7. Determination of calorific value using Bomb calorimeter.
8. Trial on reciprocating air compressor.
9. Programming assignment on entropy change for an ideal gas during process.
10. Programming assignment on Carnot cycle to determine efficiency/ COP

**C] Lab Practice - Material Science and Engineering metallurgy (MEUA21176)**

Lab practice consists of the following :

1. Study and calculate atomic packing factor for SC,BCC and FCC metals
2. Study and trial on Brinell hardness test
3. Study and trial on Vickers hardness test
4. Study and trial on impact test
5. Study and performance on magnetic particle & dye penetrant test
6. Study of metallurgical microscope
7. Study & demonstration of specimen preparation for microscopic examination.
8. Study and drawing of microstructure of steels and cast Iron.( min 2 )
9. Heat treatment of plain carbon steel and determination of relative hardness
10. To study effect of carbon percentage on hardness of steels

**Text Books:**

**A]** 1.S. Ramamurtham and R. Narayanan, "Strength of Materials", 18th Edition, Dhanpat Rai Publication, ISBN: 81-87433-54-X.
2. S.S. Rattan, "Strength of Material", 2nd Edition, Tata McGraw Hill Publication Co. Ltd., ISBN: 978-0-07-107256-4
3. R. K Bansal, "Strength of Materials", 6th Edition, Laxmi Publication, ISBN: 978-81-318
4. Rajput R. K., "Strength of Materials", S. Chand Publication. ISBN-10 : 8188458104

**B]** 1.Y. Cengel & Boles: Thermodynamics – An Engineering Approach, Tata McGraw Hill Publications, ISBN 13:9780072884951
2.R. K. Rajput, Engineering Thermodynamics, EVSS Thermo Laxmi Publications, ISBN: 978-81-318-0058-4
3. P. K. Nag, Engineering Thermodynamics, Tata McGraw Hill Publications.

**C]** 1.Dr. V.D. Kodgire & S. V. Kodgire, "Material Science & Metallurgy For Engineers", Everest Publication 2008, ISBN 81-86314-00-8.
2. K. Bhargava, C.P. Sharma "Mechanical Behavior & Testing Of Materials",. P H I Learning Private ltd.., ISBN: 978-81-203-4250-7

**Course Coordinator:**

Dr. D. N. Kamble

Mrs. H.Y.Kolekar

Mrs. S.V.Dravid

**BoS Member:**

**BoS Chairman:**

## Skill Development-I (Computer Aided Machine Drawing) (MEUA21178)

**Teaching Scheme**
Credit: 1
Lectures: -- Hrs/week
Laboratory Work: 2 Hrs/week

**Examination Scheme**
Formative Assessment:50 Marks
Summative Assessment : NA

**Prerequisite:** Engineering Graphics I & II, Basic knowledge of 2-D drawing using graphics software.

**Course objectives:**

- To understand Parametric Modeling Fundamentals, Procedure, and Approaches.
- To develop ability to Create Parametric 2-D Sketches, and Create and Edit Parametric Dimensions.
- To develop ability to Create Solid Models of machine components.
- To develop ability to Create assembly models of simple machine (minimum 5 components).
- To develop the ability to apply Limits Fits, and Dimensional Tolerances, as well as Geometric Tolerances to components and assemblies on Engineering Drawings.
- To develop an ability to create 2D drawings from 3D CAD models

**Course Outcomes:**

After successful completion of the course, student will be able to

1. Prepare manufacturing/ industrial drawing as per IS conventions.
2. Generate different part models from drawings
3. State basics of surface modeling and sheet metal design modeling platform
4. Pre[are the assembly of simple components
5. Describe the concept of tolerances
6. Prepare manufacturing drawings

**Unit I - Introduction**

Introduction – Machine Drawing Standard Conventions, Representation of machine elements and parts such as screws, nuts, bolts, keys, gears, webs, ribs.

**Unit II - Part Modeling**

Solid modeling. Introduction to Graphical User Interface (GUI) of commercially used solid modeling software, Fundamentals apply/modify constraints and dimensions transform the parametric 2-D sketch into 3D solid, Feature operations, Overview to Parametric Modeling.

**Unit III - Surface Modeling and Sheet Metal Design**

Generating Wireframe Elements, Generating Basic Surfaces, Performing Operations, Transformation features, Generating Multiple Walls, Bending Walls, Cutting and Stamping, Transformation features, Generating multiple views.

**Unit IV - Assembly Modeling**

Assembly modeling – defining relationship between various parts of machine, Creation of constraints, Generation of exploded view.

**Unit V –Tolerance**

Dimensioning Techniques, Geometric Dimensions and tolerances (GD and T), Limit, fits and tolerances, Introduction to Tolerance Stack-up

| **Unit VI - Manufacturing Drawing** |
|---|
| Generation of 2-D sketches from parts and assembly of 3-D models, Appropriate dimensioning and tolerance, Inserting Sheets and Tables, Generating BOM table, Generating Balloons, Dress up features Welding symbols. |

**Lab Practice:**

**Assignments:**

1. Machine Drawing Conventions.
2. Sketcher Workbench.
3. Part Modeling of a Machine Components using various Commands and Features of the CAD Software.
4. Solid Modeling of the Components of Machine Assemblies.
5. Surface Modeling of the Components of MachineAssemblies.
6. Sheet Metal Design of the Components of Machine Assemblies.
7. Assembly Modeling of Machines Components.
8. Tolerance stack-up.
9. Manufacturing Drawings (Manual) of the Parts and Assemblies with Appropriate Tolerance.
10. Manufacturing Drawings (CAD) of the Parts and Assemblies with Appropriate Tolerance.

***Important Note*:-**

***Submission of all above assignments should be in electronic format only (preferably in single CD/DVD for all batches/students)***

**Text Books:**

1. N. D. Bhatt and V.M. Panchal, Machine Drawing, Charoter Publications ISBN-13:9789380358888
2. Ajeet Singh, " Machine Drawing", Mc Graw Hill Publications, New Delhi 2012.

**Reference books:**

1. ASME Y14.5 – 2009 ISBN: 9780791822234.
2. Ibrahim Zeid, Mastering CADCAM, McGraw-Hill ISBN-10: 0072868457 ISBN-13**:** 978-0072868456
3. Help Manuals and Tutorials of Referred CAD Software.

**Course Coordinator:** Mr. N. B. Kate

**BoS Member:**

**BoS Chairman:**

# Environmental Studies (MEUA21179)

**Teaching Scheme**
Credits: 2
Lectures: 1Hr./week
Laboratory Work: 2 Hrs./week

**Examination Scheme**
Formative Assessment: 50 Marks
Summative Assessment : NA

**Prerequisite :** Engineering Physics and Chemistry.

**Course Objective:** The objective of this course is to provide knowledge about multidisciplinary nature of environment, air pollution, E waste, Noise pollution and its control.

**Course Outcomes:** At the end of the course the students will have an ability to,

1. Discuss the air pollution and its impact
2. State ambient noise pollution and its importance.
3. Describe impact of environmental problems on socio economic engineering.

**Unit I - Air Pollution Meteorology and control techniques**

Zones of atmosphere, stability of atmosphere, effects of terrain, lapse rate, atmospheric dispersion, macro and micro scale. National ambient air pollution standards for particulate matter and gaseous, Gaseous pollution control techniques such as absorption, adsorption, and combustion. Particulate matter control techniques such as fabric filter, cyclone chamber, settling chamber.

**Unit II-Water treatment, Noise Pollution control and E waste**

Filtration system- Gravity sand filter, Rapid gravity sand filters , Pressure sand filters , Dual media filters, Multimedia filters Auto valve-less gravity filters ,Activated carbon filters , Walnut shell carbon filters, Micron filtration systems, Micro filtration systems. Ion exchange treatment, membrane base treatment, Resin base treatment, Sound measurement, sound pressure, intensity, sound pressure level, decibel scale. Noise control and source, path, receiver. Noise level standards.E-waste definition, E-waste problems, hazards and solutions, Effect of e waste on human and environment, Treating E-waste,

**Unit-III- Environment Act**

Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and Control of Pollution) Act. , Wildlife Protection Act., Forest Conservation Act., Issues involved in enforcement of environmental legislation. Public awareness.

**Term work:**

1. Create and demonstrate model for forest ecosystem.
2. Determination of noise pollution by measuring sound.
3. Create presentation on different air pollution measurement techniques.
4. Create presentation on different noise pollution measurement techniques.
5. Create presentation on water pollution causes, effect and prevention.
6. Create presentation on automobile pollution causes, effect and prevention.
7. Create presentation on air pollution causes, effect and prevention.
8. Create presentation on case study on air pollution for metro city.
9. Create presentation on case study on noise pollution for any industry.
10. Study of various recycling techniques using online videos.
11. Design and present chart explaining E- waste management.

**Text books:**

1. Electronic waste management by, R E Hester, R M Harrison.
2. Air and noise pollution control vol-I, Wang, Lawrence K., Pereira, Norman C. (Eds.)
3. Principals of water treatment, Kerry J. Howe, David W. Hand, John C. Crittenden, R. Rhodes .

**Reference books:**

1. Environmental engineering by H.S. Pavey Rowe , Tata McGrawhill Publication.
2. EIA manual of MHRD (Govt. of India)

**Course Coordinator:** Dr. D.A. Kamble

**BoS Member**:

**BoS Chairman**:

# Semester – II

# Kinematics of Machinery (MEUA22171)

**Teaching Scheme**
Credits: 4
Lectures: 4Hrs./week

**Examination Scheme**
Formative Assessment : 50 Marks
Summative Assessment: 50 Marks

**Prerequisite:** Engineering Mathematics –I, II and III, Engineering Physics, Engineering Graphics-I, Engineering Mechanics, Basic Mechanical Engineering.

**Course objectives:**
After this course students will be able to:

- Make the student conversant with commonly used mechanism for industrial application.
- Develop competency in drawing velocity and acceleration diagram for simple mechanism.
- Develop analytical competency in solving kinematic problems related to four bar mechanism.
- Make the student conversant with synthesis of the mechanism.
- Develop competency in drawing cam profile.

**Course Outcomes:**
After successful completion of the course, student will be able to

1. Characterize different mechanisms used in simple mechanical systems.
2. Analyze motion conversion of simple mechanisms using analytical method.
3. Perform velocity analysis on simple mechanisms using graphical approach.
4. Perform acceleration analysis on simple mechanisms using graphical approach.
5. Able to synthesize simple four bar mechanism.
6. Design cam profile for desired motions.

**Unit I - Fundamentals of Kinematics and Mechanisms**

Kinematic link, Types of links, Kinematic pair, Types of constrained motions, Types of Kinematic pairs, Kinematic chain, Types of joints, Mechanism, Machine, Degree of freedom (Mobility), Kutzbach crieterion, Grubler's criterion.
Four bar chain and its inversions, Grashoff's law, Slider crank chain and its inversions
Exact and Approximate Straight-line mechanism, Steering gear mechanisms: Condition for correct steering, Davis steering gear mechanism, Ackermann steering gear mechanism.

**Unit II - Kinematic Analysis of Mechanisms: Analytical Methods**

Analytical method for displacement, velocity and acceleration analysis of slider crank Mechanism.
Position analysis of links with vector and complex algebra methods, Loop closure equation, Velocity and acceleration analysis of slider crank mechanisms using complex algebra method Chase solution

**Unit III -Velocity Analysis of Simple Mechanisms: Graphical Methods**

Relative velocity method: Angular velocity of a link, Sliding velocity, Velocity polygons for simple mechanisms. (mechanisms up to 6 links)
Instantaneous center of rotation (ICR) method: Definition & Types of ICR, Kennedy's Theorem, Methods of locating ICRs (mechanisms up to 6 links)

**Unit IV - Acceleration Analysis of Mechanisms: Graphical Methods**

Relative acceleration method: acceleration of a link, Acceleration polygons for simple mechanisms. (mechanisms up to 4 links)
Velocity and acceleration diagrams for the mechanisms involving Coriolis component of acceleration. (mechanisms up to 4 links)

**Unit V -Synthesis of Mechanism**

Steps in synthesis process: Type, number and dimensional synthesis.
Tasks of Kinematic synthesis: Path, function and motion generation (Body guidance).
Precision Positions, Chebychev spacing, Mechanical and structural errors.
Graphical synthesis: Two and three position synthesis using inversion method
Freudenstein's equation for four bar Mechanism, Three position function generation using the equation.

**Unit VI - Cam & Followers**

Cams and its Classification, Followers and its Classification.
Motion analysis and plotting of displacement – time, velocity time, and acceleration time, jerk-time graphs for uniform velocity, UARM, SHM and Cycloid motions
Cam profile for radial and offset followers, Motion analysis of simple cams – R-R cam, D-R-R and D-R-D-R , Pressure angle and methods to control pressure angle.

**Text Books:**

1. Ballaney P. L., "Theory of Machines and Mechanisms", Khanna Publisher Delhi, 1999. ISBN:817409122X.
2. Rattan S.S., "Theory of Machines", 2nd., TataMcGraw-hill publishing, 2005, ISBN 007-059120-2.
3. Thomas Bevan, "Theory of machines", CBS publishers and Distributors, 1984. ISBN:8131729656

**Reference Books:**

1. Ghosh Amitabh and Malik Ashok Kumar, "Theory of mechanisms and Machines", 3ed, Affiliated East West press, 2000, ISBN 81-85938-93-8
2. Allen Strickland, Jr. Hall, "Kinematics and Linkage Design", Waveland Pr Inc (1986) ISBN 10: 0881332720
3. Wilson C.E., Sandler J. P. "Kinematics and Dynamics of Machinery", Person Education. ISBN 020135099-8
4. Erdman A.G. and Sandor G.N., "Mechanism Design, Analysis and Synthesis" Volume-I, Prentice –Hall of India.
5. Shigley Joseph Edward and Vicker John Joseph. "Theory of Machines and Mechanisms", 3ed., 1995, Oxford University Press. ISBN 0-19-515598-x.

**Course Coordinator**: Mr. P. R. Anerao

**BoS Member:**

**BoS Chairman:**

# Kinematics of Machinery Practice (MEUA22172)

**Teaching Scheme**
Credits: 1
Tutorial: 1 Hr. /week

**Examination Scheme**
Formative Assessment: 50 Marks
Summative Assessment: NA

**Course Objective:** Develop competency in solving kinematic problems related to simple mechanism.

**Course Outcomes: At the end of the course students will able to**

1. Characterize different mechanisms used in simple mechanical systems.
2. Analyze motion conversion of simple mechanisms using analytical method.
3. Perform velocity analysis on simple mechanisms using graphical approach.
4. Perform acceleration analysis on simple mechanisms using graphical approach.
5. Synthesize simple four bar mechanism.
6. Design cam profile for desired motions.

**List of Assignments for Tutorial:**

1. Draw (any 4) configurations of mechanisms and determine types of pairs, links, degree of freedom.
2. Build and execute a computer program to solve problem on velocity and acceleration analysis using analytical methods and compare results.
3. Two problems on velocity analysis using ICR method.
4. Two problems on velocity and acceleration analysis using relative velocity and acceleration method.
5. Two problems on velocity and acceleration analysis using relative velocity and acceleration method involving Coriolis component.
6. Problems on velocity and acceleration analysis using Klein's construction for uniform and non-uniform crank velocity.
7. Synthesize the four bar and slider crank mechanisms using inversion methods with three precision positions.
8. Build and execute a computer program to solve problem on synthesis of four bar mechanism using Freudenstein's equation.
9. Draw the cam profiles and study the effect of different follower motions and types
10. Verify the cam jump phenomenon for an eccentric cam

**Course Project:**

At the end of the course student will submit either working model or simulated model of any simple mechanism. In which student should present following

- Identification and application of the mechanism
- Synthesis of the mechanism
- Manufacturing and assembly of the mechanism
- Kinematic analysis of the mechanism

**Course Coordinator:** Mr. P. R. Anerao

**BoS Member:**

**BoS Chairman:**

# Internal Combustion Engines (MEUA22173)

**Teaching Scheme**
**Credits :**3
**Lectures :** 3 Hrs. / week

**Examination Scheme**
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

**Prerequisite:** Engineering Chemistry, Basic Mechanical Engineering, Thermodynamics.

**Course objectives:**

- To get familiar with the fundamentals of IC engines, construction and working principle of an engine, and testing of an engine for analyzing its performance.
- To study the combustion and its controlling factors.
- To study emissions from IC engines and its controlling methods and emission norms.

**Course Outcomes:**

By the end of the course, students will able to

1. Classify various types of Engines, Compare Air standard, Fuel Air and Actual cycles and make out various losses in real cycles.
2. Compare S. I. & C. I. Engine systems.
3. Describe the stages of combustion in S. I. Engines.
4. Describe the stages of combustion in CI Engines
5. Test of I. C. Engines and analyze its performance.
6. Describe methods to minimize environmental hazards caused by IC engines.

**Unit I-Basics of IC Engines**

a) Heat Engine, IC and EC engines, IC Engine construction - components and materials, Engine nomenclature, Valve timing diagram, Intake and exhaust system, Engine classification, Applications.
b) Gas Power Cycles: Otto Cycle, Diesel Cycle, Duel Cycle and its Comparison.
c) Fuel air cycle, Assumptions, Comparison with air standard cycle, Effect of variables on performance,Actual cycle and various losses.

**Unit II- Engine Systems**

a) Fuel Injection System for S. I. Engines: Principle of carburetion, Simple or elementary carburetor, Complete carburetor, Types of carburetors, MPFI System.
Fuel Injection System for C. I. Engines: Direct & Indirect Fuel Injection System, Types of fuel pump and Injector.
b) Cooling System, Lubrication System, Ignition System, Starting System, Supercharging and turbo-charging methods and their limitations, Timing System.

**Unit III- Combustion in SI Engines**

a) Stages of combustion, Flame propagation, Rate of pressure rise, Abnormal combustion, Phenomenon of Detonation in SI engines, Effect of engine variables on Detonation.
b) Combustion chamber designs.

**Unit IV- Combustion in CI Engines**

a) Stages of combustion, Factors affecting combustion, Phenomenon of knocking in CI engine. Effects of knocking, Methods to control knock, Comparison of knocking in SI & CI engines.
b) Combustion chamber design

**Unit V-Testing of IC Engines**

a) Objective of testing, Various performance parameters for IC Engine - Indicated power, brake power, friction power, SFC, AF ratio etc. Methods to determine various performance parameters, characteristic curves, Heat balance sheet.

| **Unit VI-IC Engine Systems, Emissions & its control** |
|---|
| a) Air pollution due to IC engine and its effect, Sources of emissions, Euro norms, Bharat stage norms, Emission control methods for SI and CI engines.<br>b) Developments in IC engines (CNG / LPG / Solar / Hybrid). |
| **Text Books:** |
| 1. V. Ganesan - Internal Combustion Engines, Tata McGraw-Hill<br>2. M.L. Mathur and R.P. Sharma - A course in Internal combustion engines, Dhanpat Rai<br>**3.** H.N. Gupta - Fundamentals of Internal Combustion Engines, PHI Learning Pvt. Ltd. |
| **Reference Books :** |
| 1. Heywood - Internal Combustion Engine Fundamentals, Tata McGraw-Hill<br>2. Domkundwar & Domkundwar - Internal Combustion Engine, Dhanpat Rai<br>**3.** R. Yadav - Internal Combustion Engine, Central Book Depot, Allahabad |

**Course Coordinator:** Mr. C. R. Ramtirthkar

**BoS Member:**

**BoS Chairman:**

# Fluid Mechanics (MEUA22174)

**Teaching Scheme**
Credits: 3
Lectures: 3 Hrs./week

**Examination Scheme**
Formative Assessment :50 Marks
Summative Assessment : 50 Marks

**Prerequisite:** Engineering Mechanics, Engineering Mathematics, Engineering Physics.

**Course objectives:**

- Identify various fluid properties and significances of it.
- To get conversant with the physics of fluid flows & its applications.
- To understand the basics of fluid statics & dynamics.
- Applications of Bernoulli's equations for various applications.
- To get conversant with Internal, External flow & its applications.

**Course Outcomes:**

After successful completion of the course, student will be able to

1. Explain the significance of fluid properties and be able to calculate hydrostatic forces on various types of surfaces.
2. Outline the significance of fluid flows and analyze fluid system using the integral form of the continuity equation.
3. Apply Bernoulli's principle for various fluid system and flow measuring devices.
4. Analyze internal flows and understand the significance of Buckingham's Pi theorem for research work.
5. Explain the losses occurring in pipes and analyze fluid flow through various pipes.
6. Analyze external flow around bodies and submerged bodies.

**Unit I - Fluid properties & Statics**

a) Fluid properties - Definition of fluid, types of fluids, fluid properties such as density, specific weight, specific gravity, dynamic viscosity, Newton's law of viscosity, kinematic viscosity, viscosity index, surface tension, capillarity & vapor pressure.
b) Fluid statics - Fluid pressure at a point, Hydrostatic law, Pascal's law, Total pressure & center of pressure on vertical, horizontal & inclined plane surfaces immersed in a liquid, Buoyancy, stability of floating body, metacenter & metacentric height (No numerical treatment for buoyancy & metacenter )

**Unit II - Fluid Kinematics**

a) Eulerian & Langragian approach of fluid flow, Continuity equation in cartesian coordinates, Various fluid flows such as one, two & three dimensional, steady & unsteady, uniform &nonuniform, laminar & turbulent, compressible & incompressible, rotational &irrrotational flows.
b) Stream line, Path line, Streak line and stream tube, velocity and acceleration of fluid particle, Stream function & velocity potential function, vorticity and flow net.

**Unit III - Fluid Dynamics**

a) Introduction to Navier - Stokes equation, development of Euler's equation, Bernoulli's equation, Bernoulli's theorem, assumptions & limitations of it.
b) Applications of Bernoulli's equation such as Venturimeter, Orificemeter & Pitot tube, flow through an orifice, flow over notches such as rectangular & triangular notces, HGL & TEL, Rotameter.

| **Unit IV- Internal flow & Dimensional analysis** |
|---|
| a) Laminar & turbulent flows physics, entrance region & fully developed flow, Velocity & shear stress distribution for laminar flow in a pipe, fixed parallel plates & Couette flow, hydro dynamically smooth & rough boundaries.<br>b) Dimensional analysis - Dimensions of physical quantities, Buckingham's Pi theorem & dimensionless numbers. |
| **Unit V - Flow through pipes** |
| a) Energy losses through pipes such asmajor & minor losses (No derivation of minor losses), Darcy – Weisbach's equation.<br>b) Flow through compound pipe& parallel pipes, Dupuit's equation, flow through syphon, power transmission through pipes, thermal expansion of pipes, Moody's diagram. |
| **Unit VI - External flows** |
| a) Boundary layer concept, development of boundary layer over flat plate, boundary layer thickness, displacement, momentum & energy thickness (Only numerical treatment & no derivation), Separation of boundary layer& methods of controlling it.<br>b) Forces on submerged bodies such as drag & lift forces, types of drag forces, development of lift over aerofoil , flow around cylinder ( Magnus effect), streamline and bluff bodies. |

| **Text Books:** |
|---|
| 1. Dr. R. K. Bansal , " Fluid mechanics & Hydraulic machines" , Laxmi Publication Pvt. Ltd. , New Delhi.<br>2. Dr. P. M. Modi & Dr. S. M. Seth, "Hydraulics & Fluid Mechanics", Standard Book House.<br>3. Cengel&Cimbla, "Fluid Mechanics", Tata McGraw – Hill Publication.<br>4. Streeter, Wylie, Bedford, "Fluid Mechanics" McGraw Hill Publication. |
| **Reference books:** |
| 1. White, "Fluid Mechanics", McGraw Hill Publication.<br>2. Kundu, Cohen, Dowling, "Fluid Mechanics" Elsevier India.<br>3. K. L. Kumar, "Engineering Fluid Mechanics", Eurasia Publishing House. |

**Course Coordinator:** Mr. D. B. Nalawade

**BoS Member:**

**BoS Chairman**:

# Mechatronics (MEUA22175)

**Teaching Scheme**
Credits : 3
Lectures : 3 Hrs. /week

**Examination Scheme**
Formative Assessment : 50 Marks
Summative Assessment : 50 Marks

**Prerequisite:** Electronics and Electrical Engineering.

**Course objective:**
To understand the interdisciplinary applications of Electronics, Electrical, Mechanical and Computer Systems for the Control of Mechanical and Electronic Systems.

**Course Outcomes:**
After successful completion of this course, students will able to

1. Identify the key elements of mechatronics system and its representation in terms of block diagram
2. Explain the concept of working principle of Electrical Motors.
3. Apply interfacing of Sensors, Actuators using appropriate DAQ/micro-controller
4. Apply PID control System for implementation on real time systems
5. Analyze the PLC ladder programming and implementation of real-life system
6. Evaluate the time and Frequency domain analysis of system model (for control application)

**Unit I- Sensors**

Introduction to Mechatronics, Measurement system, characteristics: - Static and Dynamic Sensors: Position Sensors: - Potentiometer, Linear variable differential transformer (LVDT), Limit switches, read switches, Encoders; Proximity sensors: - Optical, Inductive, Capacitive; Motion Sensors:- Variable Reluctance; Temperature Sensor: Resistance temperature detector (RTD), Thermocouples; Force / Pressure Sensors:- Strain gauges; Flow sensors, Image Sensor, Non contact type sensors

**Unit II-Electrical Drives**

Construction working & Principle: AC Motor, DC Motor, Stepper Motor & Servo Motor, mechanical aspects of motor selection.

**Unit III-Microcontrollers &Microprocessors**

Basic elements of control systems,Microcontroller:Architecture and terminology, Introduction to Data acquisition system (DAQ) Interfacing of Sensors / Actuators to DAQ system, Introduction, Microprocessor systems, ARM core base processor. Introduction to open hardware platform Adrunio/raspberry pi. Communication protocols RS232, RS485, CAN.

**Unit IV- Control System**

Open and Closed loop control system, block diagram reduction techniques,Proportional Integral derivative(PID) control systems, Transient response:- Percentage overshoot, Rise time, Delay time, Steady state error, PID tuning (manual).

**Unit V–Program Logic Controller**

Introduction to PLC, PLC Architecture,IEC 61131-3 standards, Latching, Timers, Counter, Different scans in PLC, Ladder diagram programming for different types of logic gates,Practical Examples of Ladder Programming, Data Handling, Analog and Digital Input / Output.

**Unit VI -Design of Mechatronics System**

Introduction to Pneumatic and hydraulic actuation systems, Different components of Hydraulic systems, valves, System modeling (Mechanical), Stability Analysis via identification of poles and

zeros,Stages in designing Mechatronics Systems – Case studies of Mechatronics systems- Pick and place Robot.

**Text Books :**

1. K.P. Ramchandran, G.K. Vijyaraghavan, M.S. Balasundaram, Mechatronics: Integrated Mechanical Electronic Systems, Willey Publication. ISBN: 9788126518371.
2. Bolton, Mechatronics - A Multidisciplinary approach, 4th Edition, Prentice Hall. ISBN 13: 9780132407632.
3. Smaili.A and Mrad.F , "Mechatronics integrated technologies for intelligent machines", Oxford university press, 2008.
4. NitaigourPremchandMahalik, Mechatronics-Principles, Concepts and Applications, Tata McGraw Hill, 1stEdition, 2003 ISBN.No. 0071239243, 9780071239240.

**Reference Books :**

1. Alciatore & Histand, Introduction to Mechatronics and Measurement system, 4th Edition, McGraw Hill publication, 2011. ISBN-10: 0073380237.
2. Bishop (Editor), Mechatronics – An Introduction, CRC Press, 2006. ISBN 13: 9780849363580.
3. Mahalik, Mechatronics – Principles, concepts and applications, Tata Mc-Graw Hill publication, New Delhi.ISBN 13: 9780070483743.
4. C. D. Johnson, Process Control Instrumentation Technology, Prentice Hall, New Delhi. ISBN-13: 978-0134413051.
5. Rajput. R.K, A textbook of mechatronics, S. Chand & Co, 2007.

**Course Coordinator:** Mr. P. P. Rathod

**BoS Member:**

**BoS Chairman**:

# Industrial Psychology (MEUA22176)

**Teaching Scheme**
Credits: 3
Lectures: 3 Hrs./week

**Examination Scheme**
Formative Assessment: 50 Marks
Summative Assessment: 50 Marks

**Prerequisite:** Knowledge about human nature, need and personality type.

**Course objectives:**

- To impart the knowledge and understanding of basic concepts in and various facets of industrial and organizational Psychology.
- To study the human behavior and to suggest various ways and means to improve the efficiency of workers in industries.
- To know how to improve the labor relations in industry.
- To create awareness about the role and importance of psychological factors and processes.

**Course Outcomes:**

After successful completion of the course, student will be able to

1. Describe different managerial approaches, principles and leadership.
2. Evaluate the jobs for right recruitment and selection.
3. Explain the productive systems, STI policy to imply S and T based solutions to deploy it in economy or society.
4. Describe engineering psychology, industrial and corporate social responsibility for sustainable development of society.
5. Apply training and motivational techniques for improvement of personnel.
6. Describe the professional ethics, responsibilities to resolve industrial disputes through codes of discipline.

**Unit I - Introduction to Industrial Psychology**

Definition and scope, Hawthorne experiment, organizational development, theories and culture, leadership, approaches and group dynamics, fields of industrial organizational (I/O) psychology , research methods in I/O psychology

**Unit II - Work Environment and Standards for decision making**

Productive and counterproductive work, safety, job analysis, methods of job analysis, recruitment selection, reliability and validity tests and job evaluation, job performances.

**Unit III – Personal decisions and organizational learning**

Social context, legal context for personal decisions, recruitment, regression analysis, validity generalization, model of performance, personal selection , test utility and organizational utility, placement and classification.

Organizational learning – Learning and task performance, pre-training and post-training environment, assessing training needs, methods and techniques of training, management development issues, evaluation criterion of training program.

**Unit IV – Organizational behavior and Occupational health**

Job satisfaction, job involvement, organizational commitment, organizational justice, citizenship behavior, psychology contact, responses to downsizing, anti social behavior in work place,

Occupational health – Origin, concept of mental health, environmental influences, work stress, work/family conflict, work schedule, Social organization in industry, corporate social responsibilities.

**Unit V– Performance Management**

| |
|---|
| a) Motivation: Definition, work motivation theory, reinforcement, expectancy and self – efficacy, justice, goal setting, control and action theories, rater motivation.<br>b) Performance appraisal: Performance criteria, objective and subjective methods of assessment, impact of technology, legal issues in performance appraisal, 360° feedback. |
| **Unit VI - Contemporary Issues** |
| Grievances and Grievance handling Procedure, Industrial Disputes: Causes, Strikes and Lockouts, Preventive Machinery of Industrial Disputes: Schemes of Workers Participation in Management-Works Committee, Collective Bargaining, Bi-partite & Tri-partite Agreement, Code of Discipline, Standing Orders. Labor courts & Industrial Tribunals |

| **Text Books** |
|---|
| 1. Milton L. Blum and J. C. Naylor, Industrial Psychology, Harper, Row & Weatherhill, Inc. , Tokyo.<br>2. Mamoria C.B. And Mamoria S., Dynamics of Industrial Relations in India<br>3. Paul M. Muchinsky, Psychology Applied to Work, Thomson Wadsworth. |
| **Reference books:** |
| 1. Nadkarni, Lakshmi, Sociology of Industrial Worker, Rawat, Jaipur, 1998.<br>2. Bhowmick Sharit, Industry, Labour and Society, Orient, 2012.<br>3. Aamodt J. W. and Davis K. : Organization behavior: Human Behavior at work, Tata Mcgraw Hill. |

**Course Coordinator:** Mr. M. G. Gadge

**BoS Member:**

**BoS Chairman:**

# Lab Practice –II (MEUA22177)

**Teaching Scheme**
Credits: 3
Lectures: -- Hrs./week
Laboratory Work: 6 Hrs. /week

**Examination Scheme**
Formative Assessment: 50 Marks
Summative Assessment:50 Marks

**Course Objectives:**

- To understand the fundamentals of IC engines, construction and working principle of an engine, and testing of an engine for analyzing its performance.
- To provide hands on experience of Bernouillis principle, measurement of pressure, viscosity and pipe and open channel flow.
- To understand the working of control system using PLC/ Microcontroller and hands on experience to measure displacement and speed.

**Course Outcomes:**

After successful completion of the course, student will be able to

1. Determine various engine parameters by conducting trial on Petrol and Diesel engine.
2. Study different engine components and technologies related to Internal Engines.
3. Apply practical knowledge in verification of Bernoulli's principle and measure fluid parameters such as viscosity, pressure and discharge.
4. Conduct and analyze pipe flow, open channel flow and flow around submerged objects.
5. Demonstrate various control system using PLC / Microcontroller and measure parameters such as displacement and speed.
6. Provide knowledge of PLC and PID control system

**A] Lab Practice - Internal Combustion Engine (MEUA22173)**

The Lab practice consist of the following:

1. Overhauling of petrol / diesel engine.2.
2. Demonstration & study of commercial exhaust gas analyzers.
3. Test on Multi cylinder Petrol / Gas engine for determination of Friction power (Mores Test).
4. Test on diesel engine to determine various efficiencies, SFC and Heat balance sheet.
5. Test on variable speed diesel / petrol engine.
6. Test on variable compression ratio engine.
7. Visit to Automobile service station / engine manufacturing plant.
8. Assignment using engine simulation software.
9. Assignment on any one advanced technology related to I.C. Engine such as VVT, VGT, HCCI, CRDI.
10. Assignment on alternative fuels used in I.C. Engines.

**B] Lab Practice - Fluid Mechanics (MEUA22174)**

Lab practice consist of any ten of the following :

1. Study and demonstration of pressure measuring devices
2. Determination of viscosity of liquids & its variation with temperature.
3. Verification of modified Bernoulli's equation.
4. Calibration of V notch.
5. Study of flow measuring devices like Venturimeter, Orificemeter and Rotameter.
6. Laminar & turbulent flows by Reynolds' apparatus.
7. Determination of Major losses through pipes of different materials.
8. Determination of stability of floating body.

9. Flow around immersed bodies and formation of wake by Haleshaw's aparatus.
10. Industrial visit to CWPRS / Process industries / Piping industries and report based on it.
11. Study of different types of pipe materials.

**C] Lab Practice –Mechatronics (MEUA22175)**

Lab practice consist of the following :

1. Study of different types of sensor using sensor board
2. Measurement of displacement using LVDT characteristics.
3. Speed control of DC motor.
4. Demonstration of water level controlsystem using PLC / Microcontroller / Relays System.
5. Demonstration of bottle filling plant using PLC.
6. Interfacing of any one sensor to Data Acquisition System.
7. PLC control system: - ladder logic implementation on real time system.
8. Real Time Temperature / Flow Control using PID Control system.
9. PID control Design, Tuning using suitable Simulation Software
10. Study of Modeling and Analysis of a typical Mechanical System

**Text Books:**

**A]** 1.V. Ganesan - Internal Combustion Engines, Tata McGraw-Hill
2.M.L. Mathur and R.P. Sharma - A course in Internal combustion engines, Dhanpat Rai
3. H.N. Gupta - Fundamentals of Internal Combustion Engines, PHI Learning Pvt. Ltd.

**B]** 1.Dr. R. K. Bansal , " Fluid mechanics & Hydraulic machines" , Laxmi Publication Pvt. Ltd. , New Delhi.
2. Dr. P. M. Modi & Dr. S. M. Seth, "Hydraulics & Fluid Mechanics", Standard Book House.
3. Cengel&Cimbla, "Fluid Mechanics", Tata McGraw – Hill Publication.
4. Streeter, Wylie, Bedford, "Fluid Mechanics" McGraw Hill Publication.

**C]** 1.K.P. Ramchandran, G.K. Vijyaraghavan, M.S. Balasundaram, Mechatronics: Integrated Mechanical Electronic Systems, Willey Publication. ISBN: 9788126518371.
2. Bolton, Mechatronics - A Multidisciplinary approach, 4th Edition, Prentice Hall. ISBN 13: 9780132407632.
3.Smaili.A and Mrad.F , "Mechatronics integrated technologies for intelligent machines", Oxford university press, 2008.

**Course Coordinator** :
Dr. C. R. Ramtirthkar

Mr. D. B. Nalawade

Mr. P. P. Rathod

**BoS Member:**

**BoS Chairman**:

# Skill Development-II (Workshop Practice–II) (MEUA22178)

**Teaching Scheme**
Credits: 1
Laboratory Work: 2 Hrs./week

**Examination Scheme**
Formative Assessment : 50 Marks
Summative Assessment : NA

**Prerequisite:** Students should know about basic non machining processes such as fitting, carpentry, sheet metal working etc.

**Course objective:**

To give the students hands on experience on different machines such as welding, turning, milling, drilling and grinding etc to aware them machining characteristics and also quality consciousness.

**Course Outcomes:**

After successful completion of the course, student will be able to

1. Practice different machining operations such as turning, drilling, milling, grinding etc.
2. Produce welding job involving 2-3 welded joints.
3. Describe Sand moulding, Press working operations, and Injection moulding.

**Lab Practice/Term Work**

**Composite Job:**

One composite job involving different machining operations such as turning, drilling, milling, grinding etc.

**Welding Job:** One welding job involving 2-3 welded joints

**Demonstration on following processes:**

a) Sand moulding .
b) Press working operation for manufacturing of utility items eg.door handle,washer,clamp etc
c) Injection moulding for any one utility item.

**Skill Development:**

a) At the end of semester students should give presentation on **machining skill for** assembled job in a group of 4-5 students using PPT.
**b)** Submit an Industry visit report.

**Text /Reference Books**

1. Production Technology, HMT, Tata McGraw-Hill Publishing Co. Ltd, New Delhi
2. Elements of Workshop Technology, Vol. I&II, S.K.H. Choudhary, Media Promoters & Publishers Pvt. Ltd. Mumbai.
3. Workshop Technology, Part.I, II, III, W.A.J Chapman, Viva Books Pvt. Ltd.
4. Production Technology, P.C. Sharma Published by S. Chand Co. Ltd
5. Production Technology, R.K. Jain Published by Khanna Publications.
6. Manufacturing Processes, B.H. Amsteel, Philip F. Ostwald and Myron L. Begeman, John Wiley & Sons, eighth edition.
7. Manufacturing Technology, Vol. I &II, P. N. Rao, Tata McGraw Hill.

Industrial Safety and Health Management, Ray Asfahl, C.,5th Edition, Prentice Hall.

**Course Coordinator:** Mr. B. S. Rathod

**BoS Member:**

**BoS Chairman:**

# Project Management (MEUA22179)

**Teaching Scheme**

Credits: 2
Lectures: 2 Hrs./week

**Examination Scheme**
Formative Assessment : 50 Marks
Summative Assessment: NA

**Prerequisite:** Basic Concepts of Statistics and Probability.

**Course objective:**

- To provide students a strong foundation in project management for entry-level to mid-level professionals.

**Course Outcomes:**

After successful completion of the course, student will be able to

1. Describe fundamentals of project management and project evaluation techniques..
2. Evaluate project time and project cost using PERT.
3. Plan project resources understanding risk management.
4. Explain HRM issues in project procurement and material management

**Unit I - Introduction to Project Management**

Project Management Fundamentals, Project Management overview, Project Life cycle & Feasibility Analysis, Project identification, Sources of Project ideas, Project Evaluation Techniques, Monitoring and control of projects, Project Information System (PIMS), Summary illustrative review problems.

**Unit II -Project Network Techniques**

Project Planning & Scheduling, Probability models in networks, Crashing of networks, Project Work Breakdown Structure & networking, Project Network Techniques PERT / CPM, Time & Cost based calculations using PERT, Summary illustrative review Problems.

**Unit III -Project Resource Allocation & Risk Management**

Project scheduling with unlimited Resources, Project scheduling with limited Resources, Risk Identification, Management and Planning, Enterprise Resource planning, Capital budgeting techniques, Risk and technical analysis, Summary illustrative review Problems

**Unit IV - Project Human Resource, Procurement & Materials Management**

Project Organization Structure, Leadership Style, Effective Project Teams, Managing Conflicts, HRM issues in project management, Project Total Quality Management, Project Contract Management, Project Procurement & Materials Management, Summary illustrative review problems

**Text Books**

1. Total Project Management – The Indian Context by P. K. Joy, Macmillan Publishers India Ltd., ISBN No.: 0333-92624-2
2. PERT and CPM Principles and Applications by L. S. Srinath, Affiliated East-West Press Pvt. Ltd. New Delhi, ISBN No.: 8185336202

**Reference books:**

1. Chandra, P., Projects, Planning, Analysis, Financing, Implementation and control, Tata McGraw Hill, Fifth Edition
2. Maylor, H., Project Management, Pitman Publication, Second Edition
3. Ghattas, R.G. & Mc Kee, S.L., Practical Prokject Management, Pearson Education Asia,
4. Pinto, P.K., Project Management, Pearson Education, First Edition
5. Wyzocki, R.K. & Mc Gary R., Effective Project Management, Wiley. First Edition

**Course Coordinator:** Mr. N.B. Kate

**BoS Member**:

**BoS Chairman**: