**VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY**

*(Formerly Uttarakhand Technical University, Dehradun Established by Uttarakhand State Govt. wide Act no. 415 of 2005)*

*Suddhowala, PO-Chandanwadi, Premnagar, Dehradun, Uttarakhand (Website- www.uktech.ac.in)*

# SYLLABUS

**Approved in 13th Meeting of Executive Council held on 27th March 2023 subsequent to the 14th Meeting of Academic Council held on 20th March 2023**

**(For admission in 2022-23 and onwards)**

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# SYLLABUS

**For**

## B. TECH.

## (Mechanical Engineering)

## 2ND Year

Effective from – Session 2023-24

## B.Tech. (Mechanical Engineering) Curriculum Structure (w.e.f. 2023-24)

### SEMESTER-III

| Sl. No. | Subject Codes | Category | Subject | Periods | | | Evaluation Scheme | | | | | Subject Total | Credit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Sessional Exam | | | ESE | | | |
| | | | | L | T | P | CT | TA | Total | TE | PE | | |
| 1 | AHT-006 | BSC | Advanced Applied Mathematics | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 2 | AHT-007 | HSC | Technical Communication/Universal Human Values | 2 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| | AHT-008 | | | 3 | 0 | 0 | | | | | | | |
| 3 | MET-002 | DC | Engineering Thermodynamics | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 4 | MET-003 | DC | Materials Engineering | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 5 | MET-004 | DC | Fluid Mechanics & Fluid Machines | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 6 | MEP-004 | DLC | Materials Engineering& Testing Lab | 0 | 0 | 2 | | 25 | 25 | | 25 | 50 | 1 |
| 7 | MEP-005 | DLC | Fluid Mechanics & Fluid Machines Lab | 0 | 0 | 2 | | 25 | 25 | | 25 | 50 | 1 |
| 8 | MEP-006 | DLC | Machine Drawing & Solid Modelling Lab | 0 | 1 | 2 | | 25 | 25 | | 25 | 50 | 1 |
| 9 | MEP-007 | DLC | Internship-I/Mini Project-I* | 0 | 0 | 2 | | | 50 | | | 50 | 1 |
| 10 | CST-006/ CST-005 | NC | Cyber Security#/Python Programming# | 2 | 0 | 0 | 15 | 10 | 25 | 50 | | | |
| 11 | GP-03 | NC | General Proficiency | | | | | | 50 | | | | |
| | | | **Total** | | | | | | | | | **950** | **23** |
| 12 | | **Minor Course (Optional)** | | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | **150** | **4** |

*The Mini Project-I or Internship-I (3-4 weeks) conducted during summer break after II semester and will be assessed during III semester

# The content of the course is based on the case studies.

# Advanced Applied Mathematics (AHT-006)

**L T P: 3 1 0**

**Course Objectives:**

The course should enable the students to learn:

- The idea of Laplace transform of functions and their applications.
- The idea of Fourier transform of functions and their applications.
- To evaluate roots of algebraic and transcendental equations.
- Interpolation, numerical differentiation& integration and the solution of differential equations.
- Acquaintance with statistical analysis and techniques.

**Particulars**

**Unit 1: Laplace Transform: (8 Hrs)**

Definition of Laplace transform, Existence theorem, Laplace transforms of derivatives and integrals, Initial and final value theorems, Unit step function, Dirac- delta function, Laplace transform of periodic function, Inverse Laplace transform, Convolution theorem, Application to solve linear differential equations.

**Unit 2: Fourier Transforms: (8 Hrs)**

Fourier integral, Fourier sine and cosine integral, Complex form of Fourier integral, Fourier transform, Inverse Fourier transforms, Convolution theorem, Fourier sine and cosine transform, Applications of Fourier transform to simple one dimensional heat transfer equations.

**Unit 3: Solution of Algebraic & Transcendental equations and Interpolation: (8 Hrs)**

Number and their accuracy, Solution of algebraic and transcendental equations: Bisection method, Iteration method, Newton-Raphson method and Regula-Falsi method. Rate of convergence of these methods (without proof), Interpolation: Finite differences, Relation between operators, Interpolation using Newton's forward and backward difference formula, Interpolation with unequal intervals: Newton's divided difference and Lagrange's formula.

**Unit 4: Numerical differentiation & Integration and Solution of ODE: (8 Hrs)**

Numerical Differentiation, Numerical integration: Trapezoidal rule, Simpson's 1/3rd and 3/8 rule, Runge-Kutta method of fourth order for solving first order linear differential equations, Milne's predicator-corrector method.

**Unit 5: Statistical Techniques:** **(8 Hrs)**

Introduction: Measures of central tendency, Moments, Skewness, Kurtosis, Curve fitting: Method of least squares, Fitting of straight lines, Fitting of second degree parabola, Exponential curves. Correlation and rank correlation, Regression analysis: Regression lines of y on x and x on y, Regression coefficients, Properties of regressions coefficients and non-linear regression.

**Reference Books:**


1. E. Kreyszig: Advanced Engineering Mathematics, John Wiley & Sons, 10th ed.
2. B.V. Ramana: Higher Engineering Mathematics, McGrawHill.
3. Peter V.O'Neil: Advanced Engineering Mathematics, Cengage Learning, 7th ed.
4. B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, 44th ed.
5. T. Veerarajan: Engineering Mathematics (for semester III), McGrawHill, 3rd ed.
6. R.K. Jain and S.R.K. Iyenger: Advance Engineering Mathematics, Narosa Publishing House, Std. ed.
7. P. Kandasamy, K. Thilagavathy, K. Gunavathi: Numerical Methods, S. Chand.
8. S.S. Sastry: Introductory methods of numerical analysis, Prentice Hall India, 5thed.
9. N.P. Bali and Manish Goyal: Computer Based Numerical and Statistical Techniques, Laxmi Publications, 5th ed.
10. J.N. Kapur: Mathematical Statistics, S. Chand &Company.
11. D.N.Elhance,V. Elhance & B.M. Aggarwal: Fundamentals of Statistics, Kitab Mahal.


**Course Outcomes:**

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

**CO1:** Remember the concept of Laplace transform and apply in solving real life problems.

**CO2:** Apply the concept of Fourier transform to evaluate engineering problems.

**CO3:** Understand to evaluate roots of algebraic and transcendental equations.

**CO4:** Solve the problem related interpolation, differentiation, integration and the solution of differential equations.

**CO5:** Understand the concept of correlation, regression, moments, skewness and kurtosis and curve fitting.

# Technical Communication (AHT-007)

**L T P: 2 1 0**

**Course Objectives:**

The course should enable the students to:

- Produce technical documents that use tools commonly employed by engineering and computer science professionals.
- Communicate effectively in a professional context, using appropriate rhetorical approaches for technical documents, adhering to required templates, and complying with constraints on document format.
- Clarify the nuances of phonetics, intonation and pronunciation skills.
- Get familiarized with English vocabulary and language proficiency.

**Particulars**

**Unit 1: Fundamentals of Technical Communication: (8 Hrs)**

Technical Communication: Introduction, Features; Distinction between General and Technical Communication; The flow of Communication: Downward; upward, Lateral or Horizontal; Barriers to Communication, Importance of communication.

**Unit 2: Forms of Technical Communication (8 Hrs)**

Technical Report: Definition & importance; Thesis/Project writing: structure & importance; synopsis writing: Methods; Technical research Paper writing: Methods & style; Seminar & Conference paper writing; 7 Cs of effective business writing: concreteness, completeness, clarity, conciseness, courtesy, correctness, consideration.

**Unit 3: Technical Presentation, Strategies & Techniques: (8 Hrs)**

Presentation: Forms; interpersonal Communication; Class Room presentation; style; method, Public Speaking: method; Techniques: Clarity of substance; emotion; Humour; Modes of Presentation; Overcoming Stage Fear: Confident speaking; Audience Analysis & retention of audience interest; Methods of Presentation: Interpersonal; Impersonal; Audience Participation: Quizzes & Interjections.

**Unit 4: Technical Communication Skills (8 Hrs)**

Interview skills; Group Discussion: Objective & Method; Seminar/Conferences Presentation skills: Focus; Content; Style; Argumentation skills: Devices: Analysis; Cohesion & Emphasis; Critical thinking; Nuances, exposition, narration and description.

**Unit 5: Kinesics & Voice Dynamics** **(8 Hrs)**

Kinesics: Definitions; importance; Features of Body Language; Voice Modulation: Quality, Pitch; Rhythm; intonation, pronunciation, articulation, vowel and consonants sounds.

**Reference Books**


1. Technical Communication – Principles and Practices by Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2007, New Delhi.
2. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
3. Practical Communication: Process and Practice by L.U.B. Pandey; A.I.T.B.S. Publications India Ltd.; Krishan Nagar, 2014, Delhi.
4. Modern Technical Writing by Sherman, Theodore A (et.al); Apprentice Hall; New Jersey; U.S.
5. A Text Book of Scientific and Technical Writing by S.D. Sharma; Vikas Publication, Delhi.
6. Skills for Effective Business Communication by Michael Murphy, Harward University, U.S.
7. Business Communication for Managers by Payal Mehra, Pearson Publication, Delhi.


**Course Outcomes**

At the end of this course, the students will be:

**CO1:** Enabled to **understand** the nature and objective of Technical Communication relevant for the work place as Engineers.

**CO2:** Able to **utilize** the technical writing for the purposes of Technical Communication and its exposure in various dimensions.

**CO3:** Able to give imbibe inputs by presentation skills to **enhance** confidence in face of diverse audience.

**CO4:** Able to **create** a vast know-how of the application of the learning to promote their technical competence.

**CO5:** Enabling them to **evaluate** their efficacy as fluent & efficient communicators by learning the voice-dynamics.

# Universal Human Values (AHT-008)

**L T P: 3 0 0**

**Course Objectives:**

The course should enable the students for:

- Development of a holistic perspective based on self- exploration about themselves (human being), family, society and nature/existence.
- Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence.
- Strengthening of self-reflection.
- Development of commitment and courage to act.

**Particulars**

**Unit 1: Introduction - Value Education (8 Hrs)**

Universal human values; self-exploration, natural acceptance an experimental validation; Human aspirations, right understanding, relationship and physical facility, current scenario; Understanding and living in harmony at various levels.

**Unit 2: Harmony in the Human Being (8 Hrs)**

Understanding human being, needs of self(I) and body; body as an instrument of 'I'; characteristics and activities of 'I' and harmony in 'I'; harmony of I with the Body: Sanyam and Health, Physical needs an prosperity; Programs to ensure Sanyam and Health.

**Unit 3: Harmony in the Family and Society (8 Hrs)**

Values in human-human relationship; nine universal values in relationships; justice, truth, respect, trust; Difference between intention and competence; Respect and differentiation, Harmony in society: resolution, prosperity, fearlessness and coexistence; Universal harmonious order in society.

**Unit 4: Harmony in the Nature and Existence (8 Hrs)**

Harmony in the nature. Four orders of nature; existence as co-existence, harmony at all levels of existence.

**Unit 5: Harmony in the Professional Ethics (8 Hrs)**

Natural acceptance of human values, Definitiveness of Ethical Human Conduct; Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order; Competence in professional ethics; Case -studies; transition from the present state to Universal Human Order: at individual level and societal level.

**Text Books:**

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010.

**Reference Books:**

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karam chand Gandhi.
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

**Course Outcomes:**

At the end of this course, the students:

**CO1:** Are expected to become more aware of themselves, and their surroundings (family, society, nature)

**CO2:** Would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.

**CO3:** Would have better critical ability.

**CO4:** Would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society).

**CO5:** Would be able to apply what they have learnt to their own self in different day-to- day settings in real life, at least a beginning would be made in this direction.

# Engineering Thermodynamics (MET-002)

**L T P: 3 1 0**

**Course Objective**

The course should enable the students to:

- Learn about basic concepts, fundamental equations of thermodynamics, work and heat interactions.
- Learn about different governing laws of thermodynamics and their applications.
- Learn about various thermodynamics laws, grade of energy.
- Evaluate the changes in properties of substances in various processes by steam table and charts.
- Learn about various applications of thermodynamics in gas power cycles, vapour power cycles.

**Particulars**

**Unit 1: Introduction to Thermodynamics** **(6 Hrs)**

Fundamentals - System & Control volume; Property, State & Process; Exact & Inexact differentials; Work - Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; electrical, magnetic, gravitational, spring and shaft work. Temperature, Definition of thermal equilibrium and Zeroth law, Temperature scales, Various Thermometers.

**Unit 2: First Law of Thermodynamics** **(8 Hrs)**

Definition of heat; examples of heat/work interaction in systems- First Law for Cyclic & Non-cyclic processes; Concept of total energy; Demonstration that energy is a property; various modes of energy, Internal energy and Enthalpy. First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; Unsteady processes; examples of steady and unsteady I law applications for system and control volume. Compressibility factor and Real gas mixtures.

**Unit 3: Pure Substances** **(8 Hrs)**

Definition of Pure substance, Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures, Compressibility charts- Properties of two phase systems - Const. temperature and Const. pressure heating of water; Definitions of saturated states; P-v-T surface; Use of steam tables Saturation tables; Superheated tables; Identification of states & determination of properties, Mollier's chart.

**Unit 4: Second Law of Thermodynamics and Entropy** **(10 Hrs)**

Second law - Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external

irreversibility; Carnot cycle; Absolute temperature scale. Clausius inequality; Definition of entropy; Demonstration that entropy is a property; Evaluation of entropy for solids, liquids, ideal gases and ideal gas mixtures undergoing various processes; Determination of entropy from steam tables- Principle of increase of entropy; Illustration of processes in T-s coordinates; Definition of Isentropic efficiency for compressors, turbines and nozzles.

**Unit 5: Thermodynamic Relations, Availability and Irreversibility (10 Hrs)**

Mathematical conditions for exact differential, Maxwell's equation, T-ds equations, difference in heat capacities, ratio of heat capacities, energy equation, Clausius-Clapeyron equation, evaluation of thermodynamic properties from an equation of state, general thermodynamic considerations on an equation of state, mixtures of variable composition, conditions of equilibrium of a heterogeneous system, Gibbs phase rule, types of equilibrium, local equilibrium conditions, conditions of stability, Joule-Kelvin effect, Joule-Thompson coefficient and Inversion curve, coefficient of volume expansion, adiabatic and isothermal compressibility. Irreversibility and Availability, Availability function for systems and Control volumes undergoing different processes, Lost work, Exergy balance equation, and Exergy analysis.

**Reference Books:**

1. Cengel, Y. A., & Boles, M. A. (2011). Thermodynamics: An Engineering Approach Seventh Edition.
2. Nag, P. K. (2013). Engineering thermodynamics. Tata McGraw-Hill Education.
3. Borgnakke, C., & Sonntag, R. E. (2022). Fundamentals of thermodynamics. John Wiley & Sons.
4. Singh, O. (2005). Engineering Thermodynamics. New Age International.
5. Jones, J. (1996). Dugan. Re, Engineering Thermodynamics, 3ª edition, United States of America, Editorial Prentice Hall.
6. Moran, M. J., Shapiro, H. N., Boettner, D. D., & Bailey, M. B. (2010). Fundamentals of engineering thermodynamics. John Wiley & Sons.

**Course Outcomes**

At the end of the course, student will able to

**CO1:** Apply energy balance to systems and control volumes, in situations involving heat and work interactions.

**CO2:** Evaluate changes in thermodynamic properties of pure substances.

**CO3:** Evaluate the performance of energy conversion devices.

**CO4:** Differentiate between high grade and low-grade energies.

**CO5:** Understand the importance of thermodynamic relations.

# Materials Engineering (MET-003)

**L T P: 3 1 0**

**Course Objectives:**

The course should enable the students to:

- Understand about the different types of materials and their properties.
- Understand the various ferrous material, their production process and properties.
- Study and examine the non-ferrous metals and testing of materials.
- Study the magnetic and electric properties of materials.
- Understand the various Non-Metallic Materials and their uses.

**Particulars**

**Unit 1: Crystal Structure** **(8 Hrs)**

Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress. Mechanical Property measurement: Mechanical Properties measurement Tensile, compression and torsion tests, strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell and Vickers and their relation to strength.

**Unit 2: Static Failure Theories** **(9 Hrs)**

Ductile and brittle failure mechanisms, Tresca, Von-mises, Maximum normal stress, Mohr-Coulomb and Modified Mohr-Coulomb; Fracture mechanics: Introduction to Stress-intensity factor approach and Griffith criterion. Fatigue failure: High cycle fatigue, Stress-life approach, SN curve, endurance and fatigue limits, effects of mean stress using the Modified Goodman diagram; Fracture with fatigue, Introduction to non- destructive testing (NDT).

**Unit 3: Alloys, Substitutional and Interstitial Solid Solutions- Phase Diagrams** **(9 Hrs)**

Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotectic reactions. Iron Iron-carbide phase diagram and microstrctural aspects of ledeburite, austenite, ferrite and cementite, cast iron.

**Unit 4: Heat Treatment of Steel** **(8 Hrs)**

Annealing, tempering, normalising and spheroidising, isothermal transformation diagrams for Fe-C alloys and microstructure development. Continuous cooling curves TTT diagram, and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening.

**Unit 5** **(8 Hrs)**

Alloying of steel, properties of stainless steel and tool steels, maraging steels- cast irons; grey, white, malleable and spheroidal cast irons- copper and copper alloys; brass, bronze and cupro-nickel; Aluminium and Al-Cu – Mg alloys- Nickel based superalloys and Titanium alloys .

**References**


1. CallisterJr, W. D., &Rethwisch, D. G. (2020). Materials science and engineering: an introduction. wiley.
2. Budinski, K. G., &Budinski, M. K. (1999). Engineering materials. Pearson Education India.
3. Raghavan, V. (2015). Materials Science and Engineering: A first course. PHI Learning Pvt. Ltd.
4. Jindal, U. C. (2012). Material Science and Metallurgy. Pearson Education India.


**Course Outcomes**

At the end of this course, student will be able to:

**CO1:** Identify crystal structures for various materials and understand the defects in such structures.

**CO2:** Understand how to tailor material properties of ferrous and non-ferrous alloys.

**CO3:** Explain detailed interpretation of equilibrium phase diagrams.

**CO4:** Understand how to quantify mechanical integrity and failure in materials.

**CO5:** Explain the different metals and alloys.

# Fluid Mechanics and Fluid Machines (MET-004)

**L T P: 3 1 0**

**Course Objective**

The course should enable the students:

- To introduce and explain fundamentals of Fluid Mechanics and fluid, its properties and behavior under various conditions of internal and external flows.
- To develop understanding about hydrostatic law, principle of buoyancy and stability of a floating body and application of mass, momentum and energy equation in fluid flow. To imbibe basic laws and equations used for analysis of static and dynamic fluids.
- To determine the losses in a flow system, flow through pipes, boundary layer flow and flow past immersed bodies.
- To introduce the concepts which are used in the applications of Aerodynamics, Hydraulics, Marine Engineering, Gas dynamics etc.
- To understand the challenges with the Hydro Power plants.

**Particulars**

**Unit 1: Introduction, Kinematics of Fluid Flow** **(8 Hrs)**

Definition of fluid, Newton's law of viscosity, Units and dimensions-Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface tension, Control volume-application of continuity equation and momentum equation, Incompressible flow, Bernoulli's equation and its applications.

**Unit 2: Fluid Static and Dynamics of Fluid Flow** **(8 Hrs)**

Exact flow solutions in channels and ducts, Couette and Poisuielle flow, laminar flow through circular conduits and circular annuli- concept of boundary layer – measures of boundary layer thickness – Darcy Weisbach equation, friction factor, Moody's diagram.

**Unit 3: Dimensional Analysis and Hydraulic Similitude** **(8 Hrs)**

Need for dimensional analysis – methods of dimension analysis – Similitude – types of similitude Dimensionless parameters – application of dimensionless parameters – Model Analysis.

**Unit 4: Hydraulic Turbines** **(8 Hrs)**

Application of momentum and momentum equation to flow through hydraulic machinery, efficiencies, Euler's equation , impact of jet, velocity triangles- Axial, radial and mixed flow turbines- Pelton wheel, Francis turbine and Kaplan turbines, working principles – draft tube- Specific speed, unit quantities, performance curves for turbines – governing of turbine.

**Unit 5: Centrifugal and Positive Displacement Pumps** **(8 Hrs)**

Centrifugal pumps, working principle, work done by the impeller, performance curves –Cavitation in pumps-Reciprocating pump – working principle. Introduction of hydraulic press, hydraulic accumulator, hydraulic coupling, jet pumps, Airlift pumps , lift and cranes.

**Reference Books:**


1. Fox, R. W., Mcdonald, A. T., & Mitchell, J. W. (2020). Fox and McDonald's introduction to fluid mechanics. John Wiley & Sons.
2. Husain, Z., Mohd. Zulkifly Abdullah, &Alimuddin, Z. (2008). Basic fluid mechanics and hydraulic machines. Hyderabad, India: BS publications.
3. Narasimhan, S. (2007). A first course in fluid mechanics. CRC Press.
4. Biswas, G. (2003). Introduction to Fluid Mechanics and Fluid Machines, 2e. Tata McGraw-Hill Education.
5. Das, M. M. (2008). Fluid Mechanics and Turbo Machines. PHI Learning Pvt. Ltd.
6. Gupta, V., & Gupta, S. K. (2012). Fluid mechanics and its applications. London: New Academic Science.


**Course Outcomes**

At the end of this course, student will be able to:

**CO1:** Learn about the application of mass and momentum conservation laws for fluid flows.

**CO2:** Obtain the velocity and pressure variations in various types of simple flows.

**CO3:** Understand the importance of dimensional analysis.

**CO4:** Understand the flow in turbines.

**CO5:** Analyse the flow in water pumps.

# Materials Engineering and Testing Lab (MEP-004)

**L T P: 0 0 2**

**Course Objective**

The course should enable the students to:

- Acquire the basic knowledge of materials science, so that they would be able to understand and distinguish between varieties of materials based on their structure and properties.
- Gain the knowledge about the properties of materials at higher elevated temperatures.
- Refine properties and grain size of carbon steel and cast iron by heat treatment.
- Understand the Destructive and Non-Destructive methods of testing materials.
- Study and differentiate among microstructures of different engineering materials.

**Particulars**

**List of Experiments**

Minimum 10 experiments out of the following (or similar experiments).

1. Making a plastic mould for small metallic specimen.
2. Specimen preparation for micro structural examination-cutting, grinding, polishing, etching.
3. Grain size determination of a given specimen.
4. Comparative study of microstructures of different given specimens (mild steel, gray cast iron, brass, copper etc.)
5. Heat treatment experiments such as annealing, normalizing, quenching, case hardening and comparison of hardness before and after.
6. Study of corrosion and its effects.
7. Study of microstructure of welded component and HAZ, Macro and Micro Examination.
8. Suitable experiment on Magnetic/ Electrical/ Electronic materials.
9. To perform Tensile Test on Mild-steel specimen and draw stress strain curve.
10. To perform Izod, Charpy Impact test on standard specimen.
11. To perform Brinell, Rockwell, Vicker Hardness Test on standard specimen.
12. To calculate spring stiffness.
13. To calculate Torsional Rigidity.
14. To calculate Fatigue strength on Fatigue Testing Machine
15. To calculate Modulus of Elasticity by Non Destructive Testing.
16. Detection of cracks by Ultrasonic Testing Machine.
17. Detection of cracks by Dye Penetration Technique.

18. Detection of cracks by Eddy Current Tester.
19. To perform Wear Test

**Reference Books:**


1. CallisterJr, W. D., &Rethwisch, D. G. (2020). Materials science and engineering: an introduction. Wiley
2. Budinski, K. G., &Budinski, M. K. (1999). Engineering materials. Pearson Education India.
3. Raghavan, V. (2015). Materials Science and Engineering: A first course. PHI Learning Pvt. Ltd.
4. Jindal, U. C. (2012). Material Science and Metallurgy. Pearson Education India.
5. Khurmi, R. S., &Khurmi, N. (2019). A textbook of strength of materials. S. Chand Publishing.
6. Bansal, R. K. (2010). A textbook of strength of materials (in SI units). Laxmi Publications.


**Course Outcomes**

At the end of this course, student will be able to:

**CO1**: Correlate the microstructure with the mechanical & physical properties of given set of engineering materials.

**CO2**: Study the microstructure with the mechanical & physical properties of given set of engineering materials.

**CO3**: Perform destructive testing and find out the mechanical properties of given set of engineering materials.

**CO4**: Perform nondestructive testing and to find out any irregularities in the given set of engineering materials.

**CO5**: Conduct tribological experiments and to find out wear rate of given set of engineering materials.

# Fluid Mechanics and Fluid Machines Lab (MEP-005)

**L T P: 0 0 2**

**Course Objective**

The course should enable the students to:

- Enrich about the concept of fluid mechanics and hydraulic machines.
- Correlate the various flow measuring devices such as venturimeter, orifice meter.
- Demonstrate the dynamics of flow through verifying Bernoulli's Theorem.
- Understand loss of flow/energy in flow.
- Discuss the performance characteristics of turbines and pumps

**Particulars**

List of experiments (Minimum 10 of the followings)

1. To verify the momentum equation using the experimental set-up on diffusion of submerged air jet.
2. To determine the coefficient of discharge of an orifice of a given shape and also determine the coefficient of velocity and the coefficient of contraction of the orifice mouth piece.
3. To calibrate an orifice meter, venturimeter, and bend meter and study the variation of the coefficient of discharge with the Reynolds number.
4. To study the transition from laminar to turbulent flow and to determine the lower critical Reynolds number.
5. To study the velocity distribution in a pipe and also to compute the discharge by integrating the velocity profile.
6. To study the variation of friction factor f for turbulent flow in commercial pipes.
7. Experiment on Pelton wheel turbine.
8. Experiment on Francis turbine.
9. Experiment on Kaplan turbine.
10. Experiment on reciprocating pump.
11. Experiment on centrifugal pump.

**Reference Books:**


1. Fox, R. W., McDonald, A. T., & Mitchell, J. W. (2020). Fox and McDonald's introduction to fluid mechanics. John Wiley & Sons.
2. Husain, Z., Mohd. Zulkifly Abdullah, &Alimuddin, Z. (2008). Basic fluid mechanics and hydraulic machines. Hyderabad, India: BS publications.
3. Narasimhan, S. (2007). A first course in fluid mechanics. CRC Press.
4. Biswas, G. (2003). Introduction to Fluid Mechanics and Fluid Machines, 2e. Tata McGraw-Hill Education.
5. Das, M. M. (2008). Fluid Mechanics and Turbo Machines. PHI Learning Pvt. Ltd.
6. Gupta, V., & Gupta, S. K. (2012). Fluid mechanics and its applications. London: New Academic Science.


**Course Outcomes**

At the end of the course, student will be able to:

**CO1:** Understand the working of flow meters.

**CO2:** Understand the concept of flow transition from laminar to turbulent.

**CO3:** Understand the different forms of energy of fluid flow.

**CO4:** Understand the various losses in pipes.

**CO5:** Understand the performance of pumps and turbines.

# Machine Drawing and Solid Modeling Lab (MEP-006)

**L T P: 0 1 2**

**Course Objective**

The course should enable the students to:

- Apply knowledge of Modeling, Science & Engineering.
- Use engineering graphic skills as a means of communicating technical ideas, information and instructions
- Use of Sectional views, Part sectioning, Assembly drawings and Layouts forms a part of this learning
- Modeled this drawing even in CAD/CAM software by applying the basic knowledge of machine drawing.
- Demonstrate an ability to design and conduct experiments, analyze and interpret data and assembly and disassembly drawings knowledge will be provided.

**Particulars**

**Unit 1**

Introduction to Engineering Drawing, Classification of Engineering Drawings, Machine Drawing and representation of materials, Representation of different types of lines, Representation of geometrical and dimensional tolerance and surface roughness symbols.

**Unit 2**

Conversion of Isometric Views into Orthographic Projection, Symbols for weldments, process flow, electrical and instrumentation Units, IS/ISO codes.

Projections, Sectional views and sectioning of parts and assemblies.

**Unit 3**

Introduction of shapes of rivet heads. Caulking and Fullering pitch, Diagonal pitch, Margin, Back pitch, etc. Types of riveting lap and butt joint, zigzag and chain structure, Boiler joint.

Drawing of Machine Elements and simple parts: Views of any three sets of the following machine elements and parts; Popular forms of Screw threads, bolts, nuts, stud bolts.

Keys, cotter joints and knuckle joint.

Shaft coupling, Hook's joint, knuckle joint Journal, pivot and collar and foot step bearings.

**Unit 4**

Assembly Drawings: Drawings of assembled views for the part drawings of the following using conventions and easy drawing proportions; (any one)

a) Engine parts – Connecting rod, Piston assembly.

b) Other machine parts - Screws jacks, Machine Vices, Plummer block, Tailstock.

c) Valves: Steam stop valve, spring loaded safety valve, feed check valve and air cock

**Unit 5**

Engineering Graphics Software, Co-ordinate Systems, Drafting and Modelling, Evolution of geometric modeling, Advantages of solid modeling, Definition, Advantages and disadvantages of wireframe models, Solid Representation, Boundary Representation (B-rep), Constructive Solid Geometry (CSG).Solid modeling: Use of modeling software, Part model, Assembly.

**Reference Books:**

1. Bhatt, N. D., &Panchal, V. M. (1991). Machine drawing. Charotar.
2. Dhawan, R. K. (2006). A Textbook of Machine Drawing. S. Chand Publishing.
3. Narayana, K. L. (2009). Machine drawing. New Age International.
4. Kannaiah, P., & Reddy, K. V. (2006). Machine drawing. New Age International.
5. Pohit, G. (2004). Machine Drawing with AutoCAD. Pearson Education India.
6. John, K. C. (2009). Textbook of Machine Drawing. PHI Learning Pvt. Ltd.
7. Gill, P. S. (2013). A Textbook of Machine Drawing. S. K. Kataria& Sons Publishers.

**Course Outcomes**

At the end of the course, student will be able to:

**CO1:** Draft their technical ideas.

**CO2:** Develop their knowledge about the various practices as dimensioning, sectioning and development of views.

**CO3:** Understand the importance of the linking functional and visualization aspects in preparation of the part drawings.

**CO4:** Prepare the part or assembly drawings as per the conventions.

**CO5:** Interpret various machine drawings that will in turn help them to prepare the production drawings.

# Internship I/ Mini Project I (MEP-007)

**Course Objectives**

The course should enable the students to:

- Create an Industrial environment and culture within the institution.
- Identify the issues and challenges of an industry.
- Prepare report on the application of emerging technologies in the selected industry.
- Learn and understand the concept of entrepreneurship.
- Inculcate innovative thinking.

**Course Outcomes:**

On completion of the course, student will be able to–

**CO1:** Develop his abilities to transmit technical information clearly and test the same by delivery of Seminar based on the Mini Project or Internship.

**CO2:** Understand the importance of document design by compiling Technical Report on the Mini Project or Internship work carried out.

**CO3:** Comment and evaluate other students research questions and internship proposals.

# Python Programming (CST-005)

**L T P: 2 0 0**

**Course Objectives**

The course should enable the students to:

- Be introduced with the basic principles and concepts of python programming, and how python programming concepts are useful in problem-solving.
- Write clear and effective python code.
- Perform file operations to read and write data in files.
- Create applications using Python Programming.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction and Syntax of Python Program:** Features of Python, Interactive, Object-oriented, Interpreted, platform-independent, Python building blocks -Identifiers, Keywords, Indention, Variables, Comments, Python environment setup – Installation and working of IDE, Running Simple Python scripts to display a welcome message, Python variables.

**Python Data Types:** Numbers, String, Tuples, Lists, Dictionary. Declaration and use of datatypes, Built-in Functions.

**Unit 2** **(8 Hrs)**

**Python Operators and Control Flow statements:** Basic Operators: Arithmetic, Comparison/ Relational, Assignment, Logical, Bitwise, Membership, Identity operators, Python Operator Precedence.

**Control Flow:** Conditional Statements (if, if...else, nested if), Looping in python (while loop, for loop, nested loops), loop manipulation using continue, pass, break, else.

**Unit 3** **(8 Hrs)**

**Data Structures in Python: String:** Concept, escape characters, String special operations, String formatting operator, Single quotes, Double quotes, Triple quotes, Raw String, Unicode strings, Built-in String methods.

**Lists:** Defining lists, accessing values in lists, deleting values in lists, updating lists, Basic List Operations, and Built-in List functions.

**Tuples:** Accessing values in Tuples, deleting values in Tuples, and updating Tuples, Basic Tuple operations, and Built-in Tuple functions.

**Sets:** Accessing values in Set, deleting values in Set, and updating Sets, Basic Set operations, Built-in

Set functions.

**Dictionaries:** Accessing values in Dictionary, deleting values in Dictionary, and updating Dictionary, Basic Dictionary operations, Built-in Dictionaries functions.

**Unit 4** **(8 Hrs)**

**Python Functions, modules, and Packages:** Use of Python built-in functions (e.g., type/data conversion functions, math functions etc.).

**User-defined functions:** Function definition, Function call, function arguments and parameter passing, Return statement, **Scope of Variables:** Global variable and Local Variable.

**Modules:** Writing modules, importing modules, importing objects from modules, Python built-in modules (e.g., Numeric, mathematical module, Functional Programming Module), Packages.

**Unit 5** **(8 Hrs)**

**File Handling:** Opening files in different modes, accessing file contents using standard library functions, Reading, and writing files, closing a file, Renaming, and deleting files, File related standard functions.

**Text Books:**


1. Charles R. Severance, "Python for Everybody: Exploring Data Using Python 3", 1st Edition, CreateSpace Independent Publishing Platform, 2016.
2. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd Edition, Green Tea Press, 2015.
3. Ch Satyanarayana, "Python Programming", 1st Edition, universities press (India) private limited 2018.


**Reference Books:**


1. Charles Dierbach, "Introduction to Computer Science Using Python", 1st Edition, Wiley India Pvt Ltd. ISBN-13: 978-8126556014
2. Mark Lutz, "Programming Python", 4th Edition, O'Reilly Media, 2011.ISBN-13: 978-9350232873
3. Wesley J Chun, "Core Python Applications Programming", 3rd edition, Pearson Education India, 2015. ISBN-13: 978-9332555365
4. Roberto Tamassia, Michael H Goldwasser, Michael T Goodrich, "Data Structures and Algorithms in Python",1st Edition, Wiley India Pvt Ltd, 2016. ISBN-13: 978- 8126562176
5. Reema Thareja, "Python Programming using problem-solving approach", Oxford university press, 2017.

**Course Outcomes**

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

**CO1:** Develop essential programming skills in computer programming concepts like data types.

**CO2:** Examine Python syntax and semantics and be fluent in the use of Python flow control and functions.

**CO3:** Illustrate the process of structuring the data using lists, tuples, and dictionaries.

**CO4:** Demonstrate using built-in functions and operations to navigate the file system.

**CO5:** Interpret the concepts of modules and user-defined functions in Python.

# Cyber Security (CST-006)

**L T P 2 0 0**

**Course Objectives**

The course should enable the students to:

- Familiarize with network security, network security threats, security services, and countermeasures.
- Be aware of computer security and Internet security.
- Study the defensive techniques against these attacks.
- Familiarize with cyber forensics, cybercrimes, and Cyberspace laws.
- Understand ethical laws of computers for different countries, Offences under cyberspace and the Internet in India.

**Particulars**

**Unit 1: Introduction to Cyber Security** **(8 Hrs)**

Basic Cyber Security Concepts, layers of security, Vulnerability, threat, Harmful acts, the motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks, Spectrum of attacks, Taxonomy of various attacks, IP spoofing, Methods of defense, Security Models, risk management, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, etc., CIA Triad

**Unit 2: Cyber Forensics** **(8 Hrs)**

Introduction to cyber forensic, Historical background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber Forensics and Digital evidence, Forensics Analysis of Email, Digital Forensics Lifecycle, Forensics Investigation, Challenges in Computer Forensics, Special Techniques for Forensics Auditing.

**Unit 3: Cybercrime (Mobile and Wireless Devices)** **(8 Hrs)**

Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Organizational Security Policies and Measures in Mobile Computing Era, Laptops and desktop.

**Unit 4** **(8 Hrs)**

**Cyber Security (Organizational Implications)**: Introduction cost of cybercrimes and IPR issues, web threats for organizations, security and privacy implications, social media marketing: security risks and perils for organizations, social computing, and the associated challenges for organizations.

**Cybercrime and Cyber terrorism:** Introduction, intellectual property in cyberspace, the ethical dimension of cybercrimes, the psychology, mindset and skills of hackers and other cybercriminals.

**Unit 5: Cyberspace and the Law &Miscellaneous provisions of IT Act** **(8 Hrs)**

Introduction to Cyber Security Regulations, International Law. The INDIAN Cyberspace, National Cyber Security Policy. Internet Governance – Challenges and Constraints, Computer Criminals, Assets and Threats. Other offences under the Information Technology Act in India, The role of Electronic Evidence and miscellaneous provisions of the IT Act.2008.

**Text Books:**


1. Nina Godbole and SunitBelpure, Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley.
2. B. B. Gupta, D. P. Agrawal, Haoxiang Wang, Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives, CRC Press, ISBN 9780815371335, 2018.


**Reference Books:**


1. Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC Press.
2. Introduction to Cyber Security, Chwan-Hwa(john) Wu,J. David Irwin, CRC Press T&F Group.
3. Debby Russell and Sr. G.T Gangemi, "Computer Security Basics (Paperback)", 2nd Edition, O' Reilly Media, 2006.
4. Wenbo Mao, "Modern Cryptography – Theory and Practice", Pearson Education, New Delhi, 2006.
5. Cyberspace and Cybersecurity, George Kostopoulos, Auerbach Publications, 2012.
6. Cyber Forensics: A Field Manual for Collecting, Examining, and Preserving Evidence of Computer Crimes, Second Edition, Albert Marcella, Jr., Doug Menendez, Auerbach Publications, 2007.
7. Cyber Laws and IT Protection, Harish Chander, PHI, 2013.

**Course Outcomes**

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

**CO1:** Understand cyber-attacks and types of cybercrimes, and familiarity with cyber forensics

**CO2:** Realize the importance of cyber security and various forms of cyber-attacks and countermeasures.

**CO3:** Get familiar with obscenity and pornography in cyberspace and understand the violation of the Right to privacy on the Internet.

**CO4:** Appraise cyber laws and how to protect themselves and, ultimately, the entire Internet community from such attacks.

**CO5:** Elucidate the various chapters of the IT Act 2008 power of the Central and State Governments to make rules under IT Act 2008

| B.Tech. - Mechanical Engineering, SEMESTER-IV (w.e.f. 2023-24) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sl. No. | Subject Codes | Category | Subject | Periods | | | Evaluation Scheme | | | | | Subject Total | Credit |
| | | | | | | | Sessional Exam | | | ESE | | | |
| | | | | L | T | P | CT | TA | Total | TE | PE | | |
| 1 | AHT-008<br>AHT-007 | HSC | Universal Human Values /Technical Communication | 3<br>2 | 0<br>1 | 0<br>0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| 2 | MET-005 | DC | Mechanics of Machines | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 3 | MET-006 | DC | Applied Thermodynamics | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 4 | MET-007 | DC | Strength of Materials | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 5 | MET-008 | DC | Manufacturing Science and Technology -I | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 6 | MEP-008 | DLC | Applied Thermodynamics Lab | 0 | 0 | 2 | | 25 | 25 | | 25 | 50 | 1 |
| 7 | MEP-009 | DLC | Manufacturing Science and Technology -I Lab | 0 | 0 | 2 | | 25 | 25 | | 25 | 50 | 1 |
| 8 | MEP-010 | DLC | Mechanics of Machine Lab | 0 | 0 | 2 | | 25 | 25 | | 25 | 50 | 1 |
| 9 | CST-005/ CST-006 | NC | Python Programming[#]/ Cyber Security[#] | 2 | 0 | 0 | 15 | 10 | 25 | 50 | | 75 | |
| 10 | GP-04 | NC | General Proficiency | | | | | | 50 | | | 50 | |
| | | | **Total** | | | | | | | | | **900** | **22** |
| 11 | | **Minor Course (Optional)** | | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | **4** |

Internship-II/Mini Project-II* (4-6 weeks)
To be completed at the end of fourth semester (during Summer Break) & its evaluation/credit to be added in Fifth semester.
[#] The content of the course is based on the case studies.

## Universal Human Values (AHT-008)

**L T P: 3 0 0**

**Course Objectives:**

The course should enable the students for:

- Development of a holistic perspective based on self- exploration about themselves (human being), family, society and nature/existence.
- Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence.
- Strengthening of self-reflection.
- Development of commitment and courage to act.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction - Value Education:** Universal human values; self exploration, natural acceptance an experimental validation; Human aspirations, right understanding, relationship and physical facility, current scenario; Understanding and living in harmony at various levels.

**Unit 2** **(8 Hrs)**

**Harmony in the Human Being:** Understanding human being, needs of self(I) and body; body as an instrument of 'I'; characteristics and activities of 'I' and harmony in 'I'; harmony of I with the Body: Sanyam and Health, Physical needs an prosperity; Programs to ensure Sanyam and Health.

**Unit 3** **(8 Hrs)**

**Harmony in the Family and Society:** Values in human-human relationship; nine universal values in relationships; justice, truth, respect, trust; Difference between intention and competence; Respect and differentiation, Harmony in society: resolution, prosperity, fearlessness and coexistence; Universal harmonious order in society.

**Unit 4** **(8 Hrs)**

**Harmony in the Nature and Existence:** Harmony in the nature. Four orders of nature; existence as co-existence, harmony at all levels of existence.

**Unit 5** **(8 Hrs)**

**Harmony in the Professional Ethics:** Natural acceptance of human values, Definitiveness of Ethical Human Conduct; Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order; Competence in professional ethics; Case studies; transition from the present state to Universal Human Order: at individual level and societal level.

**Text Books:**

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

**Reference Books:**

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karam chand Gandhi.
5. Small is Beautiful - E. F Schumacher
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – Pandit Sunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

**Course Outcomes:**

At the end of this course, the students:

**CO1:** Are expected to become more aware of themselves, and their surroundings (family, society, nature)

**CO2:** Would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.

**CO3:** Would have better critical ability.

**CO4:** Would also become sensitive to their commitment towards what they have understood (human values,

human relationship and human society).

**CO5:** Would be able to apply what they have learnt to their own self in different day-to- day settings in real life, at least a beginning would be made in this direction.

# Technical Communication (AHT-007)

**L T P: 2 1 0**

**Course Objectives:**

The course should enable the students to:

- Produce technical documents that use tools commonly employed by engineering and computer science professionals.
- Communicate effectively in a professional context, using appropriate rhetorical approaches for technical documents, adhering to required templates, and complying with constraints on document format.
- Clarify the nuances of phonetics, intonation and pronunciation skills.
- Get familiarized with English vocabulary and language proficiency.

**Particulars**

**Unit 1** **(8 Hrs)**

**Fundamentals of Technical Communication:** Technical Communication: Introduction, Features; Distinction between General and Technical Communication; The flow of Communication: Downward; upward, Lateral or Horizontal; Barriers to Communication, Importance of communication.

**Unit 2** **(8 Hrs)**

**Forms of Technical Communication:** Technical Report: Definition & importance; Thesis/Project writing: structure & importance; synopsis writing: Methods; Technical research Paper writing: Methods & style; Seminar & Conference paper writing; 7 Cs of effective business writing: concreteness, completeness, clarity, conciseness, courtesy, correctness, consideration.

**Unit 3** **(8 Hrs)**

**Technical Presentation: Strategies & Techniques:** Presentation: Forms; interpersonal Communication; Class Room presentation; style; method, Public Speaking: method; Techniques: Clarity of substance; emotion; Humour; Modes of Presentation; Overcoming Stage Fear: Confident speaking; Audience Analysis & retention of audience interest; Methods of Presentation: Interpersonal; Impersonal; Audience Participation: Quizzes & Interjections.

**Unit 4** **(8 Hrs)**

**Technical Communication Skills:** Interview skills; Group Discussion: Objective & Method; Seminar/Conferences Presentation skills: Focus; Content; Style; Argumentation skills: Devices: Analysis; Cohesion & Emphasis; Critical thinking; Nuances, exposition, narration and description.

**Unit 5** **(8 Hrs)**

**Kinesics & Voice Dynamics:** Kinesics: Definitions; importance; Features of Body Language; Voice Modulation: Quality, Pitch; Rhythm; intonation, pronunciation, articulation, vowel and consonants sounds.

**Reference Books**


1. Technical Communication – Principles and Practices by Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2007, New Delhi.
2. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
3. Practical Communication: Process and Practice by L.U.B. Pandey; A.I.T.B.S. Publications India Ltd.; Krishan Nagar, 2014, Delhi.
4. Modern Technical Writing by Sherman, Theodore A (et.al); Apprentice Hall; New Jersey; U.S.
5. A Text Book of Scientific and Technical Writing by S.D. Sharma; Vikas Publication, Delhi.
6. Skills for Effective Business Communication by Michael Murphy, Harward University, U.S.
7. Business Communication for Managers by Payal Mehra, Pearson Publication, Delhi.


**Course Outcomes:**

At the end of this course, the students will be:

**CO1:** Enabled to understand the nature and objective of Technical Communication relevant for the work place as Engineers.

**CO2:** Able to utilize the technical writing for the purposes of Technical Communication and its exposure in various dimensions.

**CO3:** Able to give imbibe inputs by presentation skills to enhance confidence in face of diverse audience.

**CO4:** Able to create a vast know-how of the application of the learning to promote their technical competence.

**CO5:** Enabling them to evaluate their efficacy as fluent & efficient communicators by learning the voice-dynamics.

# Mechanics of Machines (MET-005)

**L T P: 3 1 0**

**Course Objectives**

On completing the course, the student will be able to:

- Understand static and dynamic balancing and centrifugal and Inertia governors.
- Understand the fundamentals of the theory of kinematics and dynamics of machines.
- Understand techniques for studying motion of machines and their components.
- Gain knowledge about cams, gears and gear trains.

**Particulars**

**Unit 1** **(8 Hrs)**

Classification of mechanisms- Basic kinematic concepts and definitions- Degree of freedom, mobility- Grashof's law, Kinematic inversions of four bar chain and slider crank chains- Limit positions- Mechanical advantage- Transmission angle- Description of some common mechanisms- Quick return mechanism, straight line generators- Universal Joint- Rocker mechanisms, steering mechanism.

**Unit 2** **(10 Hrs)**

Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centres, velocity and acceleration analysis using loop closure equations- kinematic analysis of simple mechanisms- slider crank mechanism dynamics-

Coincident points- Coriolis component of acceleration- introduction to linkage synthesis- three position graphical synthesis for motion and path generation.

Mechanism With Lower Pairs: Pantograph, Exact straight line motion mechanism, Peculiar's Mechanism, Hart and Scott Russel mechanisms, Approximate straight line motion mechanisms, Grasshopper, Watt and Techebicheff mechanism.

**Unit 3** **(8 Hrs)**

Classification of cams and followers- Terminology and definitions- Displacement diagrams- Uniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions- specified contour cams- circular and tangent cams- pressure angle and undercutting, sizing of cams, graphical and analytical disc cam profile synthesis for roller and flat face followers.

**Unit 4** **(8 Hrs)**

Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting- helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics.

**Unit 5** **(8 Hrs)**

Surface contacts- Types of friction, limiting friction, Laws of Friction, Static and Dynamic Friction; sliding and rolling friction- friction drives- bearings and lubrication- friction clutches- belt and rope drives- friction in brakes.

**Reference Books:**


1. Rattan, S. S, "Theory of Machines", McGraw-Hill Education, 4th edition, 2015.
2. John J Uicker, Gordon R Pennock, Joseph E Shigley, "Theory of Machines and Mechanisms",Oxford University Press, 4th Edition, 2014.
3. Thomas Bevan, Theory of Machines, 3rd edition, CBS Publishers & Distributors, 2005.
4. Cleghorn W.L., Mechanisms of Machines, Oxford University Press, 2005.
5. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill, 2009.
6. Ghosh A. and Mallick A.K., Theory of Mechanisms and Machines, Affiliated East- West Pvt. Ltd, New Delhi, 1988.


**Course Outcomes**

At the end of the course, student will be able to:

**CO1:** Know the basics of mechanism and perform kinematic analysis.

**CO2:** Implement the synthesis mechanism.

**CO3:** Construct various cam profiles based on follower motion and perform kinematic analysis.

**CO4:** Deduce the number of teeth in gears and torque transmitted in epicyclic gear trains.

**CO5:** Understand and apply the aspects of friction in clutches and belt rope drives.

# Applied Thermodynamics (MET-006)

**L T P: 3 1 0**

**Course Objectives**

The course should enable the students to:

- Learn about the basic application of thermodynamics
- Learn about application of generation of energy.
- Evaluate the changes in properties of substances in various processes
- Gain Knowledge about different types of boilers and their applications.
- Study gas dynamics of air flow and steam through nozzles and performance of rotatory and reciprocating compressors and gas turbines

**Particulars**

**Unit 1** **(8 Hrs)**

Vapor power cycles Rankine cycle with superheat, reheat and regeneration, exergy analysis. Super-critical and ultra super-critical Rankine cycle- Gas power cycles, Air standard Otto, Diesel and Dual cycles-Air standard Brayton cycle, effect of reheat, regeneration and intercooling- Combined gas and vapor power cycles, VCRS cycle.

**Unit 2** **(8 Hrs)**

**Boilers:** Steam generators: classifications, working of fire-tube and water-tube boilers, boiler mountings & accessories, Draught & its calculations, air pre-heater, feed water heater, super heater, Boiler efficiency, Equivalent evaporation. Boiler trial and heat balance. Dryness fraction determination.

**Condenser:** Classification of condenser, Air leakage, Condenser performance.

**Unit 3** **(8 Hrs)**

Basics of compressible flow, Stagnation properties, Isentropic flow of a perfect gas through a nozzle, choked flow, subsonic and supersonic flows- normal shocks- use of ideal gas tables for isentropic flow and normal shock flow- Flow of steam and refrigerant through nozzle, supersaturation- compressible flow in diffusers, efficiency of nozzle and diffuser.

**Unit 4** **(9 Hrs)**

Rotatory compressors, reciprocating compressors, staging of reciprocating compressors, optimal stage pressure ratio, effect of intercooling, minimum work for multistage reciprocating compressors.

Steam Turbines : Classification of steam turbine, Impulse and reaction turbines, Staging, Stage and overall efficiency, Reheat factor, Bleeding, Velocity diagram of simple & compound multistage

impulse & reaction turbines & related calculations: work done, efficiencies of Impulse and reaction Turbines, state point locus, Losses in steam turbines, Governing of turbines.

**Unit 5** **(9 Hrs)**

**Gas Turbine:** Gas turbine classification, Brayton cycle, Principles of gas turbine, Gas turbine cycles with inter-cooling, reheat and regeneration and their combinations, Stage efficiency, Polytropic efficiency, Deviation of actual cycles from ideal cycles.

**Jet Propulsion:** Introduction to the principles of jet propulsion, Turbojet and turboprop engines & their processes, Principle of rocket propulsion, Introduction to Rocket Engine. Introduction to ram jet and pulse jet.

**Reference Books:**


1. Borgnakke, C., & Sonntag, R. E. (2022). Fundamentals of thermodynamics. John Wiley & Sons.
2. Jones, J. (1996). Dugan. RE, Engineering Thermodynamics, 3ª edition, United States of America, Editorial Prentice Hall.
3. Moran, M. J., Shapiro, H. N., Boettner, D. D., & Bailey, M. B. (2010). Fundamentals of engineering thermodynamics. John Wiley & Sons.
4. Nag, P. K. (2002). Basic and applied thermodynamics. Tata McGraw Hill Publishing.
5. Singh, O. (2015). Applied Thermodynamics. New Age International.
6. Rajput, R. K. (2009). Applied thermodynamics. Laxmi Publications, Ltd.


**Course Outcomes**

At the end of the course, student will be able to:

**CO1:** Get a good understanding of various practical power cycles and heat pump cycles.

**CO2:** Understand the steam generator and its various types, their mountings and accessories, having knowledge to calculate the heat balance for steam generators.

**CO3:**Analyse energy conversion in various thermal devices such as combustors, air coolers, nozzles, diffusers, steam turbines and reciprocating compressors.

**CO4:** Understand the basics of different turbines used for electricity generation.

**CO5:** Understand the aspect of Jet Propulsion.

# Strength of Material (MET-007)

**L T P: 3 1 0**

**Course Objectives**

The course should enable the students to:

- Confidently tackle equilibrium equations, moments and inertia problems.
- To solve real field problems through evaluating the relationship between stress and strain.
- To understand the shear force and bending moment diagrams of symmetrical beams.
- To determine deflection, bending and shear stresses developed in beams of various sections
- To understand and apply the concept of stress and strain to analyze and design structural members and machine parts under axial load, shear load, bending moment and torsion

**Particulars**

**Unit 1** **(8 Hrs)**

**Simple Stress and Strain:** Introduction, Normal and shear stresses, Hooke's law, Stress strain diagrams for ductile and brittle materials, Elastic constants- Relationship between elastic constant one dimensional loading of members of varying cross-section, Strain energy, Thermal stresses.

Compound stress and strain: Introduction, State of plane stress, Principal stress and strain, Mohr's circle for stress, Moment of Inertia.

**Unit 2** **(9 Hrs)**

**Beams:** Definition and types of beams (cantilever, simply supported, overhanging, fixed, continuous), Types of end supports (simply support, hinged, roller, fixed), Classification of loads (point load, inclined point load, uniformly distributed load, uniformly varying load) Reactions of a simply supported and overhanging beam by analytical method.

**Pure Bending of Beams:** Introduction, Simple bending theory, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads.

**Unit 3** **(9 Hrs)**

**Stresses in Beams:** Bending moment (BM) and shear force (SF) diagrams. BM and SF diagrams for cantilevers simply supported and fixed beams with or without overhangs. Calculation of maximum BM and SF and the point of contra-flexure under concentrated loads, uniformly distributed loads over the whole span or part of the span. Deflection of beams: Equation of elastic curve, cantilever and simply supported beams. Double integration method, Moment area method, Macaulay's method, Maxwell's reciprocal theorems.

**Torsion:** Introduction, Derivation of torsion equation and its assumptions. Torsional rigidity. Torsion stresses and deformation in circular and hollow shafts, stepped shafts, combined torsion and bending of circular shafts, Torsion of non- circular shaft.

**Unit 4** **(8 Hrs)**

Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure.

**Columns and Struts:** Combined bending and direct stress, middle third and middle quarter rules. Struts with different end conditions. Euler's theory and experimental results, Rankine Jordan Formulae, Examples of columns in mechanical equipment's and machines. Columns and Struts: Combined bending and direct stress, middle third and middle quarter rules. Struts with different end conditions. Euler's theory and experimental results, Rankine Jordan Formulae, Examples of columns in mechanical equipment's and machines.

**Unit 5**

**Introduction to Stress and Strain in 3D** **(8 Hrs)**

Introduction to stress in 3D, Stress components on an arbitrary plane, Differential equations of equilibrium, Boundary conditions, Strains: Concept of strain.

**Relationship between elastic constants for different materials**

Stress-strain relations for linearly elastic solid, Generalized Hooke's law, Stress-strain relations for isotropic, orthotropic and anisotropic materials.

**Reference Books:**


1. Strength of Materials by R.Subramaniam, Oxford University Press, New Delhi, 2007.
2. Strength of Materials by B.C. Punamia, Laxmi Publications, 2015
3. Gere J. M., Timoshenko S.P., Mechanics of materials, CBS Publication, 2nd edition, ISBN-8123908946.
4. Popov Eger P.,"Engg. Mechanics of solids", Prentice Hall, New Delhi, 2nd edition, ISBN-0135713560.
5. Hibbeler R.C.,"Mechanics of Materials", Prentice Hall, New Delhi, 9th edition, ISBN-0133254429.
6. Fenner, Roger.T, "Mechanics of Solids", U.K. B.C. Publication, New Delhi.
7. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata McGraw-Hill Publishing Co. Ltd., New Delhi 2005

**Course Outcomes**

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

**CO1:** Recognize various types of loads applied on machine components of simple geometry and understand the nature of internal stresses that will develop within the components.

**CO2:** Analyze determinate beams and trusses to determine shear forces, bending moments and axial forces.

**CO3:** Gain sufficient knowledge in designing shafts to transmit required power and also spring for its maximum energy storage capacities.

**CO4:** Identify modes of failure in components.

**CO5:** Identify, formulate and solve engineering problems.

# Manufacturing Science and Technology – I (MET-008)

**L T P: 3 1 0**

**Course Objective**

The course should enable the students to:

- Understand the different metal casting processes, different metal forming and sheet metal operations along with the force calculations.
- Study the basic manufacturing processes and tools.
- Understand different conventional machining processes.
- Understand different nonconventional process.
- Emphasize the importance of manufacturing.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction:** Importance of manufacturing, Economic & technological considerations in manufacturing. Classification of manufacturing processes, Materials & manufacturing processes for common items.

**Casting:** Basic principle & survey of casting processes. Types of patterns and allowances.Types and properties of moulding sand. Elements of mould and design considerations, Gating, Riser, Runners, Core. Solidification of casting,.Sand casting, defects & remedies and inspection. Die Casting, Centrifugal casting. Investment casting, $CO_2$ casting and Stir casting etc.

**Unit 2** **(8 Hrs)**

**Metal Forming Processes:** Elastic & plastic deformation, yield criteria, Hot working vs. cold working. Analysis (equilibrium equation method) of forging process for load estimation with sliding friction sticking friction and mixed condition for slab and disc. Work required for forging, Hand, Power, Drop Forging. Analysis of Wire/strip drawing and maximum- education, Tube drawing, Extrusion and its application.

**Unit 3** **(8 Hrs)**

**Rolling:** Condition for Rolling force and power in rolling, Rolling mills & rolled-sections. Design, lubrication and defects in metal forming processes.

**Sheet Metal working:** Presses and their classification, Die & punch assembly and press work methods and processes. Cutting/Punching mechanism. Blanking vs. Piercing. Compound vs Progressive die. Flat-face vs. Inclined-face punch and Load (capacity) needed. Analysis of forming process like

cup/deep drawing. Bending & spring-back.

**Unit 4** **(8 Hrs)**

**Unconventional Metal forming processes:** Unconventional metal forming processes such as explosive forming, electromagnetic, electro-hydraulic forming.

**Powder Metallurgy:** Powder metallurgy manufacturing process. The need, process, advantage and applications.

**Manufacturing of Plastic components:** Injection moulding, Extrusion of plastic section, Welding of plastics.

**Unit 5** **(8 Hrs)**

**Jigs & Fixtures:** Locating & Clamping devices & principles, Jigs and Fixtures and its applications.

**Metrology:** Dimensions, forms and surface measurements, Limits, fits and tolerances, measurement of geometric forms like straightness, flatness and roundness; linear and angular measurement devices and systems; comparators; gauge design; interferometry; Metrology in tool wear and part quality including surface integrity, alignment and testing methods.

**Reference Books:**

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)- Pearson India, 2014.
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems.
3. Degarmo, Black &Kohser, Materials and Processes in Manufacturing.
4. Ghosh and A. K. Malik (2010) Manufacturing Science, East West Press Private Limited New Delhi.
5. PN Rao, “Manufacturing Technology”, Tata McGraw Hill, 2017.

**Course Outcomes**

At the end of this course, student will be able to:

**CO1:** Explain the different metal casting processes.

**CO2:** Explain the different metal forming and sheet metal operations along with the force calculations.

**CO3:** Explain the theory of rolling and sheet metal work.

**CO4:** Explain the different unconventional metal forming processes, powder metallurgy and manufacturing of plastic component.

**CO5:** Explain the jigs and fixture use and metrology.

# Applied Thermodynamics Lab (MEP-008)

**L T P: 0 0 2**

**Course Objective**

The course should enable the students to:

- Understand, model and appreciate concept of dynamics involved in thermal energy transformation.
- Prepare them to carry out the experimental investigation and analysis.
- Familiarize with working of different types of internal and external engines.
- Understand the basics of applied thermodynamics by working models and experiments.

**Particulars**

List of experiments (Minimum 10 of the followings)

1. Study of Fire and Water Tube boiler.
2. Study and working of two and four stroke petrol Engine.
3. Determination of Indicated H.P. of I.C. Engine by Morse Test.
4. Prepare the heat balance for Petrol and Diesel Engine test rig.
5. Study and working of two and four stroke Diesel Engine
6. Study of Impulse & Reaction turbine
7. Study of steam Engine model.
8. Study of Gas Turbine model.
9. Experiment on refrigeration test ring and calculation of various performance parameters.
10. Study of Velocity compounded steam turbine.
11. Study of Pressure compounded steam turbine.

**Reference Books:**

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, Fundamentals of Thermodynamics, John Wiley and Sons.
2. Jones, J. B. and Duggan, R. E., 1996, Engineering Thermodynamics, Prentice-Hall of India
3. Moran, M. J. and Shapiro, H. N., 1999, Fundamentals of Engineering Thermodynamics, John Wiley and Sons.
4. Nag, P.K, 1995, Engineering Thermodynamics, Tata McGraw-Hill Publishing Co. Ltd.
5. Singh, O. (2015). Applied Thermodynamics. New Age International.

**Course Outcomes**

At the end of this course, student will be able to:

**CO1**: Understand the basics of working of boilers, mountings and accessories used for industrial application.

**CO2**: Grasp the principle and working of two strokes and four strokes internal combustion engines used in automobiles.

**CO3**: Understand working of turbines used for power generation application.
**CO4**: Evaluate the working and COP of the Refrigeration and Air conditions systems used in various industrial and domestic applications.
**CO5**: Analyze the performance of steam turbines.

# Manufacturing Science and Technology – I Lab (MEP-009)

**L T P: 0 0 2**

**Course Objective**

The course should enable the students to:

- To provide practical experience in various casting and metal forming processes with different materials.
- Learn the use of jigs and fixtures.
- To inculcate the knowledge of experiments on metrology
- To impart the basic knowledge of powder metallurgy.

**Particulars**

**List of Experiments:**

Minimum 10 experiments out of following:

1. Design of pattern for a desired casting (containing hole)
2. Pattern making
3. Making a mould (with core) and casting.
4. Sand testing (at least one such as grain fineness number determination)
5. Forging: hand forging processes.
6. Forging: power hammer study & operation
7. Bending & spring back.
8. Powder metallurgy experiment.
9. Jigs & Fixture experiment.
10. Study of Linear Measuring Instruments.
11. Measurement of Taper Angle Using Slips, Rollers & Sine bar
12. Tool Makers Microscope.
13. Measurement of Surface Finish.
14. Machine Tool Alignment Tests.

**Reference Books:**

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)-Pearson India, 2014.
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems.
3. Degarmo, Black &Kohser, Materials and Processes in Manufacturing.

4. Ghosh and A. K. Malik (2010) Manufacturing Science, East West Press Private Limited New Delhi.
5. PN Rao, "Manufacturing Technology", Tata McGraw Hill, 2017.

**Course Outcomes**

At the end of this course, student will be able to:

**CO1**: Perform the different experiments on metal casting.

**CO2**: Perform the different experiments on metal forming.

**CO3**: Perform the different experiments on jigs and fixture.

**CO4**: Perform the different experiments on powder metallurgy.

**CO5**: Perform the different experiments on metrology.

## Mechanics of Machine Lab (MEP-010)

**L T P: 0 0 2**

**Course Objective**

The course should enable the student to:

- Provide basic concepts on mechanisms, machines.
- Analyse the velocities of various links in mechanisms using models.
- Introduce with the CAMs and their design.
- Introduce with various model of gears, classification and their types.

**Particulars**

**List of Experiments** (Minimum 10)

1. To study various types of Links, Pairs, Chain and Mechanism
2. To study inversion of four Bar Mechanism, Single Slider Crank Chain Mechanism and Double Slider Crank Chain Mechanism.
3. To study velocity diagram for Slider Crank Mechanism.
4. To study various kinds of belts drives.
5. To study and find coefficient of friction between belt and pulley.
6. To study various types of Cam and Follower arrangement.
7. To plot follower displacement vs cam rotation graph for various cam follower arrangement.
8. To study the working of Screw Jack and determine its efficiency.
9. To study Different types of Gears.
10. To study Different types of Gear Trains.
11. Study of Ackerman's Steering Gear Mechanism

**Course Outcomes**

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

**CO1:** Understand principle and functioning of mechanism such as slider crank, four bar chain, Ackerman's steering.

**CO2:** Gain knowledge about the kinds of belt drives and calculate the coefficient of friction between belt and pulley.

**CO3:** Plot cam profiles for different arrangements.

**CO4:** Understand functioning of different gears.

**CO5:** Determine screw jack efficiency.

# Python Programming (CST-005)

**L T P: 2 0 0**

**Course Objectives**

The course should enable the students to:

- Be introduced with the basic principles and concepts of python programming, and how python programming concepts are useful in problem-solving.
- Write clear and effective python code.
- Perform file operations to read and write data in files.
- Create applications using Python Programming.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction and Syntax of Python Program:** Features of Python, Interactive, Object-oriented, Interpreted, platform-independent, Python building blocks -Identifiers, Keywords, Indention, Variables, Comments, Python environment setup – Installation and working of IDE, Running Simple Python scripts to display a welcome message, Python variables.

**Python Data Types:** Numbers, String, Tuples, Lists, Dictionary. Declaration and use of datatypes, Built-in Functions.

**Unit 2** **(8 Hrs)**

**Python Operators and Control Flow statements:** Basic Operators: Arithmetic, Comparison/ Relational, Assignment, Logical, Bitwise, Membership, Identity operators, Python Operator Precedence.

**Control Flow:** Conditional Statements (if, if...else, nested if), Looping in python (while loop, for loop, nested loops), loop manipulation using continue, pass, break, else.

**Unit 3** **(8 Hrs)**

**Data Structures in Python: String:** Concept, escape characters, String special operations, String formatting operator, Single quotes, Double quotes, Triple quotes, Raw String, Unicode strings, Built-in String methods.

**Lists:** Defining lists, accessing values in lists, deleting values in lists, updating lists, Basic List Operations, and Built-in List functions.

**Tuples:** Accessing values in Tuples, deleting values in Tuples, and updating Tuples, Basic Tuple operations, and Built-in Tuple functions.

**Sets:** Accessing values in Set, deleting values in Set, and updating Sets, Basic Set operations, Built-in

Set functions.

**Dictionaries:** Accessing values in Dictionary, deleting values in Dictionary, and updating Dictionary, Basic Dictionary operations, Built-in Dictionaries functions.

**Unit 4** **(8 Hrs)**

**Python Functions, modules, and Packages:** Use of Python built-in functions (e.g., type/data conversion functions, math functions etc.).

**User-defined functions:** Function definition, Function call, function arguments and parameter passing, Return statement, **Scope of Variables:** Global variable and Local Variable.

**Modules:** Writing modules, importing modules, importing objects from modules, Python built-in modules (e.g., Numeric, mathematical module, Functional Programming Module), Packages.

**Unit 5** **(8 Hrs)**

**File Handling:** Opening files in different modes, accessing file contents using standard library functions, Reading, and writing files, closing a file, Renaming, and deleting files, File related standard functions.

**Text Books:**

1. Charles R. Severance, "Python for Everybody: Exploring Data Using Python 3", 1st Edition, CreateSpace Independent Publishing Platform, 2016.
2. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd Edition, Green Tea Press, 2015.
3. Ch Satyanarayana, "Python Programming", 1st Edition, universities press (India) private limited 2018.

**Reference Books:**

1. Charles Dierbach, "Introduction to Computer Science Using Python", 1st Edition, Wiley India Pvt Ltd. ISBN-13: 978-8126556014
2. Mark Lutz, "Programming Python", 4th Edition, O'Reilly Media, 2011.ISBN-13: 978-9350232873
3. Wesley J Chun, "Core Python Applications Programming", 3rd edition, Pearson Education India, 2015. ISBN-13: 978-9332555365
4. Roberto Tamassia, Michael H Goldwasser, Michael T Goodrich, "Data Structures and Algorithms in Python",1st Edition, Wiley India Pvt Ltd, 2016. ISBN-13: 978- 8126562176
5. Reema Thareja, "Python Programming using problem-solving approach", Oxford university press, 2017.

**Course Outcomes**

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

**CO1:** Develop essential programming skills in computer programming concepts like data types.

**CO2:** Examine Python syntax and semantics and be fluent in the use of Python flow control and functions.

**CO3:** Illustrate the process of structuring the data using lists, tuples, and dictionaries.

**CO4:** Demonstrate using built-in functions and operations to navigate the file system.

**CO5:** Interpret the concepts of modules and user-defined functions in Python.

# Cyber Security (CST-006)

**L T P 2 0 0**

**Course Objectives**

The course should enable the students to:

- Familiarize with network security, network security threats, security services, and countermeasures.
- Be aware of computer security and Internet security.
- Study the defensive techniques against these attacks.
- Familiarize with cyber forensics, cybercrimes, and Cyberspace laws.
- Understand ethical laws of computers for different countries, Offences under cyberspace and the Internet in India.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction to Cyber Security:** Basic Cyber Security Concepts, layers of security, Vulnerability, threat, Harmful acts, the motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks, Spectrum of attacks, Taxonomy of various attacks, IP spoofing, Methods of defense, Security Models, risk management, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, etc., CIA Triad

**Unit 2** **(8 Hrs)**

**Cyber Forensics:** Introduction to cyber forensic, Historical background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber Forensics and Digital evidence, Forensics Analysis of Email, Digital Forensics Lifecycle, Forensics Investigation, Challenges in Computer Forensics, Special Techniques for Forensics Auditing.

**Unit 3** **(8 Hrs)**

**Cybercrime (Mobile and Wireless Devices):** Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Organizational Security Policies and Measures in Mobile Computing Era, Laptops and desktop.

**Unit 4** **(8 Hrs)**

**Cyber Security (Organizational Implications)**: Introduction cost of cybercrimes and IPR issues, web

threats for organizations, security and privacy implications, social media marketing: security risks and perils for organizations, social computing, and the associated challenges for organizations.

**Cybercrime and Cyber terrorism:** Introduction, intellectual property in cyberspace, the ethical dimension of cybercrimes, the psychology, mindset and skills of hackers and other cybercriminals.

**Unit 5** **(8 Hrs)**

**Cyberspace and the Law &Miscellaneous provisions of IT Act:** Introduction to Cyber Security Regulations, International Law. The INDIAN Cyberspace, National Cyber Security Policy. Internet Governance – Challenges and Constraints, Computer Criminals, Assets and Threats. Other offences under the Information Technology Act in India, The role of Electronic Evidence and miscellaneous provisions of the IT Act.2008.

**Text Books:**


1. Nina Godbole and SunitBelpure, Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley.
2. B. B. Gupta, D. P. Agrawal, Haoxiang Wang, Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives, CRC Press, ISBN 9780815371335, 2018.


**Reference Books:**


1. Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC Press.
2. Introduction to Cyber Security, Chwan-Hwa(john) Wu,J. David Irwin, CRC Press T&F Group.
3. Debby Russell and Sr. G.T Gangemi, "Computer Security Basics (Paperback)", 2ndEdition, O' Reilly Media, 2006.
4. Wenbo Mao, "Modern Cryptography – Theory and Practice", Pearson Education, New Delhi, 2006.
5. Cyberspace and Cybersecurity, George Kostopoulos, Auerbach Publications, 2012.
6. Cyber Forensics: A Field Manual for Collecting, Examining, and Preserving Evidence of Computer Crimes, Second Edition, Albert Marcella, Jr., Doug Menendez, Auerbach Publications, 2007.
7. Cyber Laws and IT Protection, Harish Chander, PHI, 2013.


**Course Outcomes**

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

**CO1:** Understand cyber-attacks and types of cybercrimes, and familiarity with cyber forensics

**CO2:** Realize the importance of cyber security and various forms of cyber-attacks and countermeasures.

**CO3:** Get familiar with obscenity and pornography in cyberspace and understand the violation of the Right to privacy on the Internet.

**CO4:** Appraise cyber laws and how to protect themselves and, ultimately, the entire Internet community from such attacks.

**CO5:** Elucidate the various chapters of the IT Act 2008 power of the Central and State Governments to make rules under IT Act 2008

# VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY

*(Formerly Uttarakhand Technical University, Dehradun Established by Uttarakhand State Govt. wide Act no. 415 of 2005)*
*Suddhowala, PO-Chandanwadi, Premnagar, Dehradun, Uttarakhand (Website- www.uktech.ac.in)*

# SYLLABUS

**For**

## B.TECH.

## (Mechanical Engineering)

## 3RD Year

Effective from – Session 2024-25

| B.Tech. – Mechanical Engineering, SEMESTER-V (w.e.f. 2024-25) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sl.No. | Subject Codes | Category | Subject | Periods | | | Evaluation Scheme | | | | | Subject Total | Credit |
| | | | | | | | Sessional Exam | | | ESE | | | |
| | | | | L | T | P | CT | TA | Total | TE | PE | | |
| 1 | MET-009 | DC | Heat and Mass Transfer | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 2 | MET-010 | DC | Dynamics of Machines & Vibrations | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 3 | MET-011 | DC | Manufacturing Science and Technology -II | 3 | 0 | 0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| 4 | MET-XXX | DE | Departmental Elective - 1 | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 5 | MET-XXX | DE | Departmental Elective - 2 | 3 | 0 | 0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| 6 | MEP-011 | DLC | Heat and Mass Transfer Lab | 0 | 0 | 2 | | 25 | 25 | | 25 | 50 | 1 |
| 7 | MEP-012 | DLC | Dynamics of Machines and Vibration Lab | 0 | 0 | 2 | | 25 | 25 | | 25 | 50 | 1 |
| 8 | MEP-013 | DLC | Manufacturing Science and Technology -II Lab | 0 | 0 | 2 | | 25 | 25 | | 25 | 50 | 1 |
| 9 | MEP-014 | DLC | Mini Project-II or Internship-II* | 0 | 0 | 2 | | | 50 | | | 50 | 1 |
| 10 | AHT-009/ AHT-010 | NC | Constitution of India / Essence of Indian Traditional Knowledge | 2 | 0 | 0 | 15 | 10 | 25 | 50 | | 75 | 0 |
| 11 | GP-05 | NC | General Proficiency | | | | | | 50 | | | 50 | |
| | | | **Total** | **17** | **3** | **8** | | | | | | **950** | **22** |
| 12 | | **Minor Course (Optional)** | | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| *The Mini Project-II or Internship-II (4-6 weeks) conducted during summer break after IV semester and will be assessed during V semester | | | | | | | | | | | | | | |

| | **Departmental Elective - 1** | | **Departmental Elective - 2** |
|---|---|---|---|
| MET-012 | Industrial Engineering & Management | MET-017 | Internal Combustion Engines |
| MET-013 | Instrumentation & Control | MET-018 | Optimization Techniques in Engineering |
| MET-014 | Advanced Strength of Material | MET-019 | Finite Element Method |
| MET-015 | Advanced Fluid Mechanics | MET-020 | Advanced Welding Technology |
| MET-016 | Advanced Engineering Materials | MET-021 | Process Planning & Cost Estimation |

## Heat and Mass Transfer (MET-009)

**L T P: 3 1 0**

**Course Objectives**

The course should enable the students to:

- Understand the fundamentals of heat transfer
- Obtain solutions of practical problems using empirical correlations.
- Understand the mechanisms of heat transfer in fluids and solids
- Understand applications in various heat transfer equipment in process industries.
- Analyze and design heat exchangers.

**Particulars**

**Unit 1** **(10 Hrs)**

**Introduction to Heat Transfer:** Concepts of heat flows: conduction, convection and radiation, effect of temperature on thermal conductivity of materials, introduction to combined heat transfer.

**Conduction:** One-dimensional general heat conduction equation in the Cartesian, cylindrical and spherical coordinates. Initial and boundary conditions.

**Steady State One-dimensional Heat Conduction:** Composite Systems in rectangular, cylindrical and spherical coordinates with and without energy generation, thermal resistance concept, Analogy between heat and electricity flow, thermal contact resistance, Overall heat transfer coefficient, critical thickness of insulation.

**Unit 2** **(8 Hrs)**

Types of fins, Fins of uniform cross-sectional area, errors of measurement of temperature in thermometer wells.

**Transient Conduction:** Transient heat conduction Lumped capacitance method, unsteady state heat conduction in one dimension only, Heisler charts.

**Unit 3** **(8 Hrs)**

**Forced Convection:** Basic concepts, hydrodynamic boundary layer, thermal boundary layer, flow over a flat plate, flow across a single cylinder and a sphere, flow inside ducts, empirical heat transfer relations, relation between fluid friction and heat transfer, liquid metal heat transfer.

**Natural Convection:** Physical mechanism of natural convection, buoyant force, and empirical heat transfer relations for natural convection over vertical planes and cylinders, horizontal plates and cylinders and sphere.

**Unit 4** **(7 Hrs)**

**Thermal Radiation:** Basic radiation concepts, radiation properties of surfaces, black body radiation laws, shape factor, black-body radiation exchange, Radiation exchange between non-blackbodies in an enclosure, Infinite parallel planes, radiation shields.

**Unit 5** **(9 Hrs)**

**Heat Exchanger:** Types of heat exchangers, fouling factors, overall heat transfer coefficient, logarithmic mean temperature difference (LMTD) method, effectiveness-NTU method, compact heat exchangers.

**Condensation and Boiling:** Introduction to condensation phenomena, heat transfer relations for laminar film condensation on vertical surfaces and on a horizontal tube, boiling modes: pool boiling curve, forced convective boiling.

**Introduction to Mass Transfer:** Introduction: Fick's law of diffusion, steady state equi-molar counter diffusion, steady state diffusion though a stagnant gas film.

**Reference Books:**

1. Elements of Heat transfer by Cengel, TMH.
2. Heat and mass transfer, M.Thirumaleswar, Pearson.
3. Fundamentals of Heat & Mass Transfer by Incropera Wiley India.
4. Heat & Mass Transfer by Khurmi, Schand,New Delhi.
5. A. Bejan, Heat Transfer Jone Wiley, 1993.
6. J.P. Holman, Heat Transfer, Eighth Edition, McGraw Hill, 1997.

**Course Outcomes**

At the end of this course, student will be able to:

**CO1:** Understand the basic laws of heat transfer and consequence of heat transfer in thermal analyses of engineering systems.

**CO2:**Analyse problems involving steady state heat conduction in simple geometries and develop solutions for transient heat conduction in simple geometries.

**CO3:** Understand the fundamentals of convective heat transfer process and evaluate heat transfer coefficients for natural convection and forced convection inside ducts, over exterior surfaces.

**CO4:** Calculate radiation heat transfer between black body surfaces and radiation heat exchange between gray body surfaces.

**CO5:** Analyse heat exchanger performance by using the method of log mean temperature difference and analyse heat exchanger performance by using the method of heat exchanger effectiveness.

# Dynamics of Machines & Vibrations (MET-010)

**L T P: 3 1 0**

**Course Objective**: This course helps to know the balancing of machines and gyroscopic couple in aero planes and ships. Moreover, the working and analysis of various types of governors are also explored in this course. Furthermore, the design of cylinders, pressure vessels and engine parts are also covered.

**Particulars**

**Unit-1** **(9 Hrs)**

Force Analysis, Turning Moment & Fly wheel: Static force analysis of linkages, Equivalent offset inertia force, Dynamic analysis of slider crank & Bar mechanism. Piston and Crank effort, Inertia, Torque, Turning moment diagrams, Fluctuation of energy, Flywheel.

Balancing of machines: Static and dynamic balancing, Balancing of rotating and reciprocating masses, Primary and secondary forces and couples.

**Unit-2** **(8 Hrs)**

Friction: Pivot and collar friction, Friction circle, Single plate, Multiplate and Cone clutches, Michelle & Kingsbury thrust bearing and rolling contact bearing, Belts and pulleys, Flat and Vbelts, Design and selection.

Brakes and Dynamometers (Mechanical Type): External and internal shoe brakes, Band and Block brakes, Hydraulic brakes, Absorption and Transmission dynamometers.

**Unit-3** **(9 Hrs)**

Governors: Dead weight and spring loaded governors, Sensitivity, Stability, Hunting, Isochronisms, Effort and Power, Friction and Insensitivity, Introduction to inertia governors.

Gyroscopic Motion: Principles, Gyroscopic acceleration, gyroscopic couple and Reaction. Effect of Gyroscopic couple upon the stability of aeroplanes, ship, two & four wheelers.

**Unit-4** **(8 Hrs)**

Periodic motion, harmonic motion, superposition of simple harmonic motions, beats, Fourier analysis; Single Degree Freedom System: Free vibration, Natural frequency, Equivalent Systems, Energy method for determining natural frequency, Response to an initial disturbance; Torsional vibrations, Damped vibrations. Damping models – Structural, Coulomb and Viscous damping, Vibrations of system with viscous damping, Logarithmic decrement, Viscous dampers.

**Unit 5: Forced Vibrations** **(8 Hrs)**

Single Degree Freedom: Forced vibration, Harmonic Excitation with viscous damping, Steady state vibrations; Forced vibrations with rotating and reciprocating unbalance, Support excitation, vibration isolation, Transmissibility, Vibration measuring instruments- Displacement, Velocity, Acceleration and Frequency measuring instrument.

**Reference Books:**


1. Shigley, J.E. and Mischke, C.R., Mechanical Engineering Design, Fifth Edition, McGraw-Hill International; 1989.
2. R. L. Norton, Mechanical Design – An Integrated Approach, Prentice Hall, 1998.
3. V. B. Bhandari, Design of Machine Elements, Tata McGraw Education Hill Pvt Ltd India.
4. Theory of Machine: Thomas Bevan (Pearson).
5. Theory of Machine: S.S.Ratan (TMH).
6. Kinematics, Dynamics & Design of Machinery-Waldron (Pearson).


**Course Outcomes**

On the completion of this course, students will be able to:

**CO1:** Design of IC Engine parts such as Crank and Connecting rods.

**CO2:** Explain the different types of brakes and dynamometers as well as the type clutches.

**CO3:** Explain the different types of Governors as well as the effect of Gyroscope on the stability of Aeroplane, Ships and Automobiles.

**CO4:** Ability to analyze natural frequency.

**CO5:** Ability to understand single degree of free and forced vibration systems.

# Manufacturing Science and Technology – II (MET-011)

**L T P: 3 1 0**

**Course Objectives**

The course should enable the students to:

- Understand the concept and basic mechanics of metal cutting, working of standard machine tools such as lathe, shaping and allied machines, milling, drilling and allied machines, grinding and allied machines and broaching.
- Understand the concepts and study various metal joining processes and their applications.
- Understand the mechanics of metal cutting, tool geometry, power required, and force calculations, structure of various machine tools, finishing operations.
- Gain knowledge about various unconventional manufacturing processes and their applications.

**Particulars**

**Unit 1** **(8 Hrs)**

**Metal Cutting:** Mechanics of metal cutting, Geometry of tool and nomenclature, ASA system Orthogonal vs. oblique cutting. Mechanics of chip formation, types of chips. Shear angle relationship. Merchant's force circle diagram. Cutting forces, power required. Cutting fluids/lubricants. Tool materials. Tool wear and tool life. Machinability. Brief introduction to machine tool vibration and surface finish. Economics of metal cutting.

**Unit 2** **(8 Hrs)**

**Machine Tools:**Lathe: Principle, types, operations, Turret/capstan, semi/Automatic, Tool layout.

Shaper, Slotter, Planer: operations & drives.

Milling: Milling cutters, up & down milling. Dividing head & indexing. Max chip thickness & power required.

Drilling and boring: Drilling, boring, reaming tools. Geometry of twist drills.

**Unit 3** **(8 Hrs)**

**Grinding & Super Finishing:** Grinding: Grinding wheels, abrasive, cutting action. Grinding wheel specification.Grinding wheel wear - attritions wear, fracture wear. Dressing and Truing. Max chip thickness and Guest criteria. Surface and Cylindrical grinding. Centerless grinding. Super finishing: Honing, lapping, and polishing.

**Unit 4** **(10 Hrs)**

**Metal Joining (Welding):** Survey of welding and allied processes. Gas welding and cutting, process and equipment. Arc welding: Power sources and consumables. TIG & MIG processes and their parameters. Resistance welding: spot, seam projection etc. Other welding processes such as atomic hydrogen, submerged arc, electroslag, friction welding. Soldering & Brazing. Thermodynamic and Metallurgical aspects in welding and weld, Shrinkage/residual stress in welds. Distortions & Defects in welds and remedies. Weld decay in HAZ.

**Unit 5** **(8 Hrs)**

**Introduction to non-conventional Manufacturing Process:** Benefits, application and working principle of EDM, ECM, LBM, EBM, USM. AJM, WJM. Non-conventional welding processes: LBW, USW, EBW, Plasma arc welding, Explosive welding.

**References**

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)- Pearson India, 2014.
2. A. Ghosh and A. K. Malik, Manufacturing Science, East West Press Private Limited New Delhi, 2010
3. PN Rao, Manufacturing Technology, Tata Mc-Graw Hill, 2017.
4. P.C. Pandey and H.S. Shan, Modern Machining Processes, Mc-Graw Hill.
5. Degarmo, Manufacturing Science, Wiley India.
6. Sontosh Bhatnagar, Manufacturing Process, BSP Hyderabad.

**Course Outcomes**

At the end of this course, student will be able to:

**CO1:** Explain the principal and classification of metal cutting.

**CO2:** Learn about different types of machine tools and their uses.

**CO3:** Gain knowledge of grinding and super finishing operations.

**CO4:** Learn about the basic and classification of welding processes.

**CO5:** Gain knowledge about the unconventional machining.

# DEPARTMENTAL ELECTIVE - 1

## Industrial Engineering and Management (MET-012)

**L T P: 3 0 0**

**Course Objectives**

The course should enable the student to:

- Achieve an understanding of productivity, production system and Work study concepts.
- Acquire the knowledge of plant layout and materials handling.
- Understand the concepts of Inventory control and Break-even analysis.
- Gain the knowledge of MRP, Job Analysis and merit rating.
- Be familiar with theories of management and their case studies.

**Particulars**

**Unit 1** **(8 Hrs)**

**Productivity:** Introduction, definition, measurement, productivity index, ways to improve productivity, Types of Production System.

**Work Study:** Meaning and benefits of work study, time & motion study. Micro motion study P.M.T.S. man machine Diagram flow chart. Motion economy, Method study, work measurement, Work sampling, standard time.

**Unit 2** **(8 Hrs)**

**Plant Layout and Materials Handling:** Plant location, type of layout, principles of facility layout principles of material handling, Material Handling equipment's.

**Replacement Analysis:** Depreciation causes, obsolescence, service life of assets, Replacement of items.

**Maintenance Management:** Maintenance Planning & Control, Maintenance Strategy.

**Unit 3** **(8 Hrs)**

**Inventory - Control:** Introduction, Classification of Inventory, Inventory function, cost, deterministic models, ABC- Analysis.

**Break Even Analysis:** Introduction, Assumption in Break-Even Analysis, Effect of Increase or Decrease in Fixed Cost and Variable Cost on BEF.

**Introduction of PERT and CPM:** Introduction, objectives of CPM and PERT, rules for network construction, estimation of activity time.

**Unit 4** **(8 Hrs)**

**MRP:** Concept of MRP, Inputs to MRP, MRP Processing, MRP outputs, Benefits and Limitations of MRP, Introduction of MRP II.

**Job Analysis and Merit Rating:** Objectives of Job Evaluation, Principle of Job Evaluation, Method Job Evaluation, Merit Rating, Selection of Factors in setting up Rating Method.

**Unit 5** **(8 Hrs)**

**Introduction to Management:** Theories of management: Traditional behavioral, contingency and systems approach, Organization as a system, Design of organization structure, leadership styles and managerial grid, Japanese management techniques, Case studies.

## Reference Books:


1. Principles of management. An analysis of management functions-H. Koontz & C.O. Donnel.TataMc-Graw-Hall Co.
2. Motion and Time Study Design and Measurement of Work, 7ed, Barnes, Wiley India
3. Manufacturing Management-J Moore Prentice Hall Englewood Cliffs: New Jersey.
4. Modern production operations Management-Buffa, E.S. Wiley Eastern.
5. Industrial Engineering & Management O.P. Khanna.
6. Industrial Engineering by Ravi Shanker.
7. Industrial Engineering by Mahajan.


**Course Outcomes**

At the end of this course, student will be able to:

**CO1:** Analyze the Productivity concept and various methods of improving Productivity.

**CO2**: Understand the layout of industries.

**CO3:** Understand and analyses Economic Order Quantity Concept.

**CO4:** Gain Knowledge of basic principal of maintenance.

**CO5**: Analyze Quality control and understand the industrial organization structure.

# Instrumentation and Control (MET-013)

**L T P: 3 0 0**

**Course Objectives**

The course should enable the student to:

- Gain a basic knowledge about measurement systems and their components.
- Develop ample regime to learn about various sensors and transducers used for measurement.
- Acquire knowledge for strain and temperature measurement.
- Develops basic concepts related to control systems.
- Gain the knowledge of frequency response and stability analysis.

**Particulars**

**Unit 1**

**Mechanical Measurements** **(8 Hrs)**

**Introduction:** Introduction to measurement and measuring instruments, Generalized measuring system and functional elements, Units of measurement, static and dynamic performance characteristics of measurement devices, calibration, concept of error, sources of error.

**Unit 2** **(8 Hrs)**

**Sensors and Transducers:** Types of sensors, types of transducers and their characteristics.

**Time Related Measurements:** Counters, stroboscope, frequency measurement by direct comparison, measurement of displacement.

**Measurement of Pressure:** Gravitational, directing acting, elastic and indirect type pressure transducers, Measurement of very low pressures.

**Unit 3** **(8 Hrs)**

**Strain Measurement:** Types of strain gauges and their working, calibration.

**Measurements of Force and Torque:** Different types of load cells, elastic transducers, pneumatic & hydraulic systems.

**Temperature Measurement**: Thermometers, bimetallic thermocouples, thermistors.

**Measurement of Geometric Forms**: Straightness, flatness, roundness. Tool maker's microscope.

**Measurement of Acceleration and Vibration**: Different simple instruments – principles of seismic instruments – Vibrometer and accelerometer using this principle.

**Unit 4** **(8 Hrs)**

**Concept of Automatic Controls**: Open loop & closed loop systems. Servo mechanism. Block diagrams. Laplace Transform and its applications, force-voltage and force current analogy, Electrical analog of simple mechanical system.

**Time Response Analysis**: Standard test signals, time response of second order systems and their Specifications, P, PI and PID Controllers.

**Unit 5** **(8 Hrs)**

**Frequency Response Analysis**: Frequency response, correlation between time and frequency responses, polar and inverse polar plots, Bode plots. Nyquist stability criterion, assessment of relative stability: gain margin and phase margin, constant.

**Stability Analysis**: Concept of stability, Routh-Hurwitz criteria and its limitations.

**Reference Books:**

1. Theory and Design for Mechanical Measurements, 3ed, w/CD, Figliola, Wiley India.
2. Beckwith Thomas G., Mechanical Measurements, Narosa Publishing House, N. Delhi.
3. Doeblein E.O., “Measurement Systems, Application Design”, McGraw Hill, 1990.
4. Nagrath & Gopal, “Control System Engineering”, 4th Edition, New age International.
5. B.C. Kuo, “Automatic Control System” Wiley India.
6. Instrumentation and control systems by W. Bolton, 2nd edition, Newnes.

**Course Outcomes**

At the end of this course, student will be able to:

**CO1**: Understand the various measuring instruments.

**CO2**: Understand different types of sensors.

**CO3**: Gain knowledge of basic principal of measurement.

**CO4**: Understand the open loop & closed loop systems.

**CO5**: Analyse frequency response.

# Advanced Strength of Materials (MET-014)

**L T P: 3 0 0**

**Course Objective**

The objective is to present the mathematical and physical principles in understanding the linear continuum behavior of solids.

**Particulars**

**Unit 1** **(8 Hrs)**

**Review of Stress and Strain in 3D:** Introduction to stress in 3D, Stress components on an arbitrary plane, Principal stresses, Stress Invariants, Plane state of stress, Differential equations of equilibrium, Boundary conditions, Strains: Concept of strain, derivation of small strain tensor, Compatibility conditions.

**Unit 2** **(8 Hrs)**

**Relationship Between Elastic Constants for Different Materials:** Introduction to Stress-strain relations for linearly elastic solid, Generalized Hooke's law, Stress-strain relations for isotropic, orthotropic and anisotropic materials, Relations between elastic constants, Material symmetry, Boundary Value Problems, Plane stress and plane strain problems.

**Unit 3** **(8 Hrs)**

**Theories of Failure:** Introduction to theories of failure, Mohr's theory of failure, Ideally plastic solid, Yield surfaces of Trescas and Von-mises, Axisymmetric problems: Lame's problem, Stress on composite tubes, Rotating shafts and cylinders, Thermal stresses: Thermo-elastic stress-strain relations, Strain displacement relations.

**Unit 4** **(8 Hrs)**

**Curved beam and Unsymmetrical Bending:** Curved Beams: Bending of beams with large initial curvature, position of neutral axis for rectangular, trapezoidal and circular cross sections, stress in crane hooks, stress in circular rings subjected to tension or compression.

Unsymmetrical Bending: Properties of beam cross-section slope of neutral axis, stress and deflection in unsymmetrical bending, determination of shear center and flexural axis (for symmetry about both axis and about one axis) for I-section and channel section.

**Unit 5** **(8 Hrs)**

**Stress Concentration and Fracture Mechanics:** Introduction to stress concentrations and fracture mechanics: Brittle fracture, Stress intensity factor, Fracture toughness, Fracture modes, Experimental determination of $K_{IC}$, Strain energy release rate, Meaning of energy criterion. Elasto-plastic fracture mechanics, J Integral.

**Reference Books:**

1. G. T. Mase, R. E. Smelser and G. E. Mase, Continuum Mechanics for Engineers, Third Edition, CRC Press, 2004.
2. Y. C. Fung, Foundations of Solid Mechanics, Prentice Hall International, 1965.
3. Lawrence. E. Malvern, Introduction to Mechanics of a Continuous Medium, Prentice Hall international, 1969.

**Course Outcomes**

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

**CO1**: Understand the deformation behavior of solids under different types of loading and obtain mathematical solutions for simple geometries.

**CO2:** Apply the different boundary conditions and superposition theorem to the various type of materials.

**CO3:** Identify and solve the plane stress and plane strain problems subjected to different loads.

**CO4:** Apply the concept of solid mechanics to the cylinders, disks and non-circular cross-sections.

**CO5:** Identify, formulate and solve engineering problems.

# Advanced Fluid Mechanics (MET-015)

**L T P: 3 0 0**

**Course Objective**

To familiarize the students about the principles and flow aspects of fluid mechanics.

**Particulars**

**Unit 1** **(8 Hrs)**

**Inviscid Irrotational Flows:** The Local Continuity Equation, Path Lines, Streamlines, and Stream Functions, Newton's Momentum Equation, Equation for Newtonian fluid, Vorticity and Circulation, Non-Newtonian fluids, Moving coordinate systems, Irrotational Flows and the Velocity Potential, Singularity Distribution Methods, Forces Acting on a Translating Sphere, Added Mass and the Lagally Theorem, Theorems for Irrotational Flow: Mean Value and Maximum Modulus Theorems, Maximum-Minimum Potential Theorem, Kelvin's Minimum Kinetic Energy Theorem.

**Unit 2** **(8 Hrs)**

**Exact Solutions of the Navier Stokes Equations:** Solutions to the Steady-State Navier-Stokes Equations, Two-Dimensional Flow Between Parallel Plates, Poiseuille Flow in a Rectangular Conduit, Poiseuille Flow in a Round Conduit, Couette Flow Between Concentric Circular Cylinders, Unsteady Flows: Impulsive Motion of a Plate—Stokes's First Problem, Oscillation of a Plate—Stokes's Second Problem, Plane Stagnation Line Flow, Three-Dimensional Axi-symmetric Stagnation Point Flow, Flow into Convergent or Divergent Channels.

**Unit 3** **(8 Hrs)**

**Thermal Effects and Flow Stability:** Thermal Boundary Layers, Forced Convection on a Horizontal Flat Plate, The Integral Method for Thermal Convection, Linear Stability Theory of Fluid Flows, Thermal Instability in a Viscous Fluid—Rayleigh-Bénard Convection, Stability of Flow Between Rotating Circular Cylinders: Couette-Taylor Instability.

**Unit 4** **(8 Hrs)**

**Turbulent Flows:** Statistical Approach—One-Point Averaging, Zero-Equation Turbulent Models, One-Equation Turbulent Models, Two-Equation Turbulent Models, Stress-Equation Models, Equations of Motion in Fourier Space, Quantum Theory Models, Large Eddy Models.

**Unit 5** **(8 Hrs)**

**Computational Methods:** Numerical Calculus, Numerical Integration of Ordinary Differential Equations, The Finite Element Method, Linear Stability Problems—Invariant Imbedding and Riccati Methods, Errors, Accuracy, and Stiff Systems, Multi-dimensional methods: Relaxation Methods, Surface Singularities, One-Step Methods: Forward Time, Centered Space, Dufort-Frankel Method, Crank-Nicholson Method, Hybrid Method, Upwind Differencing.

**Reference Books:**

1. Graebel. W.P, "Advanced Fluid Mechancis", 1st Edition, Academic Press, Elsevier Inc., 2007.
2. K. Muralidhar and G. Biswas, "Advanced Engineering Fluid Mechanics", 3rd Edition, Narosa Publishers, 2015.
3. Stevan A Jones, "Advanced Methods for Practical Applications in Fluid Mechanics", In Tech Publishers, 2012.
4. Hyoung Woo Oh, "Advanced Fluid Mechancis", InTech Publishers, 2012.
5. Roger Kinsky, "Fluid Mechanics Advanced Applications", McGraw-Hill Education Europe, 1997

**Course Outcomes**

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

**CO1**: Understand the fundamentals of irrotational flows.

**CO2**: Apply exact solutions of the Navier-Stokes equations.

**CO3**: Understand thermal effects and flow stability.

**CO4**: Analyze turbulent flows using numerical models.

**CO5**: Apply computational methods for fluid flow problems.

# Advanced Engineering Materials (MET-016)

**L T P: 3 0 0**

**Course Objective**

The course should enable the students to:

- Provide an overview of advanced engineering materials and their applications.
- Select appropriate advanced engineering materials for different engineering applications.
- Gain knowledge about Non Metallic materials, High Strength Materials, low and high temperature materials, nanomaterial and their applications.

**Particulars**

**Unit 1** **(8 Hrs)**

**Classification and Selection of Materials:** Classification of materials, Properties required in Engineering materials. Criteria of selection of materials, Requirements / needs of advance materials.

**Unit 2** **(8 Hrs)**

**Non Metallic Materials:** Classification ofnon metallic materials, Rubber: Properties, processing and applications, Plastics: Thermosetting and Thermoplastics, Applications and properties. Ceramics: Properties and applications. Adhesives: Properties and applications, Optical fibers: Properties and applications, Composites: Properties and applications.

**Unit 3** **(8 Hrs)**

**High Strength Materials:** Methods of strengthening of alloys, Materials available for high strength applications, Properties required for high strength materials, Applications of high strength materials.

**Unit 4** **(8 Hrs)**

**Low & High Temperature Materials:** Properties required for low temperature applications, Materials available for low temperature applications, Requirements of materials for high temperature applications, Materials available for high temperature applications, Applications of low and high temperature materials.

**Unit 5** **(8 Hrs)**

**Nanomaterials:** Definition, Types of nanomaterials including carbon nanotubes and nanocomposites, Physical and mechanical properties, Applications of nanomaterials.

**Reference Books:**

1. Vlack V. Elements of Material Science And Engineering, 2nd ed., Pearson Education India, 2014.
2. Kodgire V.D.,Material science and Metallurgy, Everest Publishing House.
3. Askeland D. R. and Phule P. P., The Science and Engineering of Materials, 3rd ed., Thomson Publication,1996.

**Course Outcomes**

At the end of this course, the student will be able to:

**CO1**: Differentiate the metallic and non-metallic materials.

**CO2**: Understand the preparation of high strength materials.

**CO3**: Suggest materials for low and high temperature applications.

**CO4**: Integrate knowledge of different types of advanced engineering materials.

**CO5**: Analyze problem and find appropriate solution for use of materials.

# DEPARTMENTAL ELECTIVE - 2

## Internal Combustion Engines (MET-017)

**L T P: 3 0 0**

**Course Objectives**

The course should enable the students to:

- Provide basic knowledge about the components of IC Engines.
- Understand the operation, combustion, performance and emissions of internal combustion engines.
- Learn basic concepts related to motor cycle calculation, mixture characteristics, combustion, the actual cycle, knock, power calculations and the gas exchange.
- Acquire understanding related to alternate fuels, emission and their testing.

**Particulars**

**Unit 1** **(8 Hrs)**

**Components of IC Engines:** Classification of internal combustion engines, application of IC Engines, Air standard cycles (Otto, Diesel, and Dual cycle). Function and operation of two stroke and four stroke engines, Comparison of SI and CI, two stroke and four stroke engines, Effects, limitations, and types of supercharging and scavenging process, performance characteristics of IC engines, problems on performance and heat balance, fuel air cycles and their significance.

**Unit 2** **(8 Hrs)**

**IC Engine Auxiliary Systems:** Carburetion, mixture requirements at different loads and speeds, simple carburetor. Functional requirements and classification of an injection systems, injection pump, nozzle types, MPFI and EFI systems, Battery and magneto ignition systems, ignition timing and engine parameters. Properties of lubricants, mist, wet and dry sump lubrication systems. Liquid and air cooled cooling system, coolant and antifreeze solutions.

**Unit 3** **(8 Hrs)**

**Combustion in SI Engine:** Homogeneous and heterogeneous mixture, combustion in spark ignition engines, stages of combustion in spark ignition engines. Flame front propagation, factors influencing flame speed, Rate of pressure rise, abnormal combustion, and phenomenon of knock in SI engines. Effect of engine variables on knock, combustion chambers for SI engines, smooth engine operation. High power output and thermal efficiency, stratified charge engine.

**Unit 4** **(8 Hrs)**

**Combustion in CI Engines:** Combustion in CI engine, stages of combustion in CI engines. Factors affecting the delay period, compression ratio, engine speed, output, atomization and duration of injection, injection timing, quality of fuel, intake temperature, intake pressure. Phenomenon of knock in CI engines, comparison of knock in SI and CI engines. Combustion chambers for CI engines, Homogeneous charge compression ignition engines.

**Unit 5** **(10 Hrs)**

**Alternate Fuels and Emission:** Liquid fuels, alcohol, methanol, ethanol; vegetable oil, biodiesel production, properties, advantages and disadvantages. Gaseous fuel – Hydrogen, CNG, LPG. Air pollution due to IC engines, hydrocarbon and CO emission, oxides of nitrogen, aldehydes, Sulphur, lead and phosphorus emissions. Catalytic converter, exhaust gas recirculation. Flame ionization detector, non-dispersive infra-red detector, chemiluminescence analyzer, smoke types, Bosch smoke meter, Emission standards.

**Testing and Performance:** Performance parameters, Basic measurements, blow by measurement, Testing of SI and CI engines.

**Reference Books:**

1. Ganesan.V, “Internal Combustion Engines”, Tata McGraw-Hill, New Delhi, 2015.
2. Ramalingam K.K, “Internal Combustion Engines- Theory and practice”, SciTech publications India Pvt. Ltd., Chennai, 2010.
3. Thipse S.S, “Internal Combustion Engines”, Jaico Publication House, 2010.
4. Thipse S.S, “Alternate Fuels”, Jaico Publication House, 2010.
5. Heywood.J.B, “Internal Combustion Engine Fundamentals”, McGraw Hill International, New York, 2008.
6. Mathur M.L and Sharma R.P, “A course in Internal Combustion Engines”, DhanpatRai& Sons, New Delhi, 2010.

**Course Outcomes**

At the end of this course, student is able to:

**CO1**: Acquire the knowledge of engine operation and performance.

**CO2**: Understand the working of engine auxiliary systems.

**CO3**: Understand the combustion aspects of spark ignition engine.

**CO4**: Understand the combustion aspects of combustion ignition engine.

**CO5**: Know the various alternate fuels, engine emissions, measuring and control techniques.

# Optimization Techniques in Engineering (MET-018)

**L T P: 3 0 0**

**Course Objective**

To study the principles of optimization and various techniques which can be used for mechanical engineering optimization along with applications.

**Particulars**

**Unit 1** **(8 Hrs)**

Unconstrained Optimization: Optimizing Single-Variable Functions, conditions for Local Minimum and Maximum, Optimizing Multi-Variable Functions.

**Unit 2** **(8 Hrs)**

**Constrained Optimization:** Optimizing Multivariable Functions with Equality Constraint: Direct Search Method, Lagrange Multipliers Method, Constrained Multivariable Optimization with inequality constrained: Kuhn-Tucker Necessary conditions, Kuhn –Tucker Sufficient Conditions.

**Unit 3** **(8 Hrs)**

**Optimization:** Quasi-Newton Methods and line search, least squares optimization, Gauss Newton, Levenberg-Marquartd, Extensions of LP to Mixed Integer Linear Programming (MILP), Non-Linear Programming, The Newton Algorithm, Non-Linear Least Squares, Sequential Quadratics Programming (SQP), Constrained Optimization, SQP Implementation, Multi-Objective Optimization, Branch and Bound Approaches, Genetic Algorithms and Genetic Programming, Singular Based Optimization, On-Line Real- Time Optimization, Optimization in Econometrics Approaches – Blue.

**Unit 4** **(8 Hrs)**

Optimization and Functions of a Complex Variable and Numerical Analysis: The Finite Difference Method for Poisson's Equation in two Dimensions and for the Transient Heat Equation, Eulers Method, The Modified Euler Method and the Runge-Kutta Method for Ordinary Differential Equations, Gaussian Quardative Trapezoidal Rule and Simpson's 1/3 and 3/8 Rules, the Newton Raphson in one and two Dimensions, Jacobi's Iteration Method.

**Unit 5** **(8 Hrs)**

Optimization in Operation Research: Dynamic Programming, Transportation – Linear Optimization Simplex and Hitchcock Algorithms, Algorithms, Minimax and Maxmin Algorithm, Discrete Simulation, Integer Programming – Cutting Plane Methods, Separable Programming, Stochastic Programming, Goal Programming, Integer Linear Programming, Pure and Mixed Strategy in theory of Games, Transhipment Problems, Heuristic Methods.

**Reference Books:**


1. Rao Singaresu. S, "Engineering Optimization – Theory & Practice", New Age International (P) Limited, New Delhi, 2009.
2. Kalyanamoy Deb, "Optimization for Engineering design algorithms and Examples", Prentice Hall ofIndia Pvt. Ltd., 2006.
3. Johnson Ray C, "Optimum design of mechanical elements", Wiley, John & Sons, Digitized 2007
4. Goldberg .D.E, "Genetic algorithms in search, optimization and machine", Barnen, Addison Wesley, New York, 1989.
5. William Orthwein, "Machine Component Design", Vol. I and II, Jaico Publishing house, New Edition,2006.
6. Rao.C.S, "Optimization Techniques", Dhanpat Rai& Sons, New Delhi
7. Fox.R.L, "Optimization methods for Engineering Design", Addison Wesley Pub, Digitized 2007.
8. Garret N. Vanderplaats, "Numerical optimization techniques for engineering", McGraw-Hill Ryerson,Limited, 1984.


**Course Outcomes**

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

**CO1**: Define and use optimization terminology and concepts, and understand how to classify an optimization problem.

**CO2**: Demonstrate the ability to choose and justify optimization techniques that are appropriate for solving realistic engineering problems.

**CO3**: Understand and apply unconstrained optimization theory for continuous problems, including the necessary and sufficient optimality conditions and algorithms

**CO4**: Understand and apply gradient-free and discrete optimization algorithms.

**CO5**: Apply optimization techniques to determine a robust design.

# Finite Element Method (MET-019)

**L T P: 3 0 0**

**Course Objective**

To illustrate the principle of mathematical modelling of engineering problems and to introduce the basics and application of Finite Element Method.

**Particulars**

**Unit 1** **(8 Hrs)**

Historical Background, Mathematical modeling of field problems in engineering, governing equations, discrete and continuous models, boundary and initial value problems, Weighted Residual Methods, Variational formulation of boundary value problems, Ritz technique, Basic concept of Finite Element Method.

**Unit 2** **(8 Hrs)**

One dimensional second order equation, discretization, linear and higher order elements, derivation of shape functions, Stiffness matrix and force vectors, assembly of elemental matrices, solution of problems from solid mechanics and heat transfer, longitudinal vibration and mode shapes, fourth order beam equation, transverse deflections and natural frequencies.

**Unit 3** **(8 Hrs)**

Trusses: Introduction, plane trusses, three dimensional trusses, assembly of global stiffness matrix for the banded and skyline solution.

Beams and Frames: Introduction, finite element formulation, load vector, boundary considerations, shear force and bending moment, plane frames.

**Unit 4** **(8 Hrs)**

Two dimensional equations, variational formulation, finite element formulation, triangular elements-shape functions, elemental matrices and RHS vectors; application to thermal problems, torsion of non-circular shafts, quadrilateral and higher order elements. Plane stresses and plane strain problems, body forces and thermal loads, plate and shell elements.

**Unit 5** **(8 Hrs)**

Natural coordinate systems, iso-parametric elements and shape functions, numerical integration and application to plane stress problems, matrix solution techniques, solution of dynamic problems and introduction to FE software.

**Reference Books:**

1. Rao S.S., The Finite Element Method in Engineering, 3rd ed., Butterworth Heinemann, 2004.
2. Chandrupatla & Belegundu, Introduction to Finite Elements in Engineering, 3rd ed., Prentice Hall, 1990.
3. Reddy J.N., An Introduction to Finite Element Method, 3rd ed., Tata McGraw Hill, 2005.
4. Seshu P., Text Book of Finite Element Analysis, Prentice Hall, New Delhi, 2007.

**Course Outcomes**

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

**CO1**: Understand the FEM formulation and its application to simple structural and thermal problems.

**CO2**: Understand the numerical methods involved in Finite Element Theory.

**CO3**: Analyze the direct and formal (basic energy and weighted residual) methods for deriving finite element equations.

**CO4**: Analyze the role and significance of shape functions in finite element formulations and use linear, quadratic, and cubic shape functions for interpolation.

**CO5**: Design and analyze the complicated systems.

# Advanced Welding Technology (MET-020)

**L T P: 3 0 0**

**Course Objectives**

The course should enable the student to:

- Impart knowledge of various parameters and requirements of welding processes and advanced welding practices in industries.
- Understand the weldability of specific materials.
- Acquire knowledge about the principle and applications of advance welding processes.
- Gain the knowledge of weld design, defects and its remedies.
- Know the thermal and metallurgical considerations of welds.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction:** Importance and application of welding, classification of welding process; Selection of welding process; Arc and Power Source characteristics, Review of conventional welding process: Gas welding, Arc welding, MIG, TIG welding, Resistance welding. Electroslag welding, Friction welding etc., Soldering & Brazing.

**Unit 2** **(8 Hrs)**

**Weldability of Specific Materials:** Weldability of: Carbon steel, High strength low alloy steels, stainless steel, Cast Iron, Copper and its alloys, Aluminum and its alloys, Magnesium and its alloys and Titanium alloys& Maurer/Schacfflar Diagram.

**Unit 3** **(8 Hrs)**

**Advanced Welding Techniques:** Principle, working and application of advanced welding techniques such as Plasma Arc welding, Laser beam welding, Electron beam welding, Ultrasonic welding, explosive welding, Underwater welding, Spraywelding /Metallising, Hard facing.

**Unit 4** **(8 Hrs)**

**Weld Design:** Weld defects and distortion and its remedies, Inspection/testing of welds, HAZ, Weld Design, Welding of pipe-lines and pressure vessels. Life prediction.

**Unit 5** **(8 Hrs)**

**Thermal and Metallurgical Considerations:** Thermal considerations for welding, temperature distribution, Analytical analysis, heating & cooling curves. Metallurgical consideration of weld, HAZ and Parent metal, micro & macro structure. Solidification of weld and properties.

**Reference Books:**

1. Welding Engineering & Technology by R. S. Parmar, Khanna Publishers.
2. Welding Processes and Technology by R.S. Parmar, Khanna Publishers.
3. Principles of welding (Processes, Physics, Chemistry, and Metallurgy) Robert W. Messler Wiley Publishers.
4. Advanced Welding Processes by John Norrish, Woodhead Publishing.
5. Welding Metallurgy by Sindo Kou, Wiley-Interscience Publication.
6. Welding Handbook (Vol-2, 3 & 4) by American Welding Society.

**Course Outcomes**

At the end of this course, the student will be able to:

**CO1:** Acclaim knowledge regarding various advanced welding practices in industries.

**CO2:** Understand various parameters and requirements of welding processes.

**CO3:** Know the comparative merits and demerits of various welding processes

**CO4:** Understand the right kind of welding techniques suitable for various joints.

**CO5:** Learn about the joint designs adopted in different types of welding techniques

# Process Planning and Cost Estimation (MET-021)

**L T P: 3 0 0**

**Course Objective**

To introduce the process planning concepts to make cost estimation for various products after process planning.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction to Process Planning:** Introduction- methods of process planning- drawing interpretation – material evaluation – steps in process selection. Production equipment and tooling selection.

**Unit 2** **(8 Hrs)**

**Process Planning Activities:** Process parameters calculation for various production processes. Selection of jigs and fixtures, election of quality assurance methods- Set of documents for process planning, Economics of process planning.

**Unit 3** **(8 Hrs)**

**Introduction to Cost Estimation:** Importance of costing and estimation – methods of costing, elements of cost estimation- types of estimates, Estimating procedure – estimation of labor cost, material cost. Allocation of overhead charges – Calculation of depreciation cost.

**Unit 4** **(8 Hrs)**

**Production Cost Estimation:** Estimating of different types of jobs- estimation of forging shop, estimation of welding shop, estimation of foundry shop.

**Unit 5** **(8 Hrs)**

**Machining Time Calculation:** Estimation of Machining Time – importance of machine time calculation.Calculation of machining time for different lathe operation, drilling and boring, milling shaping, planning and grinding.

**Reference Books:**

1. Peter Scalon, “Process planning, Design/Manufacture Interface”, Elsevier science technology.
2. Russell R.S. and Tailor B.W, Operation Management”, 4th Edition, PHI, 2007.
3. Chitale A.V. and Gupta R.C. , “Product Design and Manufacturing”, 2nd Edition, PHI, 2002.

**Course Outcomes**

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

**CO1:** Apply process planning concepts in industrial perspective to describe the best process for each job.

**CO2:** Determine systematically engineering processes and systems to manufacture a product economically and competitively.

**CO3**: Evaluate the process of forecasting the expenses that must be incurred to manufacture a product.

**CO4**: Predetermination of cost expected to be incurred in production of a component in advance.

**CO5**: Evaluation of machining time to find the manufacturing cost of a particular job.

# Heat and Mass Transfer Lab (MEP-011)

**L T P: 0 0 2**

**Course Objectives**

The course should enable the students to:

- Provides the necessary background to understand the fundamental modes of heat transfer and mass transfer.
- Understand the various forms of heat transfer and their applications in real life problems.
- Analyze different methods to calculate the heat transfer coefficient in various heat transfer problems.
- Analyze the theoretical knowledge and apply it in conducting experiments in the forms of heat transfer.

**Particulars**

List of experiments (minimum 10 of the following)

1. Conduction - Composite wall experiment
2. Conduction - Composite cylinder experiment
3. Convection - Pool Boiling experiment
4. Convection - Experiment on heat transfer from tube-natural convection.
5. Convection - Heat Pipe experiment.
6. Convection - Heat transfer through fin-natural convection.
7. Convection - Heat transfer through tube/fin-forced convection.
8. Determination of Stephan Boltzmann Constant
9. Determination of emissivity.
10. Heat exchanger - Parallel flow experiment
11. Heat exchanger - Counter flow experiment
12. Experiment on critical insulation thickness.
13. Conduction - Determination of thermal conductivity of fluids.
14. Conduction - Thermal Contact Resistance Effect.

**Reference Books:**


**1.** Elements of Heat transfer by Cengel, TMH

**2.** Heat and mass transfer, M.Thirumaleswar, Pearson

**3.** Fundamentals of Heat & Mass Transfer by Incropera Wiley India

**4.** Heat & Mass Transfer by Khurmi, Schand,New Delhi

**5.** J.P. Holman, Heat Transfer, Eighth Edition, McGraw Hill, 1997.

**Course Outcomes**

At the end of the course, student will be able to:

**CO1:** Analyze the Insulation thickness effect on heat transfer.

**CO2:** Evaluate the Conduction, convection and radiation heat transfer.

**CO3:** Analyze the performance of heat exchangers in parallel and counter flow arrangement.

**CO4:** Evaluate the thermal conductivity of working fluids of heat transfer.

**CO5:** Analyze the performance of boiling apparatus.

# Dynamics of Machines and Vibration Lab (MEP-012)

**L T P: 0 0 2**

**Course Objectives**

The course will enable the student to:

- Learn about the working of different type of governors and gyroscope.
- Understand concepts related to balancing of rotating and reciprocating masses.
- Determine the vibration frequency of different rotor arrangements.
- Study the working and principle of clutches, brakes and dynamometers.

**Particulars**

**List of experiments (Minimum 10)**

1. Experiment on Governor.
   a) To perform experiment on watt and Porter Governors to prepare performance characteristic Curves, and to find stability & sensitivity.
   b) To perform experiment on Proell Governors to prepare performance characteristic Curves, and to find stability & sensitivity.
   c) To perform experiment Hartnell Governors to prepare performance characteristic Curves, and to find stability & sensitivity.
2. Experiment on critical speed of shaft (whirling of shaft)
3. Experiment on Gyroscope
   a) Study of the Principles of Gyroscope and Verification of the Equation of Gyroscopic Couple.
   b) To determine percentage variation of theoretical and experimental variation of gyroscopic couple.
   c) To study gyroscopic effects through models.
4. Experiment on Balancing of Rotating Masses
5. Experiment on Balancing of Reciprocating Masses
6. Study of various types of clutches.
7. Study of various types of brakes.
8. Study of various types of dynamometers.
9. To determine natural frequency of a spring mass system.
10. To determine natural frequency of free torsional vibrations of single rotor system.
    i) Horizontal rotor
    ii) Vertical rotor
11. Performing the experiment to find out damping co-efficient in case of free damped torsional vibration.

**Course Outcomes**

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

**CO1:** Determine the performance of different governors.
**CO2:** Evaluate the performance of gyroscope
**CO3:** Understand the balancing of rotating and reciprocating masses.
**CO4:** Understand different types of clutches and brakes.
**CO5:** Calculate the frequency of different rotor arrangements.

# Manufacturing Science and Technology-II Lab (MEP-013)

**L T P: 0 0 2**

**Course Objective**

The course should enable the students to:

- To provide practical experience in various welding processes with different materials.
- Use the basic machine tools like lathes, milling machines, drill press and shaping machines.
- To inculcate the knowledge of tool geometry in manufacturing.
- To impart knowledge about cutting forces and chip formation in metal cutting.
- Give hands-on exposure to perform metal cutting, welding and unconventional machining and welding experiments.

**Particulars**

**List of Experiments:**

Minimum 10 experiments out of the following.

1. Bolt (thread) making on Lathe machine.
2. Tool grinding (to provide tool angles) on tool-grinder machine.
3. Gear cutting on milling machine.
4. Machining a block on shaper machine.
5. Finishing of a surface on surface-grinding machine.
6. Drilling holes on drilling machine and study of twist-drill.
7. Experiment on tool wear and tool life.
8. Gas welding experiment
9. Arc welding experiment
10. Resistance welding experiment.
11. Soldering & Brazing experiment
12. Experiment on TIG/MIG Welding.
13. Macro and Microstructure of welding joints, HAZ.
14. Experiment on unconventional machining such as EDM & WEDM.
15. Experiment on unconventional welding.

**Reference Books:**

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)-Pearson India, 2014.
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems.
3. Degarmo, Black & Kohser, Materials and Processes in Manufacturing.
4. Ghosh and A. K. Malik (2010) Manufacturing Science, East West Press Private Limited New Delhi.
5. PN Rao, “Manufacturing Technology”, Tata McGraw Hill, 2017.

**Course Outcomes**

At the end of this course, student will be able to:

**CO1**: Perform the different experiments on lathe.

**CO2**: Perform the different experiments on milling, shaper and planer.

**CO3**: Perform the different experiments on grinding.

**CO4**: Perform the different experiments on welding.

**CO5**: Perform the different experiments on unconventional machining processes.

# Internship II/ Mini Project II (MEP-014)

**Course Objectives**

The course should enable the students to:

- Create an Industrial environment and culture within the institution.
- Identify the issues and challenges of an industry.
- Prepare report on the application of emerging technologies in the selected industry.
- Learn and understand the concept of entrepreneurship.
- Inculcate innovative thinking.

**Course Outcomes:**

On completion of the course, student will be able to–

**CO1:** Develop his abilities to transmit technical information clearly and test the same by delivery of Seminar based on the Mini Project or Internship.

**CO2:** Understand the importance of document design by compiling Technical Report on the Mini Project or Internship work carried out.

**CO3:** Comment and evaluate other students research questions and internship proposals.

# Constitution of India (AHT-009)

**L T P: 2 0 0**

**Course Objectives**

The course should enable the students to:

- Acquaint them with legacies of constitutional development in India and help to understand the most diversified legal document of India and philosophy behind
- Make them aware of the theoretical and functional aspects of the Indian Parliamentary System.
- Channelize their thinking towards basic understanding of the legal concepts and its implications for engineers.

**Particulars**

**Unit 1** **(8 Hrs)**

**Constitutional Framework**

Meaning of Terms and Phrases frequently used in political system like constitution, constitutionalism, Rule of Law, Federal system, Government and so on. Historical Background of Indian Constitution, Making of Indian Constitution, Salient features of Indian Constitution, Preamble of Indian Constitution.

**Unit 2** **(8 Hrs)**

**Different Parts, Articles, and their Significance**

Part I to IVA (Union and its territories w.r.t. Indian States, Citizenship, Fundamental Rights conferred to citizens and foreigners, Directive Principles of State Policy– Its importance and implementation and Fundamental Duties and its legal status), Article 1 to 51A and their significance.

**Unit 3** **(8 Hrs)**

**System of Government**

Parliamentary Form of Government in India – The constitution powers and status of the President of India, Federal structure and distribution of legislative and financial powers between the Union and the States, Emergency Provisions: National Emergency, President Rule, Financial Emergency and Amendment of the Constitutional Powers and Procedure and the significance of basic structure in Indian Judicial system.

**Unit 4** **(8 Hrs)**

**Working of Central, State & Local Self Government as per Constitution**

Framework for central government (President, Vice president, Prime Minister, Central council of ministers, Parliament, Supreme court and so on), Framework for state government (Governor, Chief Minister, state legislature, High court and so on) and Framework for local self-government (Panchayatiraj, Municipalities) and Union Territories.

**Unit 5** **(8 Hrs)**

**Constitutional, Non-Constitutional and other bodies**

Discussion on Various constitutional bodies like Election Commission, UPSC, SPSC, Finance commission, NCSC, NCST, NCBC, CAG and AGI. Discussion on Various non-constitutional bodies like NITI Aayog, NHRC, CIC, CVC, CBI, Lokpal and Lokayukta. Discussion on Various other constitutional bodies like Co- operative societies, Official Language, Tribunals etc.

**Text/Reference Books-**

1. M. Laxmikanth, “Indian Polity”, McGraw- Hill, 6th edition, 2020
2. D.D. Basu, “Introduction to the Indian Constitution”, LexisNexis, 21st edition, 2020
3. S.C. Kashyap, “ Constitution of India”, Vitasta publishing Pvt. Ltd., 2019

**Course Outcomes**

The course should enable the students to:

**CO1:** Understand the basic knowledge and salient features of Indian Constitution.

**CO2:** Identify and explore the basic features and modalities about Indian constitution.

**CO3:** Discusses the essence of Union and its territories, Citizenship, Fundamental Rights, DPSP and Fundamental Duties.

**CO4:** Differentiate and relate the functioning of Indian parliamentary system at the center and state level.

**CO5:** Differentiate different aspects of Indian Legal System and its related bodies.

# Essence of Indian Traditional Knowledge (AHT-010)

**L T P: 2 0 0**

**Course Objectives**

The course should enable the students:

- With the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.
- To understand the traditional knowledge and analyse it and apply it to their day to day life.
- To know the need and importance of protecting traditional knowledge.
- To understand the concepts of Intellectual property to protect the traditional knowledge.
- For concentrating on various acts in protecting the environment and Knowledge management impact on various sectors in the economy development of the country.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction to Traditional and Culture Knowledge**

Define culture, traditional, civilization and heritage knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK). Indigenous traditional knowledge Vs western traditional knowledge vis-à-vis formal knowledge.

**Unit 2** **(8 Hrs)**

**Protection of Traditional Knowledge**

Protection of traditional knowledge: The need for protecting traditional knowledge Significance of traditional knowledge Protection, value of traditional knowledge in global economy, Role of Government to harness traditional knowledge.

**Unit 3** **(8 Hrs)**

**Traditional Knowledge and Intellectual Property**

Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, Global legal forums for increasing protection of Indian Traditional Knowledge.

**Unit 4** **(8 Hrs)**

**Traditional Knowledge in Different Sectors**

Traditional knowledge in engineering, biotechnology and agriculture, traditional medicine system, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of traditional knowledge.

**Unit 5** **(8 Hrs)**

**Education System in India**

Education in ancient, medieval and modern India, aims of education, subjects, languages, Science and Scientists of Ancient India, Scientists of Medieval India, Scientists of Modern India. The role Gurukulas in Education System, Value based Education.

**Text/Reference Books:**


1. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002.
2. "Knowledge Traditions and Practices of India" Kapil Kapoor1, Michel Danino2.
3. Traditional Knowledge System in India, by Amit Jha, 2009.
4. Satya Prakash, “Founders of Sciences in Ancient India”, Vijay Kumar Publisher, 1989
5. Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta and Vipin Kumar Singh Pratibha Prakashan 2012.


**Course Outcomes**

The course should enable the students to:

**CO1:** Understand the concept of Traditional knowledge and its importance.

**CO2:** Know the need and importance of protecting traditional knowledge.

**CO3:** Know the various enactments related to the protection of traditional knowledge.

**CO4:** Understand the concepts of Intellectual property to protect the traditional knowledge.

**CO5:** Know the contribution of scientists of different areas.

| SEMESTER-VI (w.e.f. 2024-25) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B.TECH. – MECHANICAL ENGINEERING | | | | | | | | | | | | | |
| S. No. | Subject Codes | Category | Subject | Periods | | | Evaluation Scheme | | | | | Subject Total | Credit |
| | | | | | | | Sessional Exam | | | ESE | | | |
| | | | | L | T | P | CT | TA | Total | TE | PE | | |
| 1 | MET-022 | DC | Operation Research | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 2 | MET-023 | DC | Design of Machine Elements | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 3 | MET-024 | DC | Refrigeration & Air Conditioning | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| 4 | MEP-XXX | DE | Departmental Elective - 3 | 3 | 0 | 0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| 5 | AHT-XXX | HSC | Open Elective-1 | 3 | 0 | 0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| 6 | MEP-015 | DLC | MATLAB Programming for Mechanical Engineers | 0 | 0 | 2 | | 25 | 25 | | 25 | 50 | 1 |
| 7 | MEP-016 | DLC | Design of Machine Elements Lab | 0 | 0 | 2 | | 25 | 25 | | 25 | 50 | 1 |
| 8 | MEP-017 | DLC | Project Stage -I | 0 | 0 | 2 | | 25 | 25 | | 25 | 50 | 1 |
| 9 | AHT-010/ AHT-009 | NC | Essence of Indian Traditional Knowledge / Constitution of India | 2 | 0 | 0 | 15 | 10 | 25 | 50 | | 75 | 0 |
| 10 | AHT-014 | NC | Happiness and Well being | 2 | 0 | 0 | 25 | 25 | 50 | | | 50 | 0 |
| 11 | GP-06 | NC | General Proficiency | | | | | | 50 | | | 50 | 0 |
| | | | **Total** | **17** | **3** | **6** | | | | | | **900** | **21** |
| 12 | | **Minor Course (Optional)** | | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| Mini Project-III or Internship-III* (4-6 weeks)<br>To be completed at the end of sixth semester (during Summer Break) & its evaluation/credit to be added in seventh semester. | | | | | | | | | | | | | |

| **Departmental Elective - 3** | |
|---|---|
| MET-025 | Experimental Stress Analysis |
| MET-026 | Machine Tool Design |
| MET-027 | Fuels and Combustion |
| MET-028 | Precision Engineering |
| MET-029 | Automobile Engineering |

| **Open Elective – 1 (HSC)** | |
|---|---|
| AHT-011 | Total Quality Management |
| AHT-012 | Managing e-Commerce & Digital Communication |
| AHT-013 | Industrial Safety and Hazards Management |

# Operation Research (MET-022)

**L T P: 3 1 0**

**Course Objective**

The course should enable the students to:

- To impart knowledge in concepts and tools of Operations Research.
- To understand mathematical models used in Operations Research.
- To understand the usage of linear programming, transportation and assignment problems, queuing, game theory, decision making and network scheduling and project management problems.
- To building capabilities in the students for analyzing different situations in the industrial/ business scenario involving limited resources and finding the optimal solution within constraints.

**Particulars**

**Unit 1** **(10 Hrs)**

**Introduction and Linear Programming Problems**

**Introduction:** Linear programming, Definition, scope of Operations Research (OR) approach and limitations of OR Models, Characteristics and phases of OR Mathematical formulation of L.P. Problems. Graphical solution methods.

**Linear Programming Problems:** The simplex method - slack, surplus and artificial variables. Concept of duality, Big-M method, Two-phase method, degeneracy, and procedure for resolving degenerate cases, Dual Simplex method.

**Unit 2** **(8 Hrs)**

**Transportation and Assignment Problem**

**Transportation Problem:** Formulation of transportation model, Basic feasible solution using different methods, Optimality Methods, Unbalanced transportation problem, Degeneracy in transportation problems, Applications of Transportation problems.

**Assignment Problem:** Formulation, unbalanced assignment problem, traveling problem.

**Unit 3** **(8 Hrs)**

**Game Theory and Decision Theory**

**Game Theory:** Formulation of games, two person-Zero sum game, games with and without saddle point, Graphical solution (2x n, m x 2 game), dominance property, mixed strategy (3x3 games).

**Decision Theory:** Steps in Decision theory approach - Decision making Environments-Making under conditions of Certainty, Uncertainty, Conditions of Risk, Decision making conditions – problems, Decision trees. - Utility Theory.

**Unit 4** **(8 Hrs)**

**Queuing Theory**

Queuing systems and concepts, Queuing system characteristics, classification of queuing situations; Kendall's notation, solution of queuing problems, single channel, single stage, finite and infinite queues with Poisson arrival and exponential service time, Steady state performance analyzing of M/M/ 1 and M/M/C queuing model, applications to industrial problems, Birth-Death Model.

**Unit 5** **(8 Hrs)**

**PERT-CPM Techniques**

Network construction, determining critical path, floats, scheduling by network, project duration, variance under probabilistic models, prediction of date of completion, crashing of simple networks.

**Reference Books:**


1. Hira, D. S. (1992). Operations Research. S. Chand Publishing.
2. Hillier, F. S. (1967). Introduction to Operations Research.
3. Taha, H. A. (2003). Operations research: an introduction. Pearson Educación.
4. Ravindran, A., Phillips, D. T., & Solberg, J. J. (1976). Operations research: principles and practice.
5. Natarajan, A. M., Balasubramanie, P., &Talilarasi, A. (2006). Operations Research. Pearson Education India.
6. Sharma, J. K. (2009). Operations research theory and application. MACMILAN Publishers.
7. Sharma, S. D. (1992). Operations research. KedarNath Ram Nath& Company


**Course Outcomes**

At the end of the course, student will be able to:

**CO1:** Identify and develop operational research models from the verbal description of the real system and to formulate a real-time situation into a mathematical model.

**CO2:** Understand the mathematical tools that are needed to solve optimization problems.

**CO3:** Understand the characteristics of different types of decision-making environments and the appropriate decision-making approaches and tools to be used in each type.

**CO4:** Understand the need and importance of modelling the industrial problem.

**CO5:** Make right decisions in operations management using game theory, decision theory, queuing theory, transportation models, assignment models, dynamic programming and goal programming.

# Design of Machine Elements (MET-023)

**L T P: 3 1 0**

**Course Objectives**

The course will enable the student to:

- Learn the basics of machine design, material selection criterion, design against static and fluctuating loads.
- Explain the design process for joints like welded & screwed under eccentric and fatigue loading and design of shaft, keys and couplings.
- Teach stresses in power screws, design process of screw jack and also design of helical and leaf springs.
- Gain knowledge about the classification, selection and design of various types of gears and bearings with the help of design data book.
- Provide an appreciation of the relationships between component level design and overall machine system design and performance.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction:** Definition, Methods, standards in design & selection of preferred size. Selection of materials for static & fatigue loads, BIS system of designation of steels. AISI (American Iron & Steel Institution), ASTM.

Design considerations - limits, fits and standardization, Review of failure theories for static and dynamic loading (including fatigue failure).

**Unit 2** **(8 Hrs)**

**Design against static load:** Modes of failure, Factor of safety, stress-strain relationship, principal stresses, theories of Failure, Design of Cotter and Knuckle Joint under static load.

**Design against fluctuating load:** stress concentration, stress concentration factors, Fluctuating/alternating stresses, fatigue failure, endurance limit, design for finite & infinite life, Soderberg & Goodman criteria.

**Unit 3** **(8 Hrs)**

**Design of Joints:** Welded joint, screwed joints, eccentric loading of above joints, Joint design for fatigue loading.

**Shaft, keys & coupling:** Design against static and fatigue loads, strength & rigidity design, Selection of square & flat keys & splines, rigid & flexible couplings.

**Unit 4** **(9 Hrs)**

**Design of Bearing:** Sliding Contact Bearing: Types, Selection of bearing, Plain journal bearing, Hydrodynamic lubrication, Properties and materials, Lubricants and lubrication, Hydrodynamic journal bearing, Heat generation, Design of journal bearing, Thrust bearing-pivot and collar bearing, Hydrodynamic thrust bearing.

**Rolling Contact Bearing:**Advantages and disadvantages, Types of ball bearing, Thrust ball bearing, Types of roller bearing, Selection of radial ball bearing, Bearing life, Selection of roller bearings, Dynamic equivalent load for roller contact bearing under constant and variable loading, Reliability of Bearing, Selection of rolling contact bearing, Lubrication of ball and roller bearing, Mounting of bearing.

**Design Analysis of Power Screws:** Form of threads, square threads, trapezoidal threads, stresses in screw, design of screw jack.

**Unit 5** **(9 Hrs)**

**Mechanical Springs:** Design of Helical and leaf springs, against static & fatigue loading.

**Design of Transmission Elements:** Spur Gears: Tooth forms, System of gear teeth, contact ratio, Standard proportions of gear systems, Interference in involute gears, Backlash, Selection of gear materials, Gear manufacturing methods, Design considerations, Beam strength of gear tooth, Dynamic tooth load, Wear strength of gear tooth, Failure of gear tooth, Design of spur gears, AGMA and Indian standards.

**Helical Gears:** Terminology, Proportions for helical gears, Beam strength and wear strength of helical gears, herringbone gears, crossed helical gears, Design of helical gears.

**Worm Gears:** Types of worms, Terminology, Gear tooth proportions, Efficiency of worm gears, Heat dissipation in worm gearing, Strength and wear tooth load for worm gears, Design of worm gearing.

**Reference Books:**

1. Shigley, J.E. and Mischke, C.R., Mechanical Engineering Design, Fifth Edition, McGraw-Hill International; 1989.
2. Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan, 1992.
3. Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley, 1994.
4. Spottes, M.F., Design of Machine elements, Prentice-Hall India, 1994.
5. R. L. Norton, Mechanical Design – An Integrated Approach, Prentice Hall, 1998.
6. V. B. Bhandari, Design of Machine Elements, Tata McGraw Education Hill Pvt Ltd India.

**Course Outcomes**

Upon completion of this course, students will be able to:

**CO1:** Explain the different standard system for designating engineering materials.

**CO2:**Design of Helical and leaf springs, against static & fatigue loading.

**CO3:** Design of Joints, Shaft, keys & coupling.

**CO4:** Design of bearing and power screw.

**CO5:** Design of transmission elements like gears.

# Refrigeration and Air Conditioning (MET-024)

**L T P: 3 1 0**

**Course Objectives**

The course will enable the student to:

- Be familiarize with the terminology associated with refrigeration systems and air conditioning.
- Be Introduce with various Refrigeration and Air Conditioning systems.
- Impart knowledge on refrigerants and their impact on the environment.
- Familiarize with the components of refrigeration systems.
- Acquire the skills required to model, analyze and design different refrigeration as well as air conditioning processes and components.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction to Refrigeration System:** Methods of refrigeration, Carnot cycle, Reversed Carnot cycle, Carnot refrigerator and heat pump Unit of refrigeration, Air Refrigeration cycle: Open and closed air refrigeration cycles, Bell Coleman or Reversed Brayton air refrigeration cycle, Aircraft refrigeration system, Classification of aircraft refrigeration system. Simple system, Boot strap refrigeration, Regenerative, Reduced ambient, Dry air rated temperature (DART). Steam jet refrigeration.

**Unit 2** **(9 Hrs)**

**Vapour Compression System and Refrigerants:** Modification in reversed Carnot cycle, Single stage system, Analysis of vapour compression cycle, use of T-s and p-h charts, Effect of change in suction and discharge pressures on C.O.P, Effect of sub cooling & superheating of suction vapour on performance of the cycle, Actual vapour compression cycle, Different configuration of multistage system, Cascade system.

Classification, Nomenclature, Desirable properties of refrigerants, Common refrigerants, Secondary refrigerants and CFC free refrigerants.

**Unit 3** **(8 Hrs)**

**Vapour Absorption System:** Working Principal of vapour absorption refrigeration system, Comparison between absorption & compression systems, Ammonia – Water vapour absorption system, Lithium- Bromide water vapour absorption system, Comparison.

**Unit 4** **(9 Hrs)**

**Review of Psychrometry and Air-Conditioning Processes** Introduction to air conditioning, Psychrometric properties and their definitions, Psychrometric chart, Different Psychrometric processes, Sensible heat factor (SHF), By pass factor, Apparatus dew point (ADP), Thermal analysis of human

body, Design considerations, Effective temperature and comfort chart, Cooling and heating load calculations, Infiltration & ventilation, Internal heat gain, Grand Sensible heat factor (GSHF).

**Unit 5** **(8 Hrs)**

**Refrigeration Equipment & Applications:** Elementary knowledge of refrigeration & air conditioning equipment's e.g compressors, condensers, evaporators & expansion devices, Air washers, Cooling, towers & humidifying efficiency, Food preservation, cold storage, Freezers, Ice plant, Water coolers, Elementary knowledge of transmission and distribution of air through ducts and fans, Basic difference between comfort and industrial air conditioning, Ozone depletion and global warming issues.

**Reference Books:**

1. Arora, C.P., Refrigeration and Air conditioning, Tata McGraw Hill, 2nd Edition, 2000.
2. Kuehn, T.H., Ramsey, J.W. and Threlkeld, J.L., Thermal Environmental Engineering, 3rd Edition, Prentice Hall, 1998.
3. Refrigeration and Air conditioning by Arora & Domkundwar, Dhanpat Rai.
4. Stoecker, W.F. and Jones, J.W., Refrigeration and Air conditioning, Tata McGraw Hill, 1986.
5. Refrigeration and Air conditioning by Roy J. Dossat Pearson
6. Heating Ventilating and Air conditioning by Mcquiston
7. Gosney, W.B, Principles of Refrigeration, Cambridge University Press, 1982.

**Course Outcomes**

At the end of this course, student will be able to:

**CO1**: Understand the working principles of refrigeration and air-conditioning systems and will be Able to Analyze, evaluate and compare the performances of complex vapor compression systems and air-craft refrigeration systems.

**CO2**: Able to Perform thermodynamic analysis of absorption refrigeration systems and steam jet refrigeration system.

**CO3**: Able to Classify & designate different types of refrigerants, select the best refrigerant for specific purposes. Evaluate the various sources of heat load on buildings and perform heat load estimation.

**CO4**: Able to Design summer and winter air conditioning systems.

**CO5**: Able to Understand the use and working of air-washer, cooling tower cold storage, water cooler etc.

# DEPARTMENT ELECTIVE-3

## Experimental Stress Analysis (MET-025)

**L T P: 3 0 0**

**Course Objectives**

The course will enable the student to:

- Apply modern experimental stress analysis techniques to measure strains and stresses in engineering components and structures.
- Learn strain gauge measurements and analysis.
- Learn concepts of photo elasticity and stress analysis.

**Particulars**

**Unit 1** **(8 Hrs)**

**Elementary Elasticity Stress:** Introduction, Stress Equations of Equilibrium, Laws of Stress Transformations, principal Stresses, Two-Dimensional State of Stress, Stresses Relative to Principal Co-ordinate System, Special States of Stress. Strain: Introduction, Displacement and Strain, Strain Transformation Equation, Principal Strains, Compatibility, Volume Dilation, Stress Strain Relations, Strain Transformation Equations and Stress Strain Relations for Two-Dimensional State of Stress.

**Unit 2** **(8 Hrs)**

**Strain Measurements:** Introduction, Properties of Strain Gage Systems, Types of Strain Gages, Grid-Method of Strain Analysis. Brittle Coating Method: Coating Stresses, Failure Theories, Brittle Coating Crack Patterns, Resin and Ceramic Based Brittle Coating, Test Procedure, Analysis of Brittle Coating Data.

**Unit 3** **(8 Hrs)**

**Electrical Resistance Strain Gages:** Introduction, Strain Sensitivity in Alloys, Strain Gage Adhesives, Gage Sensitivity and Gage Factor. Strain Gage Circuit: Potentiometer and its Application, Wheat-Stone Bridge, Bridge Sensitivity, Null Balance Bridges. Analysis of Strain Gage Data: Three Element Rectangular Rosette, Delta Rosette, Stress Gage, Plane Shear-Gage.

**Unit 4** **(8 Hrs)**

**Theory of Photo elasticity:** Introduction, Temporary Double Refraction, Stress Optic Law, Relative Retardation, Stressed Model in Plane Polariscope, Effect of Principal Directions, Effect of Principal Stress Difference, Stressed Model in Circular Polariscope, Light and Dark Field arrangements, Tardy Compensation, Fringe Sharpening and Multiplication by Partial Mirrors.

**Unit 5** **(8 Hrs)**

**Two Dimensional Photoelasticity:** Introduction, Isochromatic Fringe Patterns, Isoclinic Fringe Patterns, Compensation Techniques, Calibration Methods, Separation Methods, Shear Difference Method, Electrical Analogy Method, Oblique Incidence Method, Materials for Two-dimensional Photo elasticity.

**Reference Books:**

1. Experiment Stress Analysis by Dr. Sadhu Singh, Khanna Publishers.
2. Experiment Stress Analysis by James W. Dally and William F. Riley, International Student Edition, McGraw Hill Book Company.

**Course Outcomes**

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

**CO1**: Demonstrate a basic understanding of experimental methods (e.g. strain gages, photoelasticity, image correlation) commonly used in experimental solid mechanics.

**CO2**: Complete a detailed laboratory report and present their findings in a structured, logical manner.

**CO3**: Apply knowledge learned in previous classes.

**CO4**: Analyze experimental data.

**CO5**: Develop appropriate, logical conclusions based on comparisons to theoretical results and other experimental evidence.

# Machine Tool Design (MET-026)

**L T P: 3 0 0**

**Course Objectives**

The course will enable the students to:

- Be familiar with machine tool drives and mechanisms.
- Learn designing of machine tool structures.
- Learn designing of guide ways, power screws and spindles.
- Learn designing of Spindles and Spindle Supports.
- Understand dynamics of machine tools.

**Particulars**

**Unit 1** **(9 Hrs)**

**Introduction to Machine Tool Drives and Mechanisms**: Introduction to the course, Working and Auxiliary Motions in Machine Tools, Kinematics of Machine Tools, Motion Transmission.
Regulation of Speeds and Feeds: Aim of Speed and Feed Regulation, Stepped Regulation of Speeds, Multiple Speed Motors, Ray Diagrams and Design Considerations, Design of Speed Gear Boxes, Feed Drives, Feed Box Design.

**Unit 2** **(9 Hrs)**

**Design of Machine Tool Structures**: Functions of Machine Tool Structures and their Requirements, Design for Strength, Design for Rigidity, Materials for Machine Tool Structures, Machine Tool Constructional Features, Beds and Housings, Columns and Tables, Saddles and Carriages.

**Unit 3** **(8 Hrs)**

**Design of Guide ways, Power Screws and Spindles**: Functions and Types of Guide ways, Design of Guide ways, Design of Aerostatic Slide ways, Design of Anti-Friction Guide ways, Combination Guide ways, Design of Power Screws.

**Unit 4** **(8 Hrs)**

**Design of Spindles and Spindle Supports**: Functions of Spindles and Requirements, Effect of Machine Tool Compliance on Machining Accuracy, Design of Spindles, Antifriction Bearings.

**Unit 5** **(6 Hrs)**

**Dynamics of Machine Tools**: Machine Tool Elastic System, Static and Dynamic Stiffness Acceptance Tests.

**Reference Books:**

1. N.K. Mehta, Machine Tool Design and Numerical Control, TMH, New Delhi, 2010.
2. G.C. Sen and A. Bhattacharya, Principles of Machine Tools, New Central Book Agency, 2009.
3. D. K Pal, S. K. Basu, “Design of Machine Tools”, 5th Edition. Oxford IBH, 2008.
4. N. S. Acherkhan, “Machine Tool Design”, Vol. I, II, III and IV, MIR publications, 1968.

**Course Outcomes**

At the end of the course, the student will be able to:

**CO1**: Understand basic motions involved in a machine tool and design machine tool structures.
**CO2**: Design and analyze systems for specified speeds and feeds.

**CO3**: Select subsystems for achieving high accuracy in machining.
**CO4**: Understand control strategies for machine tool operations.
**CO5**: Apply appropriate quality tests for quality assurance.

# Fuels and Combustion (MET-027)

**L T P: 3 0 0**

**Course Objectives**

The course will enable the students to:

- Impart basic knowledge about solid, liquid and gaseous fuels, their origin, classification and preparation procedure.
- Impart knowledge of stoichiometry relations and combustion process.
- Impart knowledge on combustion of various fuels, flue gas analysis, and combustion applications.
- Acquire knowledge about different types of burners and emissions norms and effects.

**Particulars**

**Unit 1** **(7 Hrs)**

Classification of coal, analysis and properties of coal, oxidation of coal, hydrogenation of coal, agro fuels, solid fuel handling.

**Unit 2** **(9 Hrs)**

Classification of petroleum products, Handling and storage of petroleum products, Refining and other conversion processes, property and testing of petroleum products, other liquid fuels. Types of gaseous fuels, natural gases, methane from coal mines, manufactured gases, producer gas, water gas, blast furnace gas, refinery gas, LPG, cleaning and purification of gaseous fuels.

**Unit 3** **(9 Hrs)**

Stoichiometry relations, theoretical and minimum air required for complete combustion, calculation of dry flue gases, exhaust gas analysis, flue gas analysis.

Principles of combustion, rapid methods of combustion, flame propagation, various methods of flame stabilization.

**Unit 4** **(8 Hrs)**

Basic features of burner, types of solid, liquid and gaseous fuel burners, design consideration of different types of burners, recuperative and regenerative burners, Pulverised fuel furnaces–fixed, entrained, and fluidized bed systems.

**Unit 5** **(7 Hrs)**

Emissions, Emission index, corrected concentrations, control of emissions for premixed and non-premixed combustion.

**Text Book:**

1. S. Sarkar, Fuels and combustion, 3rd Edition, Universities Press, 2009.

**Reference Books**:

1. H. Joshua Phillips, “Fuels, solid, liquid and gaseous – Their analysis and valuation”, General Books, 2010.
2. S.R. Turns, “An introduction to combustion – Concepts and applications”, Tata McGraw- Hill, 2000.
3. K. Kanneth, “Principles of combustion”, Wiley and Sons, 2005.S.P. Sharma and C. Mohan, “Fuels and combustion”, Tata McGraw-Hill, 1984

**Course Outcomes**

On the completion of this course the students will be able to:

**CO1:** Differentiate between various fuels.

**CO2:** Analyse exhaust and flue gases.

**CO3:** Understand design considerations of burners.

**CO4:** Gain Knowledge about fuel burners and furnaces.

**CO5:** Control of emissions in combustion.

# Precision Engineering (MET-028)

**L T P: 3 0 0**

**Course Objectives**

The course will enable the students to:

- Be familiar with the concepts of accuracy.
- Gain knowledge about datum systems.
- Learn concepts about tolerance analysis.
- Gain knowledge about surface finishing.
- Understand fundamentals of nanotechnology.

**Particulars**

**Unit 1** **(8 Hrs)**

**Concepts of Accuracy:** Introduction – Concept of Accuracy of Machine Tools – Spindle ad Displacement Accuracies – Accuracy of numerical Control Systems – Errors due to Numerical Interpolation Displacement Measurement System and Velocity Lags. Geometric Dimensioning and Tolerancing: Tolerance Zone Conversions – Surfaces, Features, Features of Size, Datum Features – Datum Oddly Configured and Curved Surfaces as Datum Features, Equalizing Datums –Datum Feature of Representation – Form Controls, Orientation Controls – Logical Approach to Tolerancing.

**Unit 2** **(8 Hrs)**

**Datum Systems:** Design of freedom, Grouped Datum Systems – different types, two and three mutually perpendicular grouped datum planes; Grouped datum system with spigot and recess, pin and hole; Grouped Datum system with spigot and recess pair and tongue – slot pair – Computation of Transnational and rotational accuracy, Geometric analysis and application.

**Unit 3** **(8 Hrs)**

**Tolerance Analysis:** Process Capability, Mean, Variance, Skewness, Kurtosis, Process Capability Metrics, Cp, Cpk, Cost aspects, Feature Tolerances, Geometric Tolerances. Tolerance Charting Techniques-Operation Sequence for typical shaft type of components, Preparation of Process drawings for different operations, Tolerance worksheets and centrally analysis, Examples. Design features to facilitate machining; Datum Features – functional and manufacturing. Components design – Machining considerations, Redesign for manufactured, Examples.

**Unit 4** **(8 Hrs)**

**Surface Finish:** Review of relationship between attainable tolerance grades and different machining process. Cumulative effect of tolerances sure fit law, normal law and truncated normal law.

**Unit 5** **(8 Hrs)**

**Fundamentals of Nanotechnology:** System of nanometer accuracies – Mechanism of metal Processing – Nano physical processing of atomic bit units. Nanotechnology and Electrochemical atomic bit processing. Measuring Systems Processing: In processing or in-situ measurement of position of processing point-Post process and on-machine measurement of dimensional features and surface-mechanical and optical measuring systems.

**Reference Books:**

1. Nano Technology / Norio Taniguchi / Oxford University Press, 1996
2. Engineering Design – A systematic Approach / Matousek / Blackie & Son Ltd, London.
3. Precision Engineering in Manufacturing / murthy R. L., / New Age International (P) limited, 1996.
4. Geometric Dimensioning and Tolerancing / James D. Meadows / Marcel Dekker Inc.1995.

**Course Outcomes**

At the end of the course, the student will be able to:

**CO1**: Learn concepts of accuracy.

**CO2**: Understand about datum systems.

**CO3**: Understand concepts of tolerance analysis.

**CO4**: Understand and apply concepts of surface finishing.

**CO5**: Gain basic knowledge about nanotechnology.

# Automobile Engineering (MET-029)

**L T P: 3 0 0**

**Course Objectives**

The course will enable the students to learn:

- The anatomy of the automobile in general.
- The location and importance of each part.
- The functioning of the engine and its accessories, gear box, clutch, brakes, steering, axles and wheels.
- Suspension, frame, springs and other connections.
- Emissions, ignition, controls, electrical systems and ventilation.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction**: Types of automobiles, vehicle construction and layouts, chassis, frame and body, vehicle aerodynamics, IC engines- components, function and materials, variable valve timing (VVT). Engine auxiliary systems.

**Unit 2** **(8 Hrs)**

**Fuel Injection and Engine Emission:** Electronic injection for SI and CI engines, unit injector system, rotary distributor type and common rail direct injection system, transistor-based coil ignition & capacitive discharge ignition systems, turbo chargers (WGT, VGT), engine emission control by 3-way catalytic converter system, Emission norms (Euro & BS).

**Unit 3** **(8 Hrs)**

**Transmission of Engine Power:** Transmission systems, clutch types & construction, gear boxes-manual and automatic gear shift mechanisms, Over drive, transfer box, flywheel, torque converter, propeller shaft, slipjoints, universal joints, differential and rear axle, Hotchkiss drive and Torque tube drive.

**Unit 4** **(8 Hrs)**

**Controlling Mechanism in Automobiles:** Steering geometry and types of steering gear box, power steering, types of front axle, types of suspension systems, pneumatic and hydraulic braking systems, antilock braking system (ABS), electronic brake force distribution (EBD) and traction control.

**Unit 5** **(8 Hrs)**

**Types of Fuel and its Combustion:** Alternative energy sources, natural gas, LPG, biodiesel, bio-ethanol, gasohol and hydrogen fuels in automobiles, modifications needed, performance, combustion & emission characteristics of alternative fuels in SI and CI engines, Electric and Hybrid vehicles, application of Fuel Cells.

**Reference Books;**


1. Kirpal Singh, "Automobile Engineering", Standard Publishers, Vol-I & II, 2004.
2. Ramalingam, K. K, "Automobile Engineering", Scitech Publications, 2014.
3. Rajput R K, "A Text book of Automobile Engineering", Laxmi Publication, 2015.
4. Crouse, W.H., and Anglin, D.L., "Automotive Mechanics", Tata McGraw Hill, 2005.
5. Narang, G.B., "Automobile Engineering", Khanna Publishers, 2001.
6. Kamaraju Ramakrishna, "Automobile Engineering", PHI Learning Pvt. Ltd, 2012.


**Course Outcomes**

At the end of the course, student will be able to:

**CO1**: Broaden the understanding of automotive architecture and performance.

**CO2**: Introduce students about the transmission system.

**CO3**: Familiarize about the wheels, tyres, and braking system.

**CO4**: Understand the fuel injection and emission.

**CO5**: Learn about the different types of fuels and their combustion.

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# OPEN ELECTIVE -1

## Total Quality Management (AHT-011)

**L T P: 3 0 0**

**Course Objective**

The course should enable the students to:

- Understand the concept of Quality in Manufacturing and Service units.
- Understand the Implication of Quality in Business.
- Understand the Organization Structure in TQM.
- Understand how to implement Quality Programs in an Organization.
- Have exposure to challenges in Quality Improvement Programs.

**Particulars**

**Unit 1** **(7 hours)**

**Introduction:** Evolution of Quality, Historical Perspectives, Relationship among Quality, Vision, Mission and Objectives of an Organization, Role of Quality in a Corporate Structure of an Organization, Attributes of Product and Service Quality, Quality Characteristics: Quality of Design, Quality of Performance and Quality of Conformance, Zero Defect and Continuous Improvement.

**Unit 2** **(7 hours)**

**Conceptualization of TQM:** Introduction to Total Quality Management (TQM), Barriers to TQM, Benefits of TQM implementation, Basic Approaches of TQM, TQM Models, Quality Information System and Planning. Importance of TQM in manufacturing and Service Industry.

**Unit 3** **(7 hours)**

**Organization Structure in TQM:** Role of Top Management, Quality Council, Quality Circles, Organization Structure for Quality Circles, Quality Policies, Role of Middle and Lower Management, Problem Solving Techniques.

**Unit 4** **(10 hours)**

**Tools and Systems for Quality Management:** Basic Tools: Cause & Effect Diagram, Flow Diagrams, Trend Charts, Histogram, Scatter Diagram, Control Chart, Advanced Tools: Affinity Diagram, Inter Relationship Diagram, Tree Diagram, Matrix Diagram, Process Decision Program Chart (PDPC) and Matrix Data Analysis, Fault Tree Analysis, Quality Function Deployment (QFD) Definition and Phases in QFD. Taguchi Approach To Quality System Design, Six - sigma Definition & Implementation Steps, Just In Time Production System, Quality Production through JIT and Kanban, Failure Mode and Effect

Analysis (FMEA): Scope, Mode, Illustrative Example and Applications.

**Unit 5** **(9 hours)**

**Quality Assurance:** Causes of Quality Failure, Quality Assurance: Need and Various Elements in Quality Assurance Programme, Quality Control- on Line and off Line, Statistical Concepts in Quality, Chance and Assignable Causes, Bench Making in Quality Management.

Implementation and Need of ISO 9000: ISO 9000 - 2000 Quality System: Elements, Registration, Documentation, Implemental Steps, Quality Audit, Product and Process Audit Scope, Steps and Benefits.

## Reference Books:

1. Total Quality Management by Dale H Bersterfilled, PHI Publication.
2. Total Quality Management by N.V.R Naidu, G. Rajendra, New Age international Publication.
3. Total Quality Management by L. Sugandhi and Samuel Anand, PHI Publication.
4. Total Quality Management by R.S Naagarazan, New Age International Publication.

## Course Outcomes

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

**CO1:** Identify the significance of quality in an organization.

**CO2:** Describe how to manage quality improvement teams.

**CO3:** Describe how to organize management and quality policies in TQM.

**CO4:** Apply the tools of quality improvement programs in an organization.

**CO5:** Assess the benefits of implementing TQM Program in an organization.

# Managing E-Commerce and Digital Communication (AHT-012)

**L T P: 3 0 0**

**Course Objectives**

The course should enable the students to:

- Understand of concepts and techniques of internet marketing.
- Study behaviour and experience of online customer.
- Study the various techniques of digital promotion.
- Find out the opportunities for marketers on digital platform.
- Understand the role of several e commerce models in customer value creation.

**Particulars**

**Unit 1** **(8 hours)**

**Introduction to Digital Marketing:** Digital marketing meaning scope and importance, Internet versus traditional marketing. Use of business to consumer and business to internet marketing, internet marketing strategy, Incorporating self-service technologies (SSTs).

**Unit 2** **(8 hours)**

**Online Buyer Behavior and Models:** marketing mix in online context. Managing online customer experience, planning website design, understanding site user requirement, site design and structure, integrated marketing communications (IIMC), measurement of interactive marketing communication, e-WOM.

**Unit 3** **(8 hours)**

**Digital Promotion Techniques:** email marketing, strategy to craft email marketing campaign, permission marketing, viral marketing, blogs, search engines marketing (SEM), Search engine optimization, content marketing.

**Unit 4** **(8 hours)**

**Social Media Marketing:** designing content for social media marketing, mobile marketing advertising on mobile devices, mobile apps, tracking mobile marketing performance, and introduction to web analytics-meaning types, key metrics and tools.

**Unit 5** **(8 hours)**

**Introduction to e-Commerce and Retailing in Online Space:** advantages of e-Commerce Platforms,

Differentiate Show-rooming and Web-rooming, e-tailing, e-Commerce Business Process, Business Models, Interpret e-Commerce Shopping Cart Software & Other Factors of e-Commerce based business, role of aggregators in e-Commerce business.

**Reference Books:**


1. Kotler, P. and Keller, K.L. (2017) Marketing Management. 15 ° ed . India: Pearson Education .
2. Chaffey, D. and Ellis - Chadwick, F. (2012) . Digital Marketing Strategy. Implementation and Practice. 1st ed. Education
3. Digital Marketing: Cases from India by Rajendra Nargundkar and Romi Sainy, Notion Press, Inc.
4. Understanding Digital Marketing: Marketing Strategies for Engaging the Digital Generation by Damian Rya Publisher.
5. Marketing 4.0: Moving from Traditional to Digital by Philip Kotler, Publisher Wiley.


**Course Outcomes**

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

**CO1:** Understand strategies used in digital marketing.

**CO2:** Apply interactive marketing communications to gratify online buyer.

**CO3:** Apply digital promotion techniques for marketing of product and services.

**CO4:** Evaluate the role of web analytics in social media marketing.

**CO5:** Apply and design various e commerce models for e-business.

# Industrial Safety and Hazard Management (AHT-013)

**L T P: 3 0 0**

**Course Objective**

The course should enable the students to:

- Impart knowledge about various aspects of industrial safety and occupational health.
- Impart knowledge about Occupational Health and Toxicology.
- Enable the students to identity hazard and assess risk.
- Understand Acts and Rules of industrial safety and hazard management.
- Teach about various safety acts and rules along with safety education and training.

**Particulars**

**Unit 1** **(8 hours)**

**Concepts and Techniques:** History of safety movement -Evolution of modern safety concept - Incident Recall Technique (IRT), disaster control, safety analysis, safety survey, safety inspection, safety sampling. Safety Audits - components of safety audit, types of audit, audit methodology, non - conformity reporting (NCR), audit checklist- identification of unsafe acts of workers and unsafe conditions in the industry.

**Unit 2** **(8 hours)**

**Occupational Health and Toxicology:** Concept and spectrum of health, functional units and activities of occupational health services, occupational related diseases and levels of prevention of diseases. Toxicology- local, systemic and chronic effects, temporary and cumulative effects, carcinogens entry into human systems.

**Unit 3** **(8 hours)**

**Hazard Identification and Risk Assessment:** The process of risk management, hazard identification, evaluation (risk assessment, risk matrix), risk control implementation, action and recommendation.

**Unit 4** **(8 hours)**

**Acts and Rules**: Indian boiler Act 1923, static and mobile pressure vessel rules (SMPV). motor vehicle rules, mines act 1952, workman compensation act, rules - electricity act and rules - hazardous wastes (management and handing) rules, 1989, with amendments in 2000 the building and other construction workers act 1996, Petroleum rules, Explosives Act 1963 Pesticides Act. Factories Act 1948 Air Act 1981 and Water Act 1974.

**Unit 5** **(8 hours)**

**Safety Education and Training:** importance of training - identification of training needs training methods - programmes, seminars, conferences, competitions - method of promoting sale practice motivation communication - role of government agencies and private consulting agencies in safety training creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign - domestic Safety and Training.

## Reference Books:

1. Industrial Accident Prevention by H.W Heinrich, McGraw - Hi 1980.
2. Safety Management in industry by NV. Krishnan, Jaico Publishing House, Bombay, 1997.
3. Loss Prevention in Process Industries by FP Lees, Butterworth London, 1990.
4. Safety at Work by J.R. Ridey Butterwort London 1983.

## Course Outcomes

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

**CO1:** Identify the key aspects of industrial safety and mitigating them.

**CO2:** Describe various types of solution to problems arising in safety operations and hygiene.

**CO3:** Apply principles of OSHA in controlling industrial disasters and losses.

**CO4:** Identify various Acts and Rules of industrial safety and hazard management.

**CO5:** Assess the overall performance of safety protocols of chemical industries and hazard management.

# MATLAB Programming for Mechanical Engineers (MEP-015)

**L T P: 0 0 2**

**Course Objectives**

The course should enable the students to:

- Learn programming using MATLAB.
- Learn basic concepts of MATLAB.
- Get Hands-on exposure of MATLAB.
- Solve the complex problems in few modules of computer programs.
- Build indispensable skill to compete in today's job market.

**Particulars**

**Unit 1** **(8 Hrs)**

**Starting with MATLAB:** Working in the command window, arithmetic operations with scalars, using MATLAB as a calculator, display formats, elementary math built-in functions, defining scalar variables, useful commands for managing variables, script files, examples of MATLAB applications.

**Creating Arrays:** Creating a one-dimensional array (vector), creating a two-dimensional array (matrix), notes about variables in MATLAB, the transpose operator array addressing, using a colon: in addressing arrays, adding elements to existing variables, deleting elements, built-in functions for handling arrays, strings and strings as variables problems.

**Unit 2** **(8 Hrs)**

**Mathematical Operations with Array:** Addition and subtraction, array multiplication, array division, element-by-element operations, using arrays in MATLAB built-in math functions, built-in functions for analyzing arrays, generation of random numbers, examples of MATLAB applications.

**Using Script Files and Managing Data:** MATLAB workspace and the workspace window, input to a script file, output commands, the save and load commands, importing and exporting data, examples of MATLAB applications.

**Unit 3** **(8 Hrs)**

**Two-Dimensional Plots:** The plot command, plot of given data, plot of a function, the fplot command, plotting multiple graphs in the same plot, formatting a plot, plots with logarithmic axes, plots with error bars, plots with special graphics, histograms, polar plots, putting multiple plots on the same page, multiple figure windows, examples of MATLAB application.

**Programming with MATALAB:** Relational and logical operators, conditional statements, the switch-case statement, loops, nested loops and nested conditional statements, the break and continue commands, examples of MATLAB applications.

**Unit 4** **(8 Hrs)**

**User-Defined Functions and Function Files:** Creating a function file, structure of a function file, local and global variables, saving a function file using a user-defined function, examples of simple user-defined functions, comparison between script files and function files, anonymous and inline functions, function functions, subfunctions, nested functions, examples of MATLAB applications.

**Polynomials, Curve Fitting, and Interpolation:** Polynomials, value of a polynomial, roots of a polynomial, addition, multiplication, and division of polynomials, derivatives of polynomials, curve fitting, interpolation, the basic fitting interface, examples of MATLAB applications.

**Unit 5** **(8 Hrs)**

**Applications in Numerical Analysis:** Solving an equation with one variable, finding a minimum or a maximum of a function, numerical integration, ordinary differential equations, examples of MATLAB applications. Introductory lesson for differentiation, integration, solving an ordinary differential equation.

**Three-Dimensional Plots:** Line plots, mesh and surface plots, plots with special graphics, the view command, examples of MATLAB applications.

**Reference Books:**

1. Amos Gilat. MATLAB an introduction with applications. John Wiley& Sons.
2. Fausett L.V. (2007) Applied Numerical Analysis Using MATLAB, 2nd Ed., PearsonEducation.
3. Chapra S.C. and Canale R.P. (2006) Numerical Methods for Engineers, 5th Ed., McGraw Hill.

**Course Outcomes**

After this course students will be capable of:

**CO1**: Forming the 1 and 2-dimensional array and preparing 2 and 3 dimensional plots using MATLAB.

**CO2**: Managing script files and data and doing programming in MATLAB.

**CO3**: Preparing 2 dimensional plots using MATLAB and writing and applying UDF

**CO4**: Understanding the engineering problem domain and doing curve fitting and interpolation.

**CO5**: Applying the logic for solving the complex problem and applying MATLAB in numerical analysis.

# Design of Machine Elements Lab (MEP-016)

**L T P: 0 0 2**

**Course Objectives**

The course will enable the student to:

- Amplify the understanding about designing different mechanism.
- Learn about the design of different joints.
- Learn the procedure of machine design and develop an ability to apply it practically for design of various machine components and joints.
- Understand use of Design Data Hand Book and ISO standards for selection of materials, strengths, standard dimensions.

**Particulars**

List of experiments (Minimum 10 of the following)

1. Failure analysis of machine elements using FEM software
2. Design & drawing of Helical Spring.
3. Design & drawing of Leaf Spring.
4. Design & drawing of Riveted joints for given operating conditions.
5. Design of an eccentrically loaded welded, riveted of bolted joint.
6. Design of bolted joint for fluctuating loads.
7. Design of Rigid Coupling for given operating condition.
8. Design of Flexible Coupling for given operating condition.
9. To study and Design of Spur and Helical Gear
10. To study of Sliding Contact Bearing
11. To study of Rolling Contact Bearing
12. Design a shaft used in some practical application, by actual working and loading conditions.
13. Design of helical and leaf springs.
14. Any other suitable experiment on Machine Design.

**Reference Books:**

1. Shigley, J.E. and Mischke, C.R., Mechanical Engineering Design, Fifth Edition, McGraw-Hill International; 1989.
2. Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan, 1992.
3. Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley, 1994.
4. Spottes, M.F., Design of Machine elements, Prentice-Hall India, 1994.
5. R. L. Norton, Mechanical Design – An Integrated Approach, Prentice Hall, 1998.
6. V. B. Bhandari, Design of Machine Elements, Tata McGraw Education Hill Pvt Ltd India

**Course Outcomes:**

At the end of the course, student will be able to:

**CO1:** Study of failure behaviour of mechanical components.
**CO2:** Evaluate and design the different types of joints.
**CO3:** Analyse and design the various gears including spur and helical.
**CO4:** Analyse and design the different bearings.
**CO5:** Analyse and design the helical and leaf springs.

# Project Stage - I (MEP-017)

**Course Objectives**

The course should enable the students:

- To allow students to demonstrate a wide range of the skills learned during their course of study
- To encourage multidisciplinary research through the integration learned in a number of courses.
- To allow students to develop problem solving, analysis, synthesis and evaluation skills.
- To encourage teamwork.
- To improve students' communication skills by asking them to produce both a professional report and to give an oral presentation

**Course Outcomes**

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

**CO1:** Demonstrate a sound technical knowledge of their selected project topic.

**CO2:** Undertake problem identification, formulation and solution.

**CO3:** Combine the theoretical and practical concepts studied in his / her academics.

**CO4:** Communicate with engineers and the community at large in written and oral forms.

**CO5:** Demonstrate the knowledge, skills and attitudes of a professional engineer.

# Essence of Indian Traditional Knowledge (AHT-010)

**L T P: 2 0 0**

**Course Objectives**

The course should enable the students:

- With the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.
- To understand the traditional knowledge and analyse it and apply it to their day to day life.
- To know the need and importance of protecting traditional knowledge.
- To understand the concepts of Intellectual property to protect the traditional knowledge.
- For concentrating on various acts in protecting the environment and Knowledge management impact on various sectors in the economy development of the country.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction to Traditional and Culture Knowledge**

Define culture, traditional, civilization and heritage knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK). Indigenous traditional knowledge Vs western traditional knowledge vis-à-vis formal knowledge.

**Unit 2** **(8 Hrs)**

**Protection of Traditional Knowledge**

Protection of traditional knowledge: The need for protecting traditional knowledge Significance of traditional knowledge Protection, value of traditional knowledge in global economy, Role of Government to harness traditional knowledge.

**Unit 3** **(8 Hrs)**

**Traditional Knowledge and Intellectual Property**

Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, Global legal forums for increasing protection of Indian Traditional Knowledge.

**Unit 4** **(8 Hrs)**

**Traditional Knowledge in Different Sectors**

Traditional knowledge in engineering, biotechnology and agriculture, traditional medicine system, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of traditional knowledge.

**Unit 5** **(8 Hrs)**

**Education System in India**

Education in ancient, medieval and modern India, aims of education, subjects, languages, Science and Scientists of Ancient India, Scientists of Medieval India, Scientists of Modern India. The role Gurukulas in Education System, Value based Education.

**Text/Reference Books:**

1. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002.
2. "Knowledge Traditions and Practices of India" Kapil Kapoor1, Michel Danino2.
3. Traditional Knowledge System in India, by Amit Jha, 2009.
4. Satya Prakash, “Founders of Sciences in Ancient India”, Vijay Kumar Publisher, 1989
5. Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta and Vipin Kumar Singh Pratibha Prakashan 2012.

**Course Outcomes**

The course should enable the students to:

**CO1:** Understand the concept of Traditional knowledge and its importance.

**CO2:** Know the need and importance of protecting traditional knowledge.

**CO3:** Know the various enactments related to the protection of traditional knowledge.

**CO4:** Understand the concepts of Intellectual property to protect the traditional knowledge.

**CO5:** Know the contribution of scientists of different areas.

# Constitution of India (AHT-009)

**L T P: 2 0 0**

**Course Objectives**

The course should enable the students to:

- Acquaint them with legacies of constitutional development in India and help to understand the most diversified legal document of India and philosophy behind
- Make them aware of the theoretical and functional aspects of the Indian Parliamentary System.
- Channelize their thinking towards basic understanding of the legal concepts and its implications for engineers.

**Particulars**

**Unit 1** **(8 Hrs)**

**Constitutional Framework**

Meaning of Terms and Phrases frequently used in political system like constitution, constitutionalism, Rule of Law, Federal system, Government and so on. Historical Background of Indian Constitution, Making of Indian Constitution, Salient features of Indian Constitution, Preamble of Indian Constitution.

**Unit 2** **(8 Hrs)**

**Different Parts, Articles, and their Significance**

Part I to IVA (Union and its territories w.r.t. Indian States, Citizenship, Fundamental Rights conferred to citizens and foreigners, Directive Principles of State Policy– Its importance and implementation and Fundamental Duties and its legal status), Article 1 to 51A and their significance.

**Unit 3** **(8 Hrs)**

**System of Government**

Parliamentary Form of Government in India – The constitution powers and status of the President of India, Federal structure and distribution of legislative and financial powers between the Union and the States, Emergency Provisions: National Emergency, President Rule, Financial Emergency and Amendment of the Constitutional Powers and Procedure and the significance of basic structure in Indian Judicial system.

**Unit 4** **(8 Hrs)**

**Working of Central, State & Local Self Government as per Constitution**

Framework for central government (President, Vice president, Prime Minister, Central council of ministers, Parliament, Supreme court and so on), Framework for state government (Governor, Chief

Minister, state legislature, High court and so on) and Framework for local self government (Panchayatiraj, Municipalities) and Union Territories.

**Unit 5** **(8 Hrs)**

**Constitutional, Non-Constitutional and other bodies**

Discussion on Various constitutional bodies like Election Commission, UPSC, SPSC, Finance commission, NCSC, NCST, NCBC, CAG and AGI. Discussion on Various non-constitutional bodies like NITI Aayog, NHRC, CIC, CVC, CBI, Lokpal and Lokayukta. Discussion on Various other constitutional bodies like Co- operative societies, Official Language, Tribunals etc.

**Text/Reference Books-**

1. M. Laxmikanth, "Indian Polity", McGraw- Hill, 6th edition, 2020
2. D.D. Basu, "Introduction to the Indian Constitution", LexisNexis, 21st edition, 2020
3. S.C. Kashyap, " Constitution of India", Vitasta publishing Pvt. Ltd., 2019

**Course Outcomes**

The course should enable the students to:

**CO1:** Understand the basic knowledge and salient features of Indian Constitution.

**CO2:** Identify and explore the basic features and modalities about Indian constitution.

**CO3:** Discusses the essence of Union and its territories, Citizenship, Fundamental Rights, DPSP and Fundamental Duties.

**CO4:** Differentiate and relate the functioning of Indian parliamentary system at the center and state level.

**CO5:** Differentiate different aspects of Indian Legal System and its related bodies.

# Happiness and Well Being (AHT-014)

**L T P: 2 0 0**

**Course Objectives**

The course should enable the students to:

- Obtain a basic understanding of Positive emotions, strengths and virtues; the concepts and determinants of happiness and well-being.
- Bring an experience marked by predominance of positive emotions and informing them about emerging paradigm of Positive Psychology.
- Build relevant competencies for experiencing and sharing happiness as lived experience and its implication.
- Become aware of contextual and cultural influences on health and happiness.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction to Positive Psychology**

Importance of positive emotions in everyday life and society, Positive Emotions and well being: Hope & Optimism, Love. The Positive Psychology of Emotional Intelligence, Influence of Positive Emotions Strength and Virtues; implications for human behavior and mental health.

**Unit 2** **(8 Hrs)**

**Happiness**

Determinants of Happiness and well-being – biological, social, psychological and spiritual, Types of happiness- Eudaimonic and Hedonic, Traits associated with Happiness, Setting Goals for Life and Happiness, Research findings on effects of happiness and well-being on mental illness and stress.

**Unit 3** **(8 Hrs)**

**Resilience and Well Being**

Meaning, Nature and Approaches Theories of Resilience, Positive Response to loss, Post Traumatic Growth, Models of PTG as Outcome, Models of PTG as a Coping Strategy Benefit Finding, Mindfulness and Positive Thinking, Building Resilience and Wellbeing.

**Unit 4** **(8 Hrs)**

**Happiness and Well-being in the Indian Context**

Indian philosophy of happiness and life satisfaction. – Karma, Moksha and destiny. Theory of happiness and wellbeing in Taittiriya Upanishad, Role of socio-demographic and cultural factors in

Happiness and well-being. Health and Happiness in contemporary India – rural and urban differences and similarities.

**Unit 5** **(8 Hrs)**

**Positive Work Life**

Employee engagement- what causes individuals to join an organization and why they stay or leave, person-centered approach to engagement Understand the concept of work as meaning, Impact of employee well-being on the organization and impact of feelings about work on the individual's well-being. Bringing Positive Psychology to Organizational Psychology.

**Reference Books:**


1. Dandekar, R. N. (1963). On dharma. In De Bary (ed.) Sources of Indian Tradition. Delhi, India: Motilal Banarasidass Publishers.
2. Dandekar R. N. (1981). Exercises in Indology. Delhi, India: Ajanta Publishers.
3. Snyder, C.R., &Lopez,S.J.(2007). Positive psychology: The scientific and practical explorations of human strengths. Thousand Oaks, CA: Sage. Snyder, C. R., & Lopez, S. (Eds.). (2002). Handbook of positive psychology. New York: Oxford University Press.
4. Seligman, M. (2011). Flourish: A Visionary New Understanding of Happiness and Well-being, Atria Books.
5. Peterson, C. A. (2006). A Primer in Positive Psychology, Oxford University Press.
6. Nettle, D.S. (2006). Happiness: The Science Behind Your Smile, Oxford University Press.
7. Lyubomirsky, S. (2013). The Myths of Happiness: What Should Make You Happy, but Doesn't, What Shouldn't Make You Happy, but Does, Penguin


**Course Outcomes:**

The course should enable the students to:

**CO1:** Provide an insight to see the importance of positive emotions, Strength and Virtues in everyday life and society.

**CO2:** Use the strength and virtues in improving human behavior and mental health.

**CO3:** Understand the biological, social, psychological and spiritual determinants of Happiness and well-being.

**CO4:** Throw light on research findings related to effects of happiness and well-being on mental illness and stress.

**CO5:** Give an insight of the Indian philosophy of happiness and life satisfaction in context of Karma, Moksha and destiny and role of socio-demographic and cultural factors in Happiness and well-being.

**VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICALUNIVERSITY**

***(Formerly Uttarakhand Technical University, Dehradun Established by Uttarakhand State Govt. wide Act no. 415 of 2005)***

***Suddhowala, PO-Chandanwadi, Premnagar, Dehradun, Uttarakhand (Website- www.uktech.ac.in)***

# SYLLABUS

**For**

## B.TECH.

## (Mechanical Engineering)

## 4TH Year

Effective from – Session 2025-26

| SEMESTER-VII (w.e.f. 2025-26) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B.TECH. (MECHANICAL ENGINEERING) | | | | | | | | | | | | | |
| S. No. | Subject Codes | Category | Subject | Periods | | | Evaluation Scheme | | | | | Subject Total | Credit |
| | | | | | | | Sessional Exam | | | ESE | | | |
| | | | | L | T | P | CT | TA | Total | TE | PE | | |
| 1 | AHT-XXX | HSC | HSMC -1 / HSMC-2 | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| 2 | MET-XXX | DE | Departmental Elective-4 | 3 | 0 | 0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| 3 | MET-XXX | DE | Departmental Elective-5 | 3 | 0 | 0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| 4 | | OE | Open Elective-2 | 3 | 0 | 0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| 5 | MEP-018 | DLC | Project Seminar | 0 | 0 | 2 | | | 50 | | | 50 | 1 |
| 6 | MEP-019 | DLC | Project Stage -II | 0 | 0 | 4 | | | 100 | | | 100 | 2 |
| 7 | MEP-020 | DLC | Mini Project-III or Internship-III* | 0 | 0 | 2 | | | 50 | | | 50 | 1 |
| 8 | AHT-017 | MC | Disaster Management | 3 | 0 | 0 | | 50 | 50 | | 100 | 150 | 3 |
| 9 | AHT-018 | NC | Innovations and Problem Solving (Audit Course) | 2 | 1 | 0 | 15 | 10 | 25 | 50 | | 75 | 0 |
| 10 | GP-07 | NC | General Proficiency | | | | | | 50 | | | 50 | 0 |
| | **Total** | | | **12** | **1** | **12** | | | | | | **950** | **19** |
| 11 | | **Minor Course (Optional)** | | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |
| *The Internship-III (4-6 weeks) conducted during summer break after VI semester and will be assessed during VII semester | | | | | | | | | | | | | |

| **Departmental Elective - 4** | | **Departmental Elective - 5** | |
|---|---|---|---|
| MET-030 | Power Plant Engineering | MET-035 | Robotics & Automation |
| MET-031 | Mechanical Vibrations | MET-036 | 3D Printing and Rapid Prototyping |
| MET-032 | Automation in Engineering | MET-037 | TQM & Reliability Engineering |
| MET-033 | Design of Jigs Fixture and Press Tools | MET-038 | Viscous Flow Theory |
| MET-034 | Flexible Manufacturing System | MET-039 | Computational Fluid Dynamics |

| | | |
|---|---|---|
| HSMC-1 | AHT-015 | Rural Development, Administration and Planning |
| HSMC-2 | AHT-016 | Project Management & Entrepreneurship |

**Open Electives offered by Mechanical Engineering Department in 7th and 8th Semester for other department students:**

| | | |
|---|---|---|
| Open Elective-2 | MET-046 | Reliability and Maintenance Engineering |
| Open Elective-3 | MET-047 | Project Management |
| Open Elective-4 | MET-048 | Six Sigma |
| **Note: Mechanical Engineering students shall opt open electives offered by other departments** | | |

# HSMC-1
# Rural Development: Administration and Planning (AHT-015)

**L T P: 3 1 0**

**Course Objectives**

This course enables the students to:

- Gain knowledge on the concepts related to administration, its importance and various approaches of Development Administration.
- Gain skills on New Public Management, Public Grievances and Redressal Mechanisms, Accountability and Transparency in Administration and e-governance in the rural development sector.
- Develop their competency on the role of Bureaucracy in Rural Development.

**Particulars**

**Unit 1** **(8 Hrs)**

**Rural Planning & Development:** Concepts of Rural Development, Basic elements of rural Development, and Importance of Rural Development for creation of Sustainable Livelihoods, An overview of Policies and Programmes for Rural Development- Programmes in the agricultural sector, Programmes in the Social Security, Programmes in area of Social Sector.

**Unit 2** **(8 Hrs)**

**Rural Development Programmes:** Sriniketan experiment, Gurgaon experiment, Marthandam experiment, Baroda experiment, Firkha development scheme, Etawapilot project, Nilokheri experiment, approaches to rural community development: Tagore, Gandhi etc.

**Unit 3** **(8 Hrs)**

**Panchayati Raj & Rural Administration:** Administrative Structure: bureaucracy, structure of administration; Panchayati Raj Institutions Emergence and Growth of Panchayati Raj Institutions in India; People and Panchayati Raj; Financial Organizations in Panchayati Raj Institutions, Structure of rural finance, Government & Non-Government Organizations / Community Based Organizations, Concept of Self help group.

**Unit 4** **(8 Hrs)**

**Human Resource Development in Rural Sector:** Need for Human Resource Development, Elements of Human Resource Development in Rural Sector Dimensions of HRD for rural development-Health, Education, Energy, Skill Development, Training, Nutritional Status access to basic amenities –

Population composition.

**Unit 5** **(8 Hrs)**

**Rural Industrialization and Entrepreneurship:** Concept of Rural Industrialization, Gandhian approach to Rural Industrialization, Appropriate Technology for Rural Industries, Entrepreneurship and Rural Industrialization- Problems and diagnosis of Rural Entrepreneurship in India, with special reference to Women Entrepreneurship; Development of Small Entrepreneurs in India, need for and scope of entrepreneurship in Rural area.

**Text Books/References:**

1. Corporate Social Responsibility: An Ethical Approach - Mark S. Schwartz.
2. Katar Singh: Rural Development in India – Theory History and Policy.
3. Todaro M.P. Economic Development in III World war.
4. Arora R.C – Integrated Rural Development in India.
5. Dhandekar V.M and Rath N poverty in India.
6. A.N.Agarwal and Kundana Lal: Rural Economy of India.
7. B.K.Prasad: Rural Development-Sarup& Son's Publications.

**Course Outcomes**

After completion of the course student will be able to:

CO1: Understand the definitions, concepts and components of Rural Development.

CO2: Students will know the importance, structure, significance, resources of Indian rural economy.

CO3: Students will have a clear idea about the area development programmes and its impact.

CO4: Students will be able to acquire knowledge about rural entrepreneurship.

CO5: Students will be able to understand about the using of different methods for human resource planning.

# HSMC-2
# Project Management & Entrepreneurship (AHT-016)

**L T P: 3 1 0**

**Course Objectives**

The course should enable the students to:

- Understand the concepts of Project Management for planning to execution of projects.
- Understand the feasibility analysis in Project Management and network analysis tools for cost and time estimation.
- Be capable to analyze, apply and appreciate contemporary project management tools and methodologies in Indian context.
- Understand the concepts of Entrepreneurship, role of entrepreneur in economic development, steps for establishing an enterprise.

**Particulars**

**Unit 1** **(8 Hrs)**

**Entrepreneurship:** Entrepreneurship: need, scope , Entrepreneurial competencies & traits, Factors affecting entrepreneurial development, Entrepreneurial motivation (Mc Clellend's Achievement motivation theory), conceptual model of entrepreneurship , entrepreneur vs. intrapreneur; Classification of entrepreneurs; Entrepreneurial Development Programmes.

**Unit 2** **(8 Hrs)**

**Entrepreneurial Idea and Innovation**: Introduction to Innovation, Entrepreneurial Idea Generation and Identifying Business Opportunities, Management skills for Entrepreneurs and managing for Value Creation, Creating and Sustaining Enterprising Model & Organizational Effectiveness.

**Unit 3** **(8 Hrs)**

**Project Management:** Project management: meaning, scope & importance, role of project manager; project life-cycle Project appraisal: Preparation of a real time project feasibility report containing Technical appraisal, Environmental appraisal, Market appraisal (including market survey for forecasting future demand and sales) and Managerial appraisal.

**Unit 4** **(8 Hrs)**

**Project Financing:** Project cost estimation & working capital requirements, sources of funds, capital budgeting, Risk & uncertainty in project evaluation , preparation of projected financial statements viz.

Projected balance sheet, projected income statement, projected funds & cash flow statements, Preparation of detailed project report, Project finance.

**Unit 5** **(8 Hrs)**

**Social Entrepreneurship:** Social Sector Perspectives and Social Entrepreneurship, Social Entrepreneurship Opportunities and Successful Models, Social Innovations and Sustainability, Marketing Management for Social Ventures, Risk Management in Social Enterprises, Legal Framework for Social Ventures.

**Case study and presentations:** Case study of successful and failed entrepreneurs. Power point presentation on current business opportunities.

**Text Books**

1. Innovation and Entrepreneurship by Drucker, P.F.; Harperand Row.
2. Business, Entrepreneurship and Management: Rao, V.S.P.;Vikas
3. Entrepreneurship: Roy Rajeev.
4. Text Book of Project Management: Gopal krishnan, P.and Ramamoorthy,V.E.; McMill
5. Project Management for Engineering, Business and Technology: Nicholas, J.M., and Steyn, H.;PHI.
6. Project Management: The Managerial Process: Gray, C.F., Larson, E.W. and Desai, G.V.;MGH.

**Course Outcomes**

After completion of the course student will be able to:
**CO1:** Understand project characteristics and various stages of a project.

**CO2:** Understand the conceptual clarity about project organization and feasibility analyses – Market, Technical, Financial and Economic.

**CO3:** Analyze the learning and understand techniques for Project planning, scheduling and Execution Control.

**CO4:** Describe Entrepreneurship, Examine role of entrepreneur in economic development.

**CO5:** Describe the steps to establish an enterprise.

# DEPARTMENTAL ELECTIVE - 4
# Power Plant Engineering (MET-030)

**L T P: 3 0 0**

**Course Objectives**

The course will enable the students to:

- Introduce them to different aspects of power plant engineering.
- Be familiar with the working of power plants based on different fuels.
- Be familiar to the principles of safety and environmental issues.
- Getan overview of power plants and the associated energy conversion issues.

**Particulars**

**Unit 1** **(8 Hrs)**

Coal based thermal power plants, basic Rankine cycle and its modifications, layout of modern coal power plant, super critical boilers, FBC boilers, turbines, condensers, steam and heating rates, subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment, binary cycles and cogeneration systems.

**Unit 2** **(8 Hrs)**

Gas turbine and combined cycle power plants, Brayton cycle analysis and optimization, components of gas turbine power plants, combined cycle power plants, Integrated Gasifier based Combined Cycle (IGCC) systems.

**Unit 3** **(8 Hrs)**

Basics of nuclear energy conversion, Layout and subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants.

**Unit 4** **(8 Hrs)**

Hydroelectric power plants, classification, typical layout and components, principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems.

**Unit 5** **(8 Hrs)**

Energy, economic and environmental issues, power tariffs, load distribution parameters, load curve,

capital and operating cost of different power plants, pollution control technologies including waste disposal options for coal and nuclear plants.

**Reference Books:**

1. Nag P.K., Power Plant Engineering, 3rd ed., Tata McGraw Hill, 2008.
2. El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010.
3. Elliot T.C., Chen K and Swanekamp R.C., Power Plant Engineering, 2nd ed., McGraw Hill, 1998.

**Course Outcomes**

After completion of this course, the students should be able to:

**CO1**: Discuss the energy resources and energy conversion methods available for the production of electric power in India.

**CO2**: Determine the efficiency and output of a modern Rankine cycle steam power plant from given data, including superheat, reheat, regeneration, and irreversibility.

**CO3**: Understand the working of different power plant units and discuss the safety measures in power plants.

**CO4**: Explain the major types of hydro-power and wind-power turbines and estimate power generation potential.

**CO5**: Discuss the economics of the power plants units and estimate the total operational costs.

# Mechanical Vibrations (MET-031)

**L T P: 3 0 0**

**Course Objective**

The course will enable the students to:

- Formulate mathematical models of the real-world's vibration problems using Newton's second law or energy principles.
- Be familiarize with the sources of vibration and concept of noise.
- Solve the complete solution of the modeled vibration problems
- Acquire understanding of vibration solution and correlating that with various characteristic parameters of the actual vibrating system.
- Make design modifications to the existing vibrating system to reduce the vibration and noise and improve the life of the mechanical component.

**Particulars**

**Unit 1** **(9 Hrs)**

**Introduction:** Periodic motion, harmonic motion, superposition of simple harmonic motions, beats, Fourier analysis; Single Degree Freedom System: Free vibration, Natural frequency, Equivalent Systems, Energy method for determining natural frequency, Response to an initial disturbance; Torsional vibrations, Damped vibrations. Damping models – Structural, Coulomb and Viscous damping, Vibrations of system with viscous damping, Logarithmic decrement, Viscous dampers.

**Unit 2** **(8 Hrs)**

**Forced Vibrations:** Single Degree Freedom: Forced vibration, Harmonic Excitation with viscous damping, Steady state vibrations; Forced vibrations with rotating and reciprocating unbalance, Support excitation, vibration isolation, Transmissibility, Vibration measuring instruments- Displacement, Velocity, Acceleration and Frequency measuring instrument.

**Unit 3** **(8 Hrs)**

**Two Degree Freedom Systems:** Introduction, Principal modes, Double pendulum, Torsional system with damping. Coupled System, Undamped dynamic, vibration absorbers, Centrifugal pendulum absorber, Dry friction damper, Untuned viscous damper.

**Unit 4** **(9 Hrs)**

**Multi Degree Freedom System:** Exact Analysis Undamped free and forced vibrations of multidegree system; Influence numbers, Reciprocal Theorem, Torsional vibration of multi rotor system, Vibration of geared system. Principal coordinates Continuous systems- Longitudinal vibration of bars, Torsional

vibrations of Circular shafts, Lateral vibration of beams.

**Unit 5** **(8 Hrs)**

**Numerical Analysis:** Rayleigh's, Dunkerley's, Holzer's and Stodola's methods, Rayleigh – Ritz method. Critical Speed of Shafts: Shafts with one disc with and without damping, Multi-disc shafts, Secondary critical speed.

**Reference Books:**


1. Rao. S.S, "Mechanical Vibrations", 5th Edition, Pearson Education Inc. Delhi 2009.
2. Kewelpujara, "Vibration and noise for engineers", Dhanpat Rai & Sons, 2009.
3. Rao .J.S and Gupta. K, "Introductory course on theory and practice of mechanical vibrations", 2nd Edition, New Age International, New Delhi, 2014.
4. Ambekar. A.G, "Mechanical Vibrations and Noise engineering", PHI New Delhi, 2015.
5. Thomson.W.T, "Theory of Vibration and its Applications", 5th Edition, Prentice Hall, New Delhi, 2001.


**Course Outcomes**

At the end of this course, students will be able to demonstrate the:

**CO1**: Ability to analyze natural frequency.

**CO2**: Ability to understand single degree of free and forced vibration systems.

**CO3**: Capability to analyze different types of absorbers.

**CO4**: Ability to understand the multi degree of free and forced vibration system.

**CO5**: Understand about critical speed.

# Automation in Engineering (MET-032)

**L T P: 3 0 0**

**Course Objective**

To familiarize with the components of computer aided manufacturing and computer aided design.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction to Automation:** Introduction to automation, why automation is needed, Current trends in automation, Industrial control systems in process, discrete manufacturing industries, introduction to robotics, classification of robots and characteristics, introduction to CAD, CAM and CIM.

**Unit 2** **(8 Hrs)**

**Types of Automation:** Rigid automation – part handling – job orienting and feeding devices, transfer mechanism and feed cut of components in machine tools, Automated Material handling.

Flexible automation – computer control of machine tools and machining centers. NC and NC part programming. CNC adaptive control, Assembly Flexible fixturing.

**Unit 3** **(8 Hrs)**

**Manufacturing Support Systems:** Fundamentals of CAD, hardware in CAD- Computer Graphics Software and Data Base, Geometric modeling for downstream applications and analysis methods.

**Computer Aided Manufacturing:** CNC technology, PLC, Micro-controller, CNC – Adaptive control.

**Unit 4** **(8 Hrs)**

**Low Cost Automation:** Mechanical and Electro mechanical systems, design aspect of hydraulic systems like pumps, valves, filters, reservoirs, accumulators, actuators, intensifiers etc. and their selection. Pneumatic fundamentals – control elements, position and pressure sensing – logic circuits, switching circuits. Practical case studies on hydraulic circuit design and performance analysis.

**Unit 5** **(8 Hrs)**

**Modeling and Simulation:** Introduction to modeling and simulation, need for system modeling, Product design, process route modeling, Modern tools- Fuzzy decision making and Artificial Neural Networks in manufacturing automation. Case studies and industrial applications of manufacturing systems.

**Reference Books:**

1. Mikell P. Groover, Automation, Production Systems and Computer integrated Manufacturing, Prentice Hall.
2. Serope Kalpaljian and Steven R Schmid, Manufacturing- Engineering and Technology, 7th edition, Pearson.
3. N. Viswanandham, Y. Narhari "Performance Modelling of Automated Manufacturing Systems" Prentice-Hall.
4. Yoram Koren, Computer control of manufacturing system, 1st edition.
5. Ibrahim Zeid, CAD/CAM : Theory & Practice, 2nd edition.

**Course Outcomes**

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

**CO1:** Understand the importance of automation in the field of machine tool-based manufacturing.

**CO2:** Acquire the knowledge of various types of automation.

**CO3:** Understand the components of manufacturing support systems.

**CO4:** Know about the low-cost automation system and their implementation.

**CO5:** Understand the basics of product design and the role of manufacturing automation.

# Design of Jigs, Fixture and Press Tools (MET-033)

**L T P: 3 0 0**

**Course Objective**

- To understand the functions and design principles of Jigs, fixtures and press tools and to gain proficiency in the development of required views of the final design.

**Particulars**

**Unit 1** **(8 Hrs)**

**Purpose Types and Functions of Jigs and Fixtures:** Tool design objectives - Production devices - Inspection devices - Materials used in Jigs and Fixtures – Types of Jigs - Types of Fixtures-Mechanical actuation-pneumatic and hydraulic actuation-Analysis of clamping force-Tolerance and error analysis.

**Unit 2** **(8 Hrs)**

**Jigs:** Drill bushes –different types of jigs-plate latch, channel, box, post, angle plate, angular post, turnover, pot jigs-Automatic drill jigs-Rack and pinion operated. Air operated Jigs components. Design and development of Jigs for given components.

**Unit-3** **(8 Hrs)**

**Fixtures:** General principles of boring, lathe, milling and broaching fixtures- Grinding, planning and shaping fixtures, assembly, Inspection and welding fixtures- Modular fixtures .Design and development of fixtures for given component.

**Unit-4** **(8 Hrs)**

**Press Working Terminologies and Elements of Dies and Strip Lay Out:** Press working Terminology-Presses and press Accessories-Computation of capacities and tonnage requirements. Elements of progressive combination and compound dies: Die block-die shoe. Bolster plate-punch plate-punch holder-guide pins and bushes – strippers –knockouts-stops –pilots-Selection f standard die sets strip lay out-strip lay out.

**Unit-5** **(8 Hrs)**

**Design and Development of Dies:** Design and development of progressive and compound dies for Blanking and piercing operations. Bending dies – development of bending dies-forming and drawing dies-Development of drawing dies. Design considerations in forging, extrusion, casting and plastic dies.

**Reference Books:**


1. Joshi, P.H. Jigs and Fixtures, Second Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2010.
2. Joshi P.H Press tools – Design and Construction, wheels publishing, 1996
3. ASTME Fundamentals of Tool Design Prentice Hall of India.
4. Design Data Hand Book, PSG College of Technology, Coimbatore.
5. Donaldson, Lecain and Goold Tool Design, 5th Edition, Tata McGraw Hill, 2017.
6. Hoffman Jigs and Fixture Design, Thomson Delmar Learning, Singapore, 2004.
7. Kempster, Jigs and Fixture Design, Third Edition, Hoddes and Stoughton, 1974.
8. Venkataraman. K., Design of Jigs Fixtures and Press Tools, Tata McGraw Hill, New Delhi, 2005.


**Course Outcomes**

Upon the completion of this course the students will be able to:

**CO1:** Summarize the different methods of Locating Jigs and Fixtures and Clamping principles

**CO2:** Design and develop jigs and fixtures for given component

**CO3:** Discuss the press working terminologies and elements of cutting dies

**CO4:** Distinguish between Bending and Drawing dies.

**CO5:** Discuss the different types of forming techniques

# Flexible Manufacturing System (MET-034)

**L T P: 3 0 0**

**Course Objective**

To understand the concepts and applications of flexible manufacturing systems.

**Particulars**

**Unit 1** **(8 Hrs)**

Types of production, production planning and control, manufacturing in a competitive environment, concept, automation of manufacturing process , numerical control, adaptive control, material handling and movement, industrial robots, flexible fixturing, design for assembly, disassembly and service. Types of FMS, types of FMS layouts, advantages and disadvantages of FMS Group technology – composite part families - classification and coding - production flow analysis.

**Unit 2** **(8 Hrs)**

Planning issues: components of FMS, types of flexibility, tradeoffs, computer control and functions, planning, scheduling and control of FMS, scheduling and knowledge-based scheduling. Hierarchy of computer control, supervisory computer, introduction to turning center, machining center, cleaning and deburring equipment, coordinate measuring machines: types, working and capabilities.

**Unit 3** **(8 Hrs)**

System support equipment, types, working capability, automated material movement and automated storage and retrieval systems, scheduling of AGVs, cutting tools and tool management, work holding considerations

**Unit 4** **(8 Hrs)**

FMS computer hardware and software, general structure and requirements, PLCs, FMS installation and implementation, acceptance testing.

**Unit 5** **(8 Hrs)**

Characteristics of JIT pull method, small lot sizes, work station loads, flexible work force, line flow strategy. Supply chain management Preventive maintenance - Kanban system, value engineering, MRD JIT, lean manufacture, quality concepts and management.

**Reference Books:**

1. Mikell P. Groover "Automation, Production Systems and Computer Integrated Manufacturing", PHI, 2008.
2. Kalpakjin, "Manufacturing Engineering and Technology ", AddisonWesley Publishing Co., 1995.
3. Shivanand H.K., Benal MM, Koti V, "Flexible Manufacturing System", New age international (P) Limited, New Delhi, 2006

**Course Outcomes**

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

**CO1:** Apply the concepts of PPC and GT to the development of FMS.

**CO2:** Discuss the planning and scheduling methods used in manufacturing systems.

**CO3:** Identify various workstations, system support equipments.

**CO4:** Identify hardware and software components of FMS.

**CO5:** Summarize the concepts of modern manufacturing such as JIT, supply chain management and lean manufacturing etc.

# DEPARTMENTAL ELECTIVE - 5
# Robotics and Automation (MET-035)

**L T P: 3 0 0**

**Course Objective**

To introduce the students to the standard terminologies, applications, design specifications, and mechanical design aspects both kinematics, Trajectory planning, work cell control and dynamics of industrial robotic manipulatorsand their applications.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction:** Brief history, robot terminology, classification, characteristic, physical configuration, structure of industrial robot. Robot and Effectors: Types, mechanical grippers, other types of gripper, tools as end effectors, Robot/end effector interface, design consideration.

**Robot Motion Analysis & Control**: Introduction to manipulator kinematics, robot dynamics, manipulator dynamics, robot control, task planning.

**Unit 2** **(8 Hrs)**

**Sensors:** Transducers and sensors, sensors in robotics, tedile sensors, proximity and range sensors, miscellaneous sensors and sensor-based systems, use of sensors in robotics, touch sensors, force-torque sensors.

**Machine Vision**: Introduction, sensing and digitizing function in machine vision, image processing and analysis, vision system robotic applications.

**Unit 3** **(8 Hrs)**

**Programming**: Basics of robot programming, languages, commands, communications and data processing. Applications: Welding, electro-plating, painting, spraying, assembling, material handling, inspection, Future applications. Introduction to design of robot in specific applications.

**Unit 4** **(8 Hrs)**

**Fundamentals of Manufacturing Automation**: Basic Principles of automation, types of automated systems, degrees of automation, Automated flow lines. Automation for machining operations Design and fabrication considerations.Analysis of multi station assembly.

**Automated Material Handling**: components, operation, types, design of automated guided vehicles and applications.Automated storage / retrieval systems - types, basic components and applications.

**Unit 5** **(8 Hrs)**

**Group Technology**: Part families, part classification and coding, machine Cell design, Benefits. Computer Aided Process Planning, benefits and limitations.

**Automated Inspection and Testing**: Automated inspection principles and methods sensors techniques

for automated inspection-techniques for automated inspection-contact and noncontact inspection methods-in process gauging, CMM's, construction, types, inspection probes, types, and applications. Machine vision, LASER Micro meter and optical inspection methods.

**Reference Books:**

1. Mikell P. Groover, "Industrial Robotics Technology Programming and Applications", McGraw Hill Co., Singapore, 2008.
2. Deb. S.R, "Robotics technology and flexible automation", Tata McGraw Hill publishing company limited, New Delhi, 2010.
3. Klafter R.D, Chmielewski T.A and Noggins, "Robot Engineering: An Integrated Approach", Prentice Hal of India Pvt. Ltd., New Delhi, 2010.
4. Fu K.S, Gonzalez, R.C., & Lee, C.S.G., "Robotics control, sensing, vision and intelligence", McGraw Hill Book Co., Singapore, Digitized 2007.
5. Craig. J. J, "Introduction to Robotics mechanics and control", Addison- Wesley, London, 2008.

**Course Outcomes**

At the end of course, the student will able to:

**CO1**: Demonstrate the knowledge of relationship between mechanical structures of industrial robots and their operational workspace characteristics.

**CO2**: Demonstrate an ability to apply spatial transformation to obtain forward kinematics equation of robot manipulators.

**CO3**: Demonstrate an ability to solve inverse kinematics of simple robot manipulators.

**CO4**: Apply localization and mapping aspects of mobile robotics.

**CO5**: Demonstrate the self-learning capability

# 3D Printing and Rapid Prototyping (MET-036)

**L T P: 3 0 0**

**Course Objective**

The course is designed to impart knowledge and skills related to 3D printing technologies, selection of material and equipment and develop a product using this technique in Industry 4.0 environment.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction:** Historical developments, Fundamentals of RP Systems and its Classification, Rapid prototyping process chains, 3D modeling and mesh generation, Data conversion and transmission.

**Unit 2** **(9 Hrs)**

**RP Systems:** Liquid polymer based rapid prototyping systems, Teijin Seikis' solid form and other similar commercial RP systems, Solid input materials based rapid prototyping systems, laminated object manufacturing (LOM) and fused deposition modelling systems etc., Power based rapid prototyping systems, selective Laser sintering, Soligen Diren's shell production casting (DSPC), Fraunhofer's multiphase jet solidification (MJS) and MIT's 3D printing (3DP) etc.

**Unit 3** **(8 Hrs)**

**RP Database:** Rapid prototyping data formats, STL format, STL file problems, STL file repair, Network based operations, Digital inspection, Data warehousing and learning from process data.

**Unit 4** **(8 Hrs)**

**RP Applications:** Development of dies for moulding, RP applications in developing prototypes of products, application in medical fields,

**Unit 5** **(7 Hrs)**

Development of bone replacements and tissues, etc, RP materials and their biological acceptability.

**Reference Books:**

1. Rapid Prototyping Of Digital Systems: A Tutorial Approach by Hamblen James O Kluwer Aca
2. Rapid Prototyping: Principles And Applications by Kai Chua Chee World Scie
3. Rapid System Prototyping With Fpgas: Accelerating The Design Process by R C CoferNewnes
4. Rapid Prototyping of Digital Systems by James O Hamblen Springer

**Course Outcomes**

At the end of course, the student will able to:

**CO1**: Gain basic knowledge of rapid prototyping and 3D modelling.
**CO2**: Understand and learn RP systems.
**CO3**: Understand RP database.
**CO4**: Apply RP systems and database.
**CO5**: Develop of bone replacements and tissues.

# TQM and Reliability Engineering (MET-037)

**L T P: 3 0 0**

**Course Objective**

To provide knowledge and understanding about the Total Quality Management (TQM), its concepts, tools and techniques, and to understand the reliability of different systems.

**Particulars**

**Unit 1** **(8 Hrs)**

**Basic Concepts:** Introduction, need for quality, evolution of quality; Definitions of quality, product quality and service quality; Basic concepts of TQM, TQM framework, contributions of Deming, Juran and Crosby. Barriers to TQM; Quality statements, customer focus, customer orientation & satisfaction, customer complaints, customer retention; costs to quality.

**Unit 2** **(8 Hrs)**

**TQM Principles:** TQM principles; leadership, strategic quality planning; Quality councils- employee involvement, motivation; Empowerment; Team and Teamwork; Quality circles, recognition and reward, performance appraisal; Continuous process improvement; PDCE cycle, 5S, Kaizen; Supplier partnership, Partnering, Supplier rating & selection.

**Unit 3** **(8 Hrs)**

**TQM Basic Tools and Techniques:** The seven traditional tools of quality; New management tools; Six sigma- concepts, methodology, applications to manufacturing, service sector including IT, Bench marking process; FMEA- stages, types. TQM tools and techniques, control charts, process capability, concepts of six sigma, Quality Function Development (QFD), Taguchi quality loss function; TPM- concepts, improvement needs, performance measures.

**Unit 4** **(8 Hrs)**

**Quality Systems:** Quality systems, need for ISO 9000, ISO 9001-9008; Quality system- elements, documentation, Quality auditing, QS 9000, ISO 14000- concepts, requirements and benefits; TQM implementation in manufacturing and service sectors.

**Unit 5** **(8 Hrs)**

**Reliability:** Introduction and definition about reliability, Probabilistic nature of failures, Mean failure rate and Mean time between failures (MTBF) of component/system: Problems, Hazard rate and Hazard models: Problems, Weibull model for reliability of components/systems, Reliability of components in Series configuration, Reliability of components in Parallel configuration, Redundant and Mixed configurations, System reliability improvement, Case studies in reliability of system.

**Reference Books:**


1. Joel E. Ross, Susan Perry, "Total Quality Management: Text, Cases, and Readings",, CRC Press, 3rd Edition, 1999.
2. Srinath, L. S., "Reliability Engineering", EastWest Press, New Delhi, 4thEdition 1995.
3. Besterfield D. H. et al., Total quality Management, 3rd ed., Pearson Education Asia, 2006.
4. Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th ed., first Indian edition, Cengage Learning, 2012.
5. Janakiraman B. and Gopal R.K., Total Quality Management, Prentice Hall India, 2006.
6. Suganthi L. and Samuel A., Total Quality Management, Prentice Hall India, 2006.
7. Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th ed., first Indian edition, Cengage Learning, 2012.
8. Zeiri, "Total Quality Management for Engineers", Wood Head Publishers, 1991.
9. Poornima M charantimath, "Total Quality Management", Pearson Education, 2nd Edition, 2011.
10. Balagurusamy, E., "Reliability Engineering", Tata Mc-Graw Hill publishing Co., New Delhi,1984.


**Course Outcomes**

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

**CO1**: Gain knowledge and understanding of the philosophies which have enabled the development of organizational quality improvement programs, use of control chart for quality assessment and some parameters of quality management such as quality in design, quality in manufacturing and quality in procurement.

**CO2**: Recognize the contributions of world's leading experts on quality management and through this, develop the intellectual skills.

**CO3**: Understand the importance of process knowledge and process control and understand how staff, customers and stakeholders are part of the success of an organization.

**CO4**: Understand the scope of quality management is aware of the need to think differently in an organization and develop a glossary of items which relate to the concepts of quality.

**CO5**: Apply the concept of reliability.

# Viscous Flow Theory (MET-038)

**L T P: 3 0 0**

**Course Objective**

To impart knowledge about various viscous flow theory and solve relevant problems.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction:** Fluid Properties, Definition of Continuum, Examples of Viscous Flow Phenomena, Laminar and Turbulent Flow, Vector and Tensor notation, Lagrangian/Eulerian Methods, Streamline, Path line, Streak line, Material Derivative and acceleration, Strain Rate, Translation, Rotation and Distortion of Fluid Element, Vorticity and Circulation.

**Unit 2** **(8 Hrs)**

**Fundamental Equations of Viscous Flow:** Conservation of Mass, Momentum and Energy, Finite Volume Approach, Derivation of Continuity Equation: conservative and non conservative form, Derivation of Navier-Stokes (N-S) equations for Compressible Flow, Stokes Hypothesis. Incompressible form of N-S equations.

**Unit 3** **(8 Hrs)**

**Exact Solutions:** Parallel Flow in a Straight Channel, Couette Flow, Lubrication Theory, Hagen-Poiseuille Flow, Unsteady Parallel Flow, Stokes Problems, Similarity Solution and Creeping Flow, Complex variable and Potential flow.

**Unit 4** **(8 Hrs)**

**Boundary Layer Theory:** Derivation of 2-D Boundary Layer Equations, Displacement, Momentum and Energy Thickness, Order of Magnitude Analysis, Shape Factor, Momentum-Integral Approach, Boundary Layer Separation, Effect of Pressure Gradient, Boundary Layer Control by Suction and Blowing, Blassius Solution of Boundary Layer Equation, Kármán-Pohlhausen Method for Non-Zero Pressure Gradient, Holsten and Bohlen Method (Modified Pohlhausen Method), Waltz's-Quadrature Formula and Example Problems.

**Unit 5** **(8 Hrs)**

**Flow Instability:** Instability, Concept of Small-Perturbations, Linearized Stability of Parallel Viscous Flows, Orr-Sommerfeld Equation, Neutral Stability Curve, Boundary Layer Transition over a Flat Plate.

**Turbulent Boundary Layers:** Introduction to Turbulent Flows, Features of Turbulence, Energy Cascade, Mean and Fluctuating Components, Derivations of Reynolds Averaged Navier-Stokes Equations, Reynolds Stress Tensor, Turbulent Boundary Layer Equations, Eddy Viscosity and Mixing Length Hypothesis, Universal Law of Wall, Laminar Sublayer, Power Law for Turbulent Boundary Layer, Skin Friction Coefficient, Turbulent Boundary Layer with Pressure Gradient, Quadrature Formula and Example Problems.

**Reference Books:**

1. Fluid Mechanics by Pijush K. Kundu, Ira M. Cohen, David R Dowling (Academic Press)
2. Fluid Mechanics by Frank M White (McGraw-Hill)
3. Viscous Fluid Flow by Frank M White (McGraw-Hill)
4. Boundary Layer Theory by H Sctllichting (McGraw-Hill)

**Course Outcomes**

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

**CO1**: Learn the basics related to viscous flow theory.

**CO2**: Gain knowledge about fundamental Equations of Viscous Flow.

**CO3**: Achieve exact solution for the viscous flow theory related problems.

**CO4**: Understand boundary layer theory concepts.

**CO5**: Learn about Flow Instability and Turbulent Boundary Layers.

# Computational Fluid Dynamics (MET-039)

**L T P: 3 0 0**

**Course Objective**

To impart knowledge about various computational methods of fluid flow and solve simple fluid flow problems.

**Particulars**

**Unit 1** **(8 Hrs)**

**Mathematical Behaviour of Partial Differential Equations:** Introduction to computational fluid dynamics, Types of model flow, substantial derivative, Divergence of velocity. Continuity equation in conservation form, integral and differential form; Continuity equation in non-conservation form, integral and differential form; Manipulation of continuity equation, Three-dimensional momentum equation; Navier's Stokes Equation, Energy equation. Different boundary conditions, Classification of PDE Mathematical behavior of PDE.

**Unit 2** **(8 Hrs)**

**Discretization Techniques:** Explanation of finite difference method; Discretization of wave equation, Discretization of Laplace equation; Numerical error types and stability criterion, One-dimensional transient heat conduction equation discretization; Explicit, Crank Nicholson and pure implicit method, Numerical error and stability of One-dimensional transient heat conduction equation; Grid independence test, Optimum step size.

**Unit 3** **(8 Hrs)**

**Solution Techniques:** Laxwendroff Technique, Maccormmacks Technique, Relaxation Technique and its significance, TDMA Algorithm, Alternative Direction Implicit method, Pressure correction Technique, Staggered Grid; Numerical SIMPLE Algorithm, Stream function and Vorticity method.

**Unit 4** **(8 Hrs)**

**Grid Generation:** Grid transformation of equations, Transformation of aerofoil from physical plane to Computational plane, Transformation of continuity and Laplace equation, Metrices and Jacobians, Stretched grid, Compressed grid, Adaptive grids, Body fitted coordinate system, Grid generation in irregular geometry, Modern development in grid generation.

**Unit 5** **(8 Hrs)**

**Finite Volume Method:** Finite Volume methods of Discretization-Central differencing scheme, Upwind scheme, hybrid scheme; One dimensional conduction problems, One dimensional convection problems, One-dimensional convection and diffusion problem with different boundary conditions, Steady state heat conduction problems, Transient heat conduction problems.

**Reference Books:**


1. Anderson J.D., "Computational Fluid dynamics", McGraw Hill Int., New York, 2010.
2. Versteeg H.K., and Malalasekera W., "An introduction to computational fluid dynamics, The finite volume method", Longman, 2007.
3. Suhas.V. Patankar, "Numerical Heat Transfer and Fluid Flow", Hemisphere Publishing Corporation, 2009.
4. Muralidhar.K, and Sundararajan.T, "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, Second Edition, 2008.
5. Ghoshdasdidar. P.S, "Computer simulation of fluid flow and heat transfer", Tata McGraw Hill Publishing Company Ltd., 1998.
6. Anil W. Date, "Introduction to computational fluid dynamics", Cambridge University Press, Cambridge, 2009.


**Course Outcomes**

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

**CO1**: Learn the formulation of governing equations for fluid flow and their mathematical behavior.

**CO2**: Learn various discretization techniques.

**CO3**: Gain knowledge of different techniques to solve numerical equations related to fluid dynamics.

**CO4**: Learn to develop various types of grids to solve the problem.

**CO5**: Study the finite volume approach to discretize the governing equations.

# OPEN ELECTIVE - 2
# Reliability and Maintenance Engineering (MET-046)

**L T P: 3 0 0**

**Course Objectives**

The course will enable the students to:

- To understand the concept to reliability.
- To understand basic maintenance terms and know methods and techniques for planning, scheduling, carry out and analyze maintenance.
- Information about the most relevant and future maintenance concepts.
- To carry out risk and vulnerability analyses and to use maintenance optimization models.
- To get information about environmental aspects related to Maintenance engineering.

**Particulars**

**Unit1** **(8 Hrs)**

**Reliability:** Introduction and definition about reliability, Probabilistic nature of failures. Mean failure rate and meantime between failures (MTBF) of component/system: Problems Hazard rate and Hazard models Problems Weibull model for reliability of components/systems. Reliability of components in Series configuration. Reliability of components in Parallel configuration. Redundant and Mixed configurations System reliability improvement. Case studies in reliability of system.

**Unit 2** **(8 Hrs)**

**Maintainability:** Introduction and definition of maintainability, availability. Choice of maintenance strategy. Factors contributing to Mean Down Time (MDT): Problems Mean time to repair (MTTR): Problems Fault diagnosis, and routine testing forum revealed faults. Factors contributing to Mean Maintenance Time (MMT): Problems Types of maintenance Economics of maintenance.

**Unit 3** **(8 Hrs)**

**Maintenance Strategies**: Break down maintenance, planned maintenance, strategies, preventive maintenance, design out maintenance, planned lubrication, total productive maintenance, zero break down, preventive inspection of equipment used in emergency.

**Unit 4** **(8 Hrs)**

Replacement planning maintain or replace decision, replacement of items that deteriorate identical

equipment, replacement of items that fail without deterioration individual, group replacement, replacement in anticipation of failure. Break down maintenance planning.

**Unit 5** **(8 Hrs)**

Maintenance Management, production maintenance system, objectives and functions, forms, policy, planning, organization, economics of maintenance, manpower planning, materials planning, spare parts planning and control, evaluation of maintenance management.

**Reference Books:**

1. Industrial Safety Handbook: William Handley.
2. Introduction to Safety Engineering: David S Gloss & Miriam Gayle Wardle.
3. Industrial Safety: Roland P Blake.
4. Industrial Hazard & Safety Handbook: Ralph King & John Magid.

**Course Outcomes**

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

**CO1:** Explain the concept to reliability.

**CO2:** Understand the concept of maintainability of a system.

**CO3:** Gain the knowledge about the concept of maintenance strategies.

**CO4:** Explain the concept of replacement planning.

**CO5:** Explain the concept of maintenance management.

## Project Seminar (MEP-018)

**Course Objectives**

The course should enable the students to:

- Identify and compare technical and practical issues related to the area of course specialization.
- Outline annotated bibliography of research demonstrating scholarly skills.
- Prepare a well-organized report employing elements of technical writing and critical thinking.
- Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presenting.

**Course Outcomes**

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

**CO1:** Establish motivation for any topic of interest and develop a thought process for technical presentation.

**CO2:** Organize a detailed literature survey and build a document with respect to technical publications.

**CO3:** Analyze and comprehend proof-of-concept and related data.

**CO4:** Make effective presentation and improve soft skills.

**CO5:** Make use of new and recent technology (e.g. Latex) for creating technical reports

## Project Stage - II (MEP-019)

**Course Objectives**

The course should enable the students:

- To allow students to demonstrate a wide range of the skills learned during their course of study
- To encourage multidisciplinary research through the integration learned in a number of courses.
- To allow students to develop problem solving, analysis, synthesis and evaluation skills.
- To encourage teamwork.
- To improve students' communication skills by asking them to produce both a professional report and to give an oral presentation

**Course Outcomes**

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

**CO1:** Demonstrate a sound technical knowledge of their selected project topic.

**CO2:** Undertake problem identification, formulation and solution.

**CO3:** Combine the theoretical and practical concepts studied in his / her academics.

**CO4:** Communicate with engineers and the community at large in written and oral forms.

**CO5:** Demonstrate the knowledge, skills and attitudes of a professional engineer.

## Internship III/ Mini Project III (MEP-020)

**Course Objectives**

The course should enable the students to:

- Create an Industrial environment and culture within the institution.
- Identify the issues and challenges of an industry.
- Prepare report on the application of emerging technologies in the selected industry.
- Learn and understand the concept of entrepreneurship.
- Inculcate innovative thinking.

**Course Outcomes:**

On completion of the course, student will be able to–

**CO1:** Develop his abilities to transmit technical information clearly and test the same by delivery of Seminar based on the Mini Project or Internship.

**CO2:** Understand the importance of document design by compiling Technical Report on the Mini Project or Internship work carried out.

**CO3:** Comment and evaluate other students research questions and internship proposals.

## Disaster Management (AHT-017)

**L T P: 3 0 0**

**Course Objectives**

The course should enable the students to:

- Introduce themselves to various types of natural and manmade disasters.
- Understand causes and impact of disasters.
- Understand approaches of Disaster Management.
- Build skills to respond to disaster.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction to Disasters**

Concepts, and definitions (Disaster, Hazard, Vulnerability, Resilience, Risks). Disaster Types, Trends, Causes, Consequences and Control of Disasters, Geological Disasters; Hydro-Meteorological, Biological, Technological and Manmade Disasters.

**Unit 2** **(8 Hrs)**

**Disasters: Classification, Causes, Impacts**

(Including social, economic, political, environmental, health, psychosocial, etc.)

Differential impacts-in terms of caste, class, gender, age, location, disability. Global trends in disasters urban disasters, pandemics, complex emergencies, Climate change.

**Unit 3** **(8 Hrs)**

**Approaches to Disaster Risk Reduction:**

Disaster cycle- its analysis, Phases, Culture of safety, prevention, mitigation and preparedness, community based DRR, Structural- nonstructural measures, roles and responsibilities of community, Panchayati Raj Institutions/ Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders.

**Unit 4** **(8 Hrs)**

**Inter-relationship between Disasters & Development**

Factors affecting Vulnerabilities, differential impacts, Impact of Development projects such as dams, embankments, changes in Land-use etc. Climate Change Adaptation. Relevance of indigenous knowledge, appropriate technology and local resources

**Unit 5** **(8 Hrs)**

**Disaster Risk Management in India:**

Hazard and Vulnerability profile of India. Components of Disaster Relief: Water, Food, Sanitation,

Shelter, Health, Waste Management Institutional arrangements (Mitigation, Response and Preparedness, DM Act and Policy, Other related policies, plans, programmes and legislation)

**Text/Reference Books:**

1. Disaster Management Guidelines, GOI-UND Disaster Risk Program (2009-2012)
2. Damon, P. Copola, (2006) Introduction to International Disaster Management, Butterworth Heineman.
3. Gupta A.K., Niar S.S and Chatterjee S. (2013) Disaster management and Risk Reduction, Role of Environmental Knowledge, Narosa Publishing House, Delhi.
4. Murthy D.B.N. (2012) Disaster Management, Deep and Deep Publication PVT. Ltd. New Delhi.
5. Modh S. (2010) Managing Natural Disasters, Mac Millan publishers India LTD.

**Course Outcomes**

At the end of the course, Student will be able to:

**CO1:** Have an exposure to disasters, their significance and types.

**CO2:** Understand the relationship between vulnerability, disasters, disaster prevention and risk reduction.

**CO3:** Understand approaches of Disaster Management.

**CO4:** Build skills within themselves to respond to disasters.

## Innovations and Problem Solving (AHT-018)

**L T P: 2 1 0**

**Prerequisite:**

Basic Engineering Aptitude

**Course Objectives:** This subject aims to inculcate critical thinking abilities and application of

knowledge for problem solving. It will expose the students with various simple methods and practices that are essential to development of new systems, problem formulation and problem solving in technical and non-technical fields. This course will stimulate the work environment of the modern day engineers and technologists by familiarizing them with the state-of-the art results, design and analysis tools in various disciplines, the ability to extract relevant information to formulate and solve problems arising in practice.

**Particulars**

**Unit 1** **8 Hrs**

**Introduction to Critical Design Thinking**

- Understanding critical thinking, creative thinking, and problem solving through examples.
- New ways to solve problems.

**Unit 2** **8 Hrs**

**Theory of Inventive Problem Solving**

- Examples of inventive problem solving
- Era of technical systems
- Science of inventing
- Art of inventing
- Amazing world of tasks.

**Unit 3** **8 Hrs**

**Logic and Tools for Creativity and Clarity of Thought**

- TRIZ tools for creativity and solutions
- World's known solutions
- Fundamentals of Problem solving
- Thinking in Time and Scale
- Uncovering and solving contradictions
- Fast Thinking with ideal outcome.

**Unit 4** **8 Hrs**

**Modeling for Problem Solving**

- Moving from problem to ideal final result
- Tradeoffs and inherent contradictions
- Invisible reserves
- Law of increasing ideality
- Evaluation of solutions
- Enriching models for problem solving.

**Unit 5** **8 Hrs**

**Principles for Innovation**

- General review
- Segmentation, Separation
- Local quality, symmetry change, merging and multifunctionality
- Nested doll and weight compensation
- Preliminary counteraction, preliminary action, and beforehand compensation

- Equipotentiality, the other way around and curvature increase
- Dynamic parts, partial or excessive actions, dimensionality change, mechanical vibration
- Periodic action, continuity of useful action, and hurrying
- Blessing in disguise, feedback, and intermediary
- Self service, copying, cheap disposables, and mechanical interaction substitution
- Pneumatics and hydraulics, flexible shells and thin films, and porous materials
- Optical property changes, homogeneous, and discarding and recovering
- Parameter changes, phase transitions, and thermal expansion
- Strong oxidants, inert atmosphere, and composite materials
- How to select most suitable principle out of 40 ways to create good solutions

**References:**

1- ABC-TRIZ Introduction to Creative Design Thinking with Modern TRIZ Modeling by Michael A. Orloff

2- TRIZ And Suddenly the Inventor Appeared TRIZ, the Theory of Inventive Problem Solving by Genrich Altshuller

3- TRIZ for Engineers Enabling Inventive Problem Solving by Karen Gadd

4- Simplified TRIZ New Problem Solving Applications for Engineers and Manufacturing Professionals by Rantanen K., Domb E.

5- Simplified TRIZ New Problem Solving Applications for Engineers and Manufacturing Professionals by Rantanen K., Domb E.

**Course Outcomes:**

The course will enable students to:

**CO1:** Identify the market and value proposition.

**CO2:** Carry out rigorous and accessible formulation to problems.

**CO3:** Solutions via reducing the search space.

**CO4:** Eliminating tradeoffs to reduce dimension of optimization problems.

**CO5:** Execution through developing strategies for experiment, construction and monetization.

**CO6:** Simulate the work environment of the modern engineer or knowledge worker in general.

| SEMESTER-VIII (w.e.f. 2025-26) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B.TECH. (MECHANICAL ENGINEERING) | | | | | | | | | | | | | |
| Sl.No. | Subject Codes | Category | Subject | Periods | | | Evaluation Scheme | | | | | Subject Total | Credit |
| | | | | | | | Sessional Exam | | | ESE | | | |
| | | | | L | T | P | CT | TA | Total | TE | PE | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | AHT-XXX | HSC | HSMC-2 /HSMC-1 | 3 | 0 | 0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| 2 | MET-XXX | DE | Departmental Elective-6 | 3 | 0 | 0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| 3 | | OE | Open Elective-3 | 3 | 0 | 0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| 4 | | OE | Open Elective-4 | 3 | 0 | 0 | 30 | 20 | 50 | 100 | | 150 | 3 |
| 5 | MEP-021 | DLC | Project Stage -III | 0 | 0 | 12 | | | 100 | | 200 | 300 | 6 |
| 6 | GP-08 | NC | General Proficiency | | | | | | 50 | | | | |
| | | | **Total** | **12** | **0** | **14** | | | | | | **900** | **18** |
| 7 | **Minor Course (Optional)** | | | 3 | 1 | 0 | 30 | 20 | 50 | 100 | | 150 | 4 |

| **Departmental Elective - 6** | |
|---|---|
| MET-040 | Modelling & Simulation |
| MET-041 | Unconventional Machining Processes |
| MET-042 | Energy Efficient Buildings |
| MET-043 | Modern Concept of Engineering Design |
| MET-044 | New Product Design & Development |
| MET-045 | Thermal Turbomachines |

**Open Electives offered by Mechanical Engineering department in 7th and 8th Semester for other department students:**

| | | |
|---|---|---|
| Open Elective-2 | MET-046 | Reliability and Maintenance Engineering |
| Open Elective-3 | MET-047 | Project Management |
| Open Elective-4 | MET-048 | Six Sigma |
| **Note: Mechanical Engineering student shall opt open electives offered by other departments** | | |

| | | |
|---|---|---|
| HSMC-1 | AHT-015 | Rural Development, Administration and Planning |
| HSMC-2 | AHT-016 | Project Management & Entrepreneurship |

# HSMC-2

## Project Management & Entrepreneurship (AHT-016)

**L T P: 3 1 0**

**Course Objectives**

The course should enable the students to:

- Understand the concepts of Project Management for planning to execution of projects.
- Understand the feasibility analysis in Project Management and network analysis tools for cost and time estimation.
- Be capable to analyze, apply and appreciate contemporary project management tools and methodologies in Indian context.
- Understand the concepts of Entrepreneurship, role of entrepreneur in economic development, steps for establishing an enterprise.

**Particulars**

**Unit 1** **(8 Hrs)**

**Entrepreneurship:** Entrepreneurship: need, scope , Entrepreneurial competencies & traits, Factors affecting entrepreneurial development, Entrepreneurial motivation (Mc Clellend's Achievement motivation theory), conceptual model of entrepreneurship , entrepreneur vs. intrapreneur; Classification of entrepreneurs; Entrepreneurial Development Programmes.

**Unit 2** **(8 Hrs)**

**Entrepreneurial Idea and Innovation**: Introduction to Innovation, Entrepreneurial Idea Generation and Identifying Business Opportunities, Management skills for Entrepreneurs and managing for Value Creation, Creating and Sustaining Enterprising Model & Organizational Effectiveness.

**Unit 3** **(8 Hrs)**

**Project Management:** Project management: meaning, scope & importance, role of project manager; project life-cycle Project appraisal: Preparation of a real time project feasibility report containing Technical appraisal, Environmental appraisal, Market appraisal (including market survey for forecasting future demand and sales) and Managerial appraisal.

**Unit 4** **(8 Hrs)**

**Project Financing:** Project cost estimation & working capital requirements, sources of funds, capital budgeting, Risk & uncertainty in project evaluation , preparation of projected financial statements viz. Projected balance sheet, projected income statement, projected funds & cash flow statements, Preparation of detailed project report, Project finance.

**Unit 5** **(8 Hrs)**

**Social Entrepreneurship:** Social Sector Perspectives and Social Entrepreneurship, Social Entrepreneurship Opportunities and Successful Models, Social Innovations and Sustainability, Marketing Management for Social Ventures, Risk Management in Social Enterprises, Legal Framework for Social Ventures.

**Case study and presentations:** Case study of successful and failed entrepreneurs. Power point presentation on current business opportunities.

**Text Books**

1. Innovation and Entrepreneurship by Drucker, P.F.; Harperand Row.
2. Business, Entrepreneurship and Management: Rao, V.S.P.;Vikas
3. Entrepreneurship: Roy Rajeev.
4. Text Book of Project Management: Gopal krishnan, P.and Ramamoorthy,V.E.; McMill.
5. Project Management for Engineering, Business and Technology: Nicholas, J.M., and Steyn, H.;PHI.
6. Project Management: The Managerial Process: Gray, C.F., Larson, E.W. and Desai, G.V.;MGH.

**Course Outcomes**

After completion of the course student will be able to:

**CO1:** Understand project characteristics and various stages of a project.

**CO2:** Understand the conceptual clarity about project organization and feasibility analyses – Market, Technical, Financial and Economic.

**CO3:** Analyze the learning and understand techniques for Project planning, scheduling and Execution Control.

**CO4:** Describe Entrepreneurship, Examine role of entrepreneur in economic development.

**CO5:** Describe the steps to establish an enterprise.

# HSMC-1

## Rural Development: Administration and Planning (AHT-015)

**L T P: 3 1 0**

**Course Objectives**

This course enables the students to:

- Gain knowledge on the concepts related to administration, its importance and various approaches of Development Administration.
- Gain skills on New Public Management, Public Grievances and Redressal Mechanisms, Accountability and Transparency in Administration and e-governance in the rural development sector.
- Develop their competency on the role of Bureaucracy in Rural Development.

**Particulars**

**Unit 1** **(8 Hrs)**

**Rural Planning & Development:** Concepts of Rural Development, Basic elements of rural Development, and Importance of Rural Development for creation of Sustainable Livelihoods, An overview of Policies and Programmes for Rural Development- Programmes in the agricultural sector, Programmes in the Social Security, Programmes in area of Social Sector.

**Unit 2** **(8 Hrs)**

**Rural Development Programmes:** Sriniketan experiment, Gurgaon experiment, Marthandam experiment, Baroda experiment, Firkha development scheme, Etawapilot project, Nilokheri experiment, approaches to rural community development: Tagore, Gandhi etc.

**Unit 3** **(8 Hrs)**

**Panchayati Raj & Rural Administration:** Administrative Structure: bureaucracy, structure of administration; Panchayati Raj Institutions Emergence and Growth of Panchayati Raj Institutions in India; People and Panchayati Raj; Financial Organizations in Panchayati Raj Institutions, Structure of rural finance, Government & Non-Government Organizations / Community Based Organizations, Concept of Self help group.

**Unit 4** **(8 Hrs)**

**Human Resource Development in Rural Sector:** Need for Human Resource Development,

Elements of Human Resource Development in Rural Sector Dimensions of HRD for rural development-Health, Education, Energy, Skill Development, Training, Nutritional Status access to basic amenities – Population composition.

**Unit 5** **(8 Hrs)**

**Rural Industrialization and Entrepreneurship:** Concept of Rural Industrialization, Gandhian approach to Rural Industrialization, Appropriate Technology for Rural Industries, Entrepreneurship and Rural Industrialization- Problems and diagnosis of Rural Entrepreneurship in India, with special reference to Women Entrepreneurship; Development of Small Entrepreneurs in India, need for and scope of entrepreneurship in Rural area.

**Text Books/References:**

1. Corporate Social Responsibility: An Ethical Approach - Mark S. Schwartz.
2. Katar Singh: Rural Development in India – Theory History and Policy.
3. Todaro M.P. Economic Development in III World war.
4. Arora R.C – Integrated Rural Development in India.
5. Dhandekar V.M and Rath N poverty in India.
6. A.N.Agarwal and Kundana Lal: Rural Economy of India.
7. B.K.Prasad: Rural Development-Sarup& Son's Publications.

**Course Outcomes**

After completion of the course student will be able to:

CO1: Understand the definitions, concepts and components of Rural Development.

CO2: Students will know the importance, structure, significance, resources of Indian rural economy.

CO3: Students will have a clear idea about the area development programmes and its impact.

CO4: Students will be able to acquire knowledge about rural entrepreneurship.

CO5: Students will be able to understand about the using of different methods for human resource planning.

# DEPARTMENTAL ELECTIVE - 6

## Modelling and Simulation (MET-040)

**L T P: 3 0 0**

**Course Objective**

On completion of this course, the students are expected to gain knowledge about modelling and analysis of various systems calculations.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction to Modelling**: Concept of system, continuous and discrete systems; Types of models and simulation; Discrete event simulation: Time advance mechanisms, components and organization of simulation model, steps in simulation study.

**Unit 2** **(8 Hrs)**

**Statistical Models in Simulation:** Discrete, continuous, Poisson and empirical distributions, output data analysis for a single system, comparing alternative system configurations, statistical procedures for comparing real world observations with simulation output data, generation of arriving processes, verification and validation of simulation models.

**Unit 3** **(8 Hrs)**

**Stochastic Simulation:** Random number generation: Properties of random numbers, techniques of generating random numbers, generation of random variates, Monte Carlo simulation and its applications in queuing models and inventory models.

**Unit 4** **(8 Hrs)**

**Simulation of Manufacturing and Material Handling Systems:** Models of manufacturing systems, models of material handling systems, goals and performance measures; Issues in manufacturing and material handling simulation: Modelling downtime failures, trace driven models.

**Unit 5** **(8 Hrs)**

**Case Studies on Simulation Packages:** Simulation of queuing system (bank/job shop), simulation of manufacturing and material handling systems.

**Reference Books:**

1. Banks, J., Nelson, B.L., Carson, J. S., and Nicol, D., "Discrete Event System Simulation", Pearson Education.
2. Law, A.M., and Kelton, W.D., "Simulation Modeling and Analysis", McGraw-Hill.
3. Schwarzenbach, J., and Gill, K.F., "System Modeling and Control", Butterworth-Heinemann.
4. Carrie, A., "Simulation of Manufacturing Systems", John Wiley & Sons.
5. Viswanadham, N., and Narahari, Y., "Performance Modeling of Automated Manufacturing System", Prentice-Hall of India.

**Course Outcomes**

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

**CO1**: Define basic concepts in modelling and simulation (M&S) and to classify various simulation models and give practical examples for each category.

**CO2**: Construct a model for a given set of data and motivate its validity.

**CO3**: Generate and test random number variates and apply them to develop simulation models.

**CO4**: Analyze output data produced by a model and test validity of the model.

**CO5**: Explain parallel and distributed simulation methods.

# Unconventional Machining Processes (MET-041)

**L T P: 3 0 0**

**Course Objectives**

The course will enable the students to:

- Learn modeling technique for machining processes
- Learn interpretation of data for process selection.
- Understand mechanics and thermal issues associated with chip formation.
- Learn the effects of tool geometry on machining force components and surface finish.
- Learn machining surface finish and material removal rate concepts.

**Particulars**

**Unit 1** **(8 Hrs)**

Introduction – Need for non-traditional machining methods-Classification of modern machining processes – considerations in process selection. Materials Applications.

Ultrasonic machining – Elements of the process, mechanics of metal removal process, parameters, economic considerations, applications and limitations, recent development.

**Unit 2** **(8 Hrs)**

Abrasive Jet Machining, Water Jet Machining and Abrasive Water Jet Machining: Basic principles, equipment, process variable, and mechanics of metal removal, MRR, application and limitations. Electro – Chemical Processes: Fundamentals of electro chemical machining, electrochemical grinding, electro chemical honing and deburring processes, metal removal rate in ECM, Tool design, Surface finish and accuracy, economic aspects of ECM – Simple problems for estimation of metal removal rate.

**Unit 3** **(8 Hrs)**

Thermal Metal Removal Processes: General Principle and applications of Electric Discharge Machining, Electric Discharge Grinding and electric discharge wire cutting processes – Power circuits for EDM, Mechanics of metal removal in EDM, Process parameters, selection of tool electrode and dielectric fluids, methods surface finish and machining accuracy, characteristics of spark eroded surface and machine tool selection. Wire EDM, principle, applications.

**Unit 4** **(8 Hrs)**

Generation and control of electron beam for machining, theory of electron beam machining, comparison of thermal and non-thermal processes –General Principle and application of laser beam machining – thermal features, cutting speed and accuracy of cut.

**Unit 5** **(8 Hrs)**

Application of plasma for machining, metal removing mechanism, process parameters, accuracy and surface finish and other applications of plasma in manufacturing industries. Chemical machining – principle – maskants – applications.

**Text Books:**

1- Advanced Machining Processes / VK Jain / Allied publishers
2- Modern Machining Processes – P. C. Pandey, H. S. Shan/ McGraw Hill

**Reference Books:**

1- Unconventional Manufacturing Processes/ Singh M.K/ New Age Publishers
2- Advanced Methods of Machining/ J.A. McGeough/ Springer International
3- Non-Traditional Manufacturing Processes/ Benedict G.F./ CRC Press

**Course Outcomes**

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

**CO1:** Understand the basic techniques of Unconventional Machining processes modelling.

**CO2:** Estimate the material removal rate and cutting force, in an industrially useful manner, for Unconventional Machining processes

**CO3:** Learn the techniques of Magnetic abrasive finishing, Abrasive flow finishing, Electro stream drilling, shaped tube electrolyte machining.

**CO4:** Gain knowledge about thermal metal removal process.

# Energy Efficient Buildings (MET-042)

**L T P: 3 0 0**

**Course Objective**

To enable the students to understand and apply their knowledge to solve energy management issues of buildings.

**Particulars**

**Unit 1** **(8 Hrs)**

**Energy Transfer in Buildings:** Concepts of energy efficient buildings, Calculation of various heating and cooling loads of the building. Heat losses - Internal heat sources. Heat load calculations, Building's energy balance accounting for solar energy gain, Climate and its influence in building design for energy requirement. Low and zero energy buildings.

**Unit 2** **(8 Hrs)**

**Passive Solar Heating and Cooling:** General principles of passive solar heating, Key design elements of passive heating and cooling, direct solar heat gain by Trombe mass walls, Water walls, evaporative cooling, convective air loops and solar chimney effects, Passive cooling, ventilation, predicting ventilation in buildings, window ventilation calculations, Thermal insulation, load control, air filtration, Odor removal and heat recovery in large buildings.

**Unit 3** **(8 Hrs)**

**Lighting Systems of Buildings:** Glazing materials: sources and concepts of day lighting and optical materials, Components of daylight factor – Recommended daylight factors and day lighting analysis, Electric lighting control for day lighted buildings and illumination requirement, selection of luminaries and performance parameters.

**Unit 4** **(8 Hrs)**

**Heat Control and Ventilation:** Heat transmission through building sections and effect of heating with orientation of buildings, Design parameters influencing thermal design of buildings, Ventilation requirements and minimum standards for ventilation, Ventilation designs and energy conservation measures, Natural and forced ventilation methods.

**Unit 5** **(8 Hrs)**

**Green Buildings:** Green building features and green construction materials, integrated ecological design, sustainable site and Landscaping, Indoor air quality, water and waste management systems, Green Globe, LEED, GRIHA, IGBC certifications and Standards, Economics, managing initial costs

and environment benefits.

**Reference Books:**


1. Means R.S., "Green building: project planning and cost estimating", Kingston, 2006.
2. Kibert C.J., "Sustainable Construction: Green Building Design", 2nd edition, Wiley, 2007.
3. Boecker J., Scot Horst, Tom Keiter, Andrew Lau, Markes Sheffer, Brian Toevs, Bill Reed, "Integrative Design Guide to Green Building", Wiley, 2009.
4. Eicker U., "Low Energy Cooling for Sustainable Buildings", Wiley, 2009.
5. Gevorkian P., "Alternative Energy Systems in Building Design",McGraw-Hill, 2010.
6. Harvey D.L., "Handbook on Low-Energy Buildings and District-Energy Systems", Earthscan, 2006.
7. Attmann O., "Green Architecture", McGraw-Hill, 2010.
8. Majumdar, M., "Energy – Efficient Buildings in India", Tata Energy Research Institute, Ministry of Non-Conventional Energy Sources, 2002.


**Course Outcomes**

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

**CO1**: Apply the concept and techniques of Energy efficient buildings systems.

**CO2**: Demonstrate solar passive heating and cooling systems.

**CO3**: Demonstrate day lighting and electrical lighting.

**CO4**: Demonstrate heat control and ventilation methods in buildings.

**CO5**: Demonstrate green buildings and certifications.

# Modern Concepts of Engineering Design (MET-043)

**L T P: 3 0 0**

**Course Objectives**

The course will enable the students to:

- Widen knowledge on design process
- Attain knowledge on tools used in Design Methods
- Create an understanding on the process of material selection and design
- Develop in depth knowledge on Engineering statistics and reliability
- Create awareness on legal and ethical issues in Design a Quality Engineering

**Particulars**

**Unit 1** **(8 Hrs)**

**Design Process**: The design process – Morphology of Design – Design Drawings – Computer Aided Engineering – Designing of standards – Concurrent Engineering – Product life cycle – Technological Forecasting – Market Identification– Competition Bench marking – Systems Engineering – Life Cycle Engineering – Human Factors in Design – Industrial Design.

**Unit 2** **(8 Hrs)**

**Design Methods**: Creativity and Problem Solving – Product Design Specifications– Conceptual design – Decision Theory – Decision Tree – Embodiment Design – Detail Design – Mathematical Modeling – Simulation – Geometric Modeling – Finite Element Modeling – Optimization – Search Methods – Geometric Programming – Structural and Shape Optimization.

**Unit 3** **(8 Hrs)**

**Material Selection Processing And Design:** Material Selection Process – Economics – Cost Vs Performance – Weighted property Index – Value Analysis – Role of Processing in Design – Classificationof Manufacturing Process – Design for Manufacture – Design for Assembly –Designing for castings, Forging, Metal Forming, Machining and Welding – Residual Stresses – Fatigue, Fracture and Failure.

**Unit 4** **(8 Hrs)**

**Engineering Statistics and Reliability:** Probability – Distributions – Test of Hypothesis – Design of Experiments – Reliability Theory – Design for Reliability – Reliability centered Maintenance.

**Unit 5** **(8 Hrs)**

**Legal and Ethical Issues in Design and Quality Engineering:** Introduction – The origin of laws – Contracts – Liability – Tort law – Product liability – Protecting intellectual property – Legal and ethical domains – Codes of ethics – Solving ethical conflicts– case studies Total Quality Concept – Quality Assurance – Statistics Process Control – Taguchi Methods – Robust Design – Failure Model Effect Analysis.

**Course Outcomes**

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

**CO1:** Get clear understanding on CAE / concurrent engineering and systems engineering.

**CO2:** Attain problem solving skills through modeling/simulation and optimize design.

**CO3:** Ability to do material selection based on economy and value analysis. Develop understanding on DFM/DFA

**CO4:** Have good understanding on DOE, Reliability theory and reliability centered maintenance

**CO5:** Exposed to laws, codes of ethics, Quality concepts and FMEA

# New Product Design and Development (MET-044)

**L T P: 3 0 0**

**Course Objectives:**

The course will enable the students to:

- Gain competence with a set of tools and methods for product design and development.
- Gain confidence in their abilities to create a new product.
- Gain awareness of the role of multiple functions in creating a new product (e.g. marketing, finance, industrial design, engineering, production).
- Acquire ability to coordinate multiple, interdisciplinary tasks in order to achieve a common objective and enhance team-working skills.

**Particulars**

**Unit1** **(8 Hrs)**

**Introduction:** Characteristics of successful product development, Design and development of products, duration and cost of product development, the challenges of product development. Development Processes and Organizations, the front-end process, adopting the generic product development process, the AMF development process, product development organizations, the AMF organization.

**Unit 2** **(8 Hrs)**

**Product Planning:** The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process.

**Identifying Customer Needs:** Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process.

**Unit 3** **(8 Hrs)**

**Product Specifications:** What are specifications, when are specifications established, establishing target specifications, setting the final specifications.

**Concept Generation:** The activity of concept generation, clarify the problem, search externally, search internally, explore systematically, reflect on the results and the process. Concept Selection, Overview of methodology, concept screening, and concept scoring,

**Unit 4** **(8 Hrs)**

**Concept Testing:** Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process.

**Industrial Design:** Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process and assessing the quality of industrial design.

**Unit 5** **(8 Hrs)**

**Design for Manufacturing:** Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors. Prototyping, Prototyping basics, principles of prototyping, technologies, planning for prototypes.

**Reference Books:**

1. Product Design and Development - Karl.T.Ulrich, Steven D Eppinger - Irwin McGrawHill - 2000.
2. Product Design and Manufacturing - A C Chitale and R C Gupta, PH1, - 3rd Edition, 2003.
3. New Product Development - Timjones. Butterworth Heinmann - Oxford. UCI -1997
4. Product Design for Manufacture and Assembly – GeofferyBoothroyd, Peter Dewhurst and Winston Knight – 2002

**Course Outcomes**

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

**CO1:** Understand the product design and development process.

**CO2:** Apply creative thinking skills for idea generation.

**CO3:** Translate conceptual ideas into products.

**CO4:** Present ideas using various types of model.

# THERMAL TURBO MACHINES (MET-045)

**L T P: 3 0 0**

**Course Objectives:**

The course will enable the students to:

- Understand and design thermal turbomachines.
- Design and analyse centrifugal compressors and axial flow compressors
- Design and analyse axial flow turbines and radial flow turbines.
- Acquire ability to understand working of steam turbines, and gas turbine operation.

**Particulars**

**Unit1** **(8 Hrs)**

Brief history of turbo machinery, introduction to blowers, pumps, compressors, steam & gas turbines, turbojet, Review of laws of thermodynamics & SFEE in reference to turbo machinery, Energy transfer in turbo machines, Euler's equation, Definition of various efficiencies, Preheat factor, Reheat factor, Blade classification, Blade terminology, Cascade testing, Velocity diagrams for axial and radial turbo machinery and pumps.

**Unit 2** **(8 Hrs)**

**Centrifugal compressors** - Principle of operation, work done and pressure rise, Velcoity diagram for centrifugal compressor, Slip factor, Stage pressure rise, Loading coefficient, Diffuser, degree of reaction, Effect of impeller blade profile, Pre-whirl and inlet guide vanes, Centrifugal Compressor characteristic curves.
**Axial flow compressor**- Principle of operation and working, Energy transfer, Velocity diagram for axial compressor, Factors affecting stage pressure ratio, Blockage in compressor annulus, Degree of reaction, 3-D flow, Design process, blade design, calculation of stage performance, Axial compressor performance characteristic curves.

**Unit 3** **(8 Hrs)**

**Axial flow turbines** - Elementary theory of axial flow turbine, Energy transfer, Velocity diagram, Types of blades, Vortex theory, Choice of blade profile, pitch and chord, Estimation of stage performance, Characteristic curves.

**Unit 4** **(8 Hrs)**
**Steam turbines** - Constructional details, working of steam turbine.
**Pumps** - Classification of Pumps, Main components, indicator diagram and modification due to piston acceleration, Performance characteristics, Cavitation and its control, Miscellaneous types of pumps.
Radial flow turbines: Elementary theory of radial flow turbines, Enthalpy- Entropy diagram, State losses, Estimation of stage performance, Performance characteristics.

**Unit 5** **(8 Hrs)**

**Gas Turbine Starting & Control Systems** - Starting ignition system, Combustion system types, Safety limits & control.
**Turbine Blade cooling** - Different cooling techniques, Types of coolants, Comparative evaluation of different cooling techniques.
**Mechanical Design considerations** - Overall design choices, Material selection, Design with traditional materials.

**Reference Books**:
1. Thermal Turbomachines, Onkar Singh, Wiley India Pvt. Ltd.
2. Gas turbine theory : Cohen & Rogers, Addison Weslay Longman Ltd.
3. Design of high efficiency turbomachinery and gas turbines, David Gordon Wilson, Theodosios Korakianitis, Prentice Hall International.
4. Turbomachinery : S.M. Yahya.
5. Turbine, Compressors and Fans, S.M. Yahya, Tata Mc Graw Hill.
6. Turbomachines , D. G. Shepherd
7. Gas Turbine- Ganeshan, Tata Mc Graw Hill.

**Course Outcomes**

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

**CO1:** Understand the principles of operation of thermal turbomachines.

**CO2:** Design different work absorbing turbomachines like compressors and pumps

**CO3:** Design different work producing turbomachines like gas and steam turbines.

**CO4:** Understand the functional parameters and components in different turbomachines.

# OPEN ELECTIVE - 3
## Project Management (MET-047)

**L T P: 3 0 0**

**Course Objectives:**

The course will enable the students to:

- Gain an understanding about the basics of project management.
- Learn the implementation of various project management concepts.
- Gain knowledge of procurement.
- Learn to implement various project controls.
- Write and complete different types of projects.

**Particulars**

**Unit 1** **(8 Hrs)**

**Introduction:** Characteristics of a project types of projects, Project Management Body of Knowledge (PMBOK), role of project manager and his qualities, project organization and benefits, idea generation, needs of society, import substitution, project lifecycle, project charter, project sponsor.

**Project Planning**: Customer needs, stakeholder concept, project scope, feasibility study and report, baseline plan, SWOT analysis, project organization structure and hierarchy, project teams, formation, attitude and aptitude.

**Unit 2** **(8 Hrs)**

**Structure:** Project selection methods, breakeven analysis, DCF methods, project implementation, estimation, cost, price, value, scheduling, bar charts, network diagrams, PERT and CPM, schedule crashing, simple introduction to risk management, probability in project management, decision trees.

**Unit 3** **(8 Hrs)**

**Procurement:** Vendor selection methods, JIT, supply chains, quality, quality circles, quality control and quality assurance, cause and effect analysis, ISO and concepts of total quality management and six sigma, resource planning and allocation, availability and constraints of resources, resource leveling and crashing.

**Unit 4** **(8 Hrs)**

**Project Control**: Project scope, project change request, and control of schedule, resources, cost and quality, project communications, channels, means, meetings, project reports, project audits Project evaluation, project close-out reports, guidelines, audit reports, maintenance and shutdown projects, plant turn- around and brief introduction to replacement analysis.

**Unit 5** **(8 Hrs)**

**Projects:** Contour maps, sitemaps, plant layout, suitability of project site, preparation of site, selection and leasing of construction equipment special considerations in selection and location of projects, safety, health, human and environment al factors, project finance, international projects, joint ventures, collaborations, impact of culture, implementation, and handing over of projects.

**Text book:**

Kamarajuramakrishna, "essentials of project management", phi learning, new delhi, 2010.

**Reference Books:**

1. Prasannachandra, "projects - planning, analysis, selection, implementation and review", Tata Mcgraw-hill, New Delhi, 2010.
2. Chitkara, "Construction project management", Tata Mcgraw- Hill, New Delhi.
3. Harold kerzner, "Project Management", Wiley, New York.

**Course Outcomes:**

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

**CO1:** Explain the basics of project management.

**CO2:** Implement the project management concepts.

**CO3:** Apply project procurement rules.

**CO4**: Implement various project controls to real projects.

**CO5:** Prepare complete project reports.

# OPEN ELECTIVE - 4
## Six Sigma (MET-048)

**L T P: 3 0 0**

**Course Objectives**

The course will enable the students to:

- Get aware about the quality perception and learn about descriptive statistics methods.
- Learn basics of Six Sigma.
- Learn about the different methodologies and implementation of Six Sigma.
- Learn about different Six Sigma tools.
- Learn about software's used with Six Sigma.

**Particulars**

**Unit 1** **(8 Hrs)**

**Quality Perception:** Quality in Manufacturing, Quality in Service Sector; Differences between Conventional and Six Sigma concept of quality; Six Sigma success stories. Statistical foundation and methods of quality improvement.

**Descriptive statistics:** Data Type, Mean, Median, Mode, Range, Variation, Standard Deviation, Skewness, Kurtosis.

**Probability Distribution:** Normal, Binomial, Poisson Distribution.

**Unit 2** **(8 Hrs)**

**Basics of Six Sigma:** Concept of Six Sigma, Defects, DPMO, DPU, Attacks on X'S, Customer focus, Six Sigma for manufacturing, Six Sigma for service. Z score, Understanding Six Sigma organization, Leadership council, Project sponsors and champions, Master Black Belt, Black Belt, Green Belts.

**Unit 3** **(8 Hrs)**

Methodology of Six Sigma, DMAIC, DFSS, Models of Implementation of Six Sigma, Selection of Six Sigma Projects.

**Unit 4** **(8 Hrs)**

Six Sigma Tools: Project Charter, Process mapping, Measurement system analysis, Hypothesis Testing, Quality Function deployment, Failure mode effect analysis, Design of Experiments.

**Unit 5** **(8 Hrs)**

Sustenance of Six Sigma, Communication plan, Company culture, Reinforcement and control, Introduction to softwares for Six Sigma, Understanding Minitab, Graphical analysis of Minitab plots.

**Reference Books:**


1. Six Sigma: SPC and TQM in manufacturing and service, Geoff Tennant, Gower Publishing Co.
2. Six Sigma for managers, Greg Brue, TMH
3. What is Six Sigma, Pete Pande, TMH
4. The Six Sigma Way, Peter S. Pande, TMH Team Field book
5. The Six Sigma way, Peter S. Pande, TMH


**Course Outcomes**

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

**CO1**: Understand quality perception and learn about descriptive statistics methods.

**CO2**: Learn basics of six sigma.

**CO3**: Learn about the different methodologies of six sigma.

**CO4**: Apply different six sigma tools.

**CO5**: Learn software's used with six sigma.

## Project Stage - III (MEP-021)

### Course Objectives

The course should enable the students:

- To allow students to demonstrate a wide range of the skills learned during their course of study
- To encourage multidisciplinary research through the integration learned in a number of courses.
- To allow students to develop problem solving, analysis, synthesis and evaluation skills.
- To encourage teamwork.
- To improve students' communication skills by asking them to produce both a professional report and to give an oral presentation

### Course Outcomes

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

**CO1:** Demonstrate a sound technical knowledge of their selected project topic.

**CO2:** Undertake problem identification, formulation and solution.

**CO3:** Combine the theoretical and practical concepts studied in his / her academics.

**CO4:** Communicate with engineers and the community at large in written and oral forms.

**CO5:** Demonstrate the knowledge, skills and attitudes of a professional engineer.

**Annexure - II**

## List of Minor Courses offered by Mechanical Engineering Department to B.Tech. Programme

| Sl. No. | Award of Degree | Eligible Major B.Tech. Degree programmes (Discipline / Branch of Study as Prescribed by the University from time to time) for minor degree | Offering Department | Minor Degree (After successfully passing the subjects worth 20 Credits as available against each Minor) |
|---|---|---|---|---|
| 1 | "B. Tech. in branch name with Minor in ***Robotics and Automation***" | Artificial Intelligence & Machine Learning<br>Computer Science (Artificial Intelligence & Machine Learning)<br>Chemical Engineering<br>Computer Science and Engineering<br>Electrical Engineering<br>Electrical & Electronics Engineering<br>Electronics & Communication Engineering<br>Information Technology<br>Mechanical Engineering<br>Mechanical Engineering (Manufacturing Engineering)<br>Production Engineering<br>Manufacturing Engineering<br>Power Plant Engineering | **ME** | **Robotics and Automation**<br>MET-051: Mechanics of Robotics<br>MET-052: Industrial Robotics and Automation<br>MET-053: Programmable Logic Controller Applications<br>MET-054: Modeling and Design of Robots<br>MET-055: Programming for Automation and Robotics<br>MET-056: Artificial Intelligence for Robotics and Automation<br>MET-057: Industrial Pneumatics, Hydraulics, E-pneumatics |

| | | | | |
|---|---|---|---|---|
| 2 | "B. Tech. in branch name with Minor in ***Additive Manufacturing***" | Artificial Intelligence & Machine Learning<br>Computer Science (Artificial Intelligence & Machine Learning)<br>Chemical Engineering<br>Computer Science and Engineering<br>Electrical Engineering<br>Electrical & Electronics Engineering<br>Electronics & Communication Engineering<br>Information Technology<br>Mechanical Engineering<br>Mechanical Engineering (Manufacturing Engineering)<br>Production Engineering<br>Manufacturing Engineering<br>Power Plant Engineering | **ME** | **Additive Manufacturing**<br>MET-061: Additive Manufacturing Processes and Product Development<br>MET-062: Powders for Additive Manufacturing<br>MET-063: 3D Printing Machines & Systems<br>MET-064: Mechanical Behaviour and Characterization of Materials<br>MET-065: CNC and Additive Manufacturing Machines and Systems<br>MET-066: Rapid Tooling and Industrial & Medical Applications<br>MET-067: Integrated Product Design and Development |
| 3 | "B. Tech. in branch name with Minor in ***Business Administration***" | Artificial Intelligence & Machine Learning<br>Computer Science (Artificial Intelligence & Machine Learning)<br>Biotechnology<br>Bio Chemical Engineering<br>Chemical Engineering<br>Civil Engineering<br>Computer Science and Engineering<br>Electrical Engineering<br>Electrical & Electronics Engineering<br>Electronics & Communication Engineering<br>Information Technology<br>Mechanical Engineering<br>Mechanical Engineering (Manufacturing Engineering)<br>Production Engineering<br>Manufacturing Engineering<br>Power Plant Engineering | **ME** | **Business Administration**<br>MET-071: Principles of Macro and micro economics<br>MET-072: Financial Management and IPR<br>MET-073: Engineering Project Management & Quality Engineering<br>MET-074: Operations Management<br>MET-075: Organizational Behavior<br>MET-076: Introduction to Business Analytics<br>MET-077: Design for Reliability Engineering |
| 4 | "B. Tech. in branch name with Minor in ***Energy System Engineering***" | Artificial Intelligence & Machine Learning<br>Computer Science (Artificial Intelligence & Machine Learning)<br>Biotechnology | **ME** | **Energy System Engineering**<br>MET-081: Wind Energy Conversion Systems<br>MET-082: Thermodynamic Analysis of Industrial |

| | | | | |
|---|---|---|---|---|
| | | Bio Chemical Engineering<br>Chemical Engineering<br>Civil Engineering<br>Computer Science and Engineering<br>Electrical Engineering<br>Electrical & Electronics Engineering<br>Electronics & Communication Engineering<br>Information Technology<br>Mechanical Engineering<br>Mechanical Engineering (Manufacturing Engineering)<br>Production Engineering<br>Manufacturing Engineering<br>Power Plant Engineering | | Systems<br>MET-083: Conversion of Energy in Buildings<br>MET-084: Materials and Devices for Energy Conversion<br>MET-085: Solar photovoltaics: fundamentals, technology and applications<br>MET-086: Energy Resource, Environment and Economics<br>MET-087: Energy Management |
| 5 | "B. Tech. in branch name with Minor in ***Industry Operations Management***" | Artificial Intelligence & Machine Learning<br>Computer Science (Artificial Intelligence & Machine Learning)<br>Biotechnology<br>Bio Chemical Engineering<br>Chemical Engineering<br>Civil Engineering<br>Computer Science and Engineering<br>Electrical Engineering<br>Electrical & Electronics Engineering<br>Electronics & Communication Engineering<br>Information Technology<br>Mechanical Engineering<br>Mechanical Engineering (Manufacturing Engineering)<br>Production Engineering<br>Manufacturing Engineering<br>Power Plant Engineering | **ME** | **Industry Operations Management**<br>MET-091: Quality and Portfolio Management<br>MET-092: Introduction to Statistical Tools and Techniques<br>MET-093: Production Planning and Control<br>MET-094: Introduction to Industry 4.0/5.0 and Six Sigma<br>MET-095: Industrial Psychology<br>MET-096: Industrial Economics, Ergonomics & IPR<br>MET-097: Financial Mathematics |

***If required the student may opt requisite fundamental course/s for a minor specialization as audit course.**

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*(Formerly Uttarakhand Technical University, Dehradun Established by Uttarakhand State Govt. wide Act no. 415 of 2005)*
*Suddhowala, PO-Chandanwadi, Premnagar, Dehradun, Uttarakhand (Website- www.uktech.ac.in)*

# SYLLABUS

**For**

## B.TECH

## (Mechanical Engineering with Minor in Additive Manufacturing)

Effective From – Session 2023-24

# Additive Manufacturing Processes and Product Development

**L T P: 3 1 0**

**Course Objective**

- To exploit technology used in additive manufacturing.
- To understand importance of additive manufacturing in advance manufacturing process.
- To acquire knowledge, techniques and skills to select relevant additive manufacturing process.
- To explore the potential of additive manufacturing in different
- To apply 3D printing technology for additive manufacturing

**Particulars**

**Unit 1**

Overview, Basic principle need and advantages of additive manufacturing, Procedure of product development in additive manufacturing, Classification of additive manufacturing processes, Materials used in additive manufacturing, Challenges in Additive Manufacturing

**Unit 2**

**Additive Manufacturing Processes**

Z-Corporation 3D-printing, Stereo lithography apparatus (SLA), Fused deposition modeling (FDM), Laminated Object Manufacturing (LOM), Selective deposition lamination (SDL), Ultrasonic consolidation, Selective laser sintering (SLS), Laser engineered net shaping (LENS), Electron beam free form fabrication (EBFFF), Electron beam melting (EBM), Plasma transferred arc additive manufacturing (PTAAM), Tungsten inert gas additive manufacturing (TIGAM), Metal inert gas additive manufacturing (MIGAM)

**Unit 3**

**Additive Manufacturing Machines and Systems**

Axes, Linear motion guide ways, Ball screws, Motors, Bearings, Encoders/ Glass scales, Process Chamber, Safety interlocks, Sensors. Introduction to NC/CNC/DNC machine tool, CNC programming and introduction, Hardware Interpolators, Software Interpolators, Recent developments of CNC systems for additive manufacturing.

**Unit 4**

**Pre-Processing in Additive Manufacturing**

Preparation of 3D-CAD model, Reverse engineering, Reconstruction of 3D-CAD model using reverse engineering, Part orientation and support generation, STL Conversion, STL error diagnostics, Slicing and

Generation of codes for tool path, Surface preparation of materials.

**Unit 5**

**AM Data Formats**: Tessellated Models, STL Format, STL File Problems, STL File Manipulation and Repair Algorithms, AMF files, 3MF, XML, Meta Data, PLY, STEP for AM Application Protocols(AP).

**AM Data Processing**: Part orientation and Support Structure Generation, model slicing and Contour Data organization, Direct and Adaptive Slicing, Hatching Strategies and Tool Path Generation. Modeling of AM Process: Surface Roughness due to Staircase Effect, Part Build-time, Fabrication Cost, Optimal Orientation, Quantification of Building Inaccuracy and Part Stability.

**References**


1. Gibson, I, Rosen, D W., and Stucker,B., Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing,Springer, 2010
2. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010
3. Chee Kai Chua, Kah Fai Leong, 3D Printing and Additive Manufacturing: Principles and Applications: Fourth Edition of Rapid Prototyping, World Scientific Publishers, 2014
4. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003
5. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007
6. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006
7. Mahamood R.M., Laser Metal Deposition Process of Metals, Alloys, and Composite Materials, Engineering Materials and Processes, Springer International Publishing AG 2018
8. Ehsan Toyserkani, Amir Khajepour, Stephen F. Corbin, "Laser Cladding", CRC Press, 2004


**Course Outcomes**

CO1: Able to define the various process used in Additive Manufacturing

CO2: Able to analyse and select suitable process and materials used in Additive Manufacturing.

CO3: Able to identify, analyse and solve problems related to Additive Manufacturing.

CO4: Able to apply knowledge of additive manufacturing for various real life applications

CO5: Able to apply technique of CAD and reverse engineering for geometry transformation in Additive Manufacturing

# Mechanical Behavior and Characterization of Materials

**L T P: 3 1 0**

**Course Objective**

To learn about creep and fracture mechanism. Further, the course discusses the detailed analysis of fracture mechanism by learning material characterization techniques.

**Particulars**

**Unit 1**

**Introduction:** A brief review of elastic and plastic deformation, dislocations and their properties. Dislocations in FCC, BCC and HCP metals, interactions with point defects and other dislocations. Tensile behavior, evaluation of strength and ductility parameters, Effect of strain rate and temperature on tensile behavior, and Protevin Le-Chatelier effect.

**Unit 2**

**Creep:** Types and mechanisms of creep deformation, Creep under combined stresses, deformation mechanism maps, Super plasticity, environmental effects, remaining life assessment.

**Fatigue:** High and low cycle fatigue, process of fatigue fracture, effect of mean stress, Cyclic stress/strain response of materials, establishment of cyclic stress/ strain curve, transition fatigue life, Coffin-Manson relationship, Evaluation of parameters, characterizing resistance against high cycle and Low cycle fatigue, Creep fatigue interaction, environmental effects, thermochemical fatigue.

**Unit 3**

**Fracture Mechanics**: Brief review of the basic concepts of linear elastic and elastic-plastic fracture mechanics, stress intensity parameter, J- integral and crack tip opening displacement as fracture criteria, standard procedures for experimental determination of these parameters.

**Unit 4**

**Failure analysis:**Analyzing Fractures, Micro mechanisms of brittle and ductile fracture, fracture mechanism maps, fractography, Visual Examination & Management of Applied FailureAnalysis, Manage Failure Analysis.

**Unit 5**

**Materials characterization techniques:** Optical microscopy techniques, Quantitative metallography, Scanning electron microscopy: Image formation methods in SEM. Applications.

**References**


1. Mechanical Metallurgy, George E. Dieter, McGraw Hill, 2nd Edition, 2005.
2. Introduction to Fracture Mechanics, Hellan K, McGraw Hill, 2002.
3. Mechanical Behavior of Materials at Elevated Temperatures, J.E.Dorn, McGraw Hill, 2000.
4. Deformation and Fracture Mechanics of Engineering Materials, Richard W. Hertzberg, Richard P. Vinci, Jason L. Hertzberg, 5th Edition, Wiley, 2012.
5. Engineering Materials I : Introduction to Properties, Applications and Design, M.F Ashby and David R H Jones,Elsevier Science, 2011, 4th edition.
6. Mechanical behaviour of Materials, Marc Andre Meyers and Krishna Kumar Chawla, 2009.


**Course Outcomes**

At the end of the course, the student will be able to:

CO1: Understand the mechanical behavior of ductile and brittle materials

CO2: Analyze creep and fatigue for various materials

CO3: Analyze the fracture mechanisms

CO4: Develop fracture mechanism maps and analyze the reasons for failure of materials

CO5: Select a characterization technique to evaluate the behavior of materials

# CNC and Additive Manufacturing Machines and Systems

**L T P: 3 1 0**

**Course Objective**

To learn about the NC and CNC machines.

**Particulars**

**Unit 1**

**CNC Systems:** Introduction to NC/CNC/machine tools, Classification of NC like continuous and point to point, absolute and increment, Components and Types of DNC, Advantage, disadvantages of NC /CNC/DNC machine tools, Application of NC/CNC/DNC. Virtual NC system.

**Unit 2**

**Design of CNC Machine**: Constructional features of CNC machine tools, guide ways-friction, anti-friction and other type of guide ways, elements used to convert the rotary motion to a linear motion-screw and nut, recirculating ball screw, spindle assembly.

**System Drives and Devices:** CNC drive systems-spindle drive, axis motion drive, D.C and A.C servo motors, stepper motors, open and closed loop, CNC controller. Control aspects: Interpolators& Controllers.

**Unit 3**

**Part Programming:** Concept of CNC Programming, CNC axis system Manual part Programmeming format G and M codes Programs for CNC like Drilling, milling, turning etc. Computer aided part Programming (CAPP)- Introductions of CAPP, APT language: Structure, geometry, motion, postprocessor statement. Programming by interactive graphics.

**Unit 4**

**Advances in CNC Machines:** Multitasking Machines: Turn Mill, Mill Turn, Multi axis machining, Parallel Kinematic Machine Tools, Improve Machining Productivity through Dynamic Analysis and Simulation.

**Construction of Basic AM Machines**: Construction of AM Machine - Axes, Linear motion guide ways, Ball screws, Motors, Bearings, resolver, encoder- linear, rotary, feed drive, laser interferometer. Glass scales, Process Chamber, Safety interlocks, Sensors, transducer, Environmental controller for temperature, oxygen level, Humidity etc

**Unit 5**

**Energy delivery, Material delivery, Nozzle and Heating Systems**: Lasers & electron beam, Laser

scanning system and Fibre Delivery Systems, Powder feeding and Wire feeding systems, Multi-material processing, Co-axial & Lateral Nozzles.

**References**


1. Computer Control of Manufacturing Systems, - Yoram Koren McGraw Hill International, Singapore, 2006
2. Computer Numerical Control: Operation and Programming, - John Stenerson and Kelly Curran PHI, New Delhi, 2009
3. Computer Aided Manufacturing, TC Chang, RA Wysk and HP Wang - PHI, New Delhi, 2009.
4. Introduction to computer numerical control, - James .V, Valentino and Joseph Goldenberg Prentice hall, Englewood cliff, New jersey 2012. 5th edition,
5. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing",- Ian Gibson, David W Rosen, Brent Stucker Springer, 2015. 2nd Edition,
6. Rapid Prototyping: Principles & Applications",- Chua Chee Kai, Leong Kah Fai World Scientific, 2003.


**Course Outcomes**

At the end of the course, the student will be able to:

CO1: Classify NC, CNC and DNC systems with their unique features

CO2: Enumerate CNC design and drive systems

CO3: Develop manual and APT part programs for 2D complex profiles

CO4: Analyze AM machine elements/Devices

CO5: Identify energy and material delivery systems in AM.

# Rapid Tooling and Industrial & Medical Applications

**L T P: 3 1 0**

**Course Objective**

To learn about direct and indirect rapid tooling used for industrial additive manufacturing. Further, the medical application also discussed and explored.

**Particulars**

**Unit 1**

**Introduction**: Conventional Tooling, Rapid Tooling, Differences between Conventional and Rapid Tooling, Classification of Rapid Tooling: Direct and Indirect Tooling methods; Soft, Bridge (firm) and Hard Tooling methods.

**Indirect Methods for Rapid Tool Production and Rapid Bridge Tooling**: Introduction to Bridge tooling, CAFÉ Bridge tooling, Direct AIM Rapid Bridge tooling, Rapid Tool Rapid Bridge tooling, Shrinkage Variation, Random-noise Shrinkage.

**Unit 2**

**Rapid Tooling Process Modeling**: Introduction to modeling, Concurrent Rapid Product and Process Development, Finite Element Modeling and Simulation, Injection-moulding, Diecasting, Blow-moulding, Thermo-forming Processes modeling. The Express Tool Process: Introduction, High-Thermal-Conductivity Materials, Conformal Cooling Channels, The Express Tool Process, Finite-Element Analysis of Express Tools, Express Tool Process Characteristics, Case studies of Express Tools.

**Direct Soft Tooling/Firm Tooling Methods**: Role of direct soft tooling methods in tool production, SLS of Sand Casting & Copper PA Moulds, EOS Direct Croning TM Process, Direct AIM (Direct ACES TM Injection Moulds), SL Composite Tooling, 3DPTM Ceramic Shells, Topographic Shape Formation (TSF) tools.

**Unit 3**

**Indirect Soft Tooling/Firm Tooling Methods**: Role of indirect soft tooling methods in tool production, Metal Deposition Tools, Silicon rubber mould/RTV/Vacuum Casting, Epoxy tools, Spin casting with Vulcanized Rubber moulds, Castable Resin moulds, Castable Ceramic moulds, Plaster moulds, Casting (Investment/Die/Spin/Sand Castings).

**Direct Hard Tooling Methods**: Role of Direct Hard tooling methods in tool production, EOS DirectTool/ Direct Metal Laser Sintering, DTM RapidTool, LOM Tooling in Ceramic, ProMetal Rapid Tooling, Laser Engineered Net Shaping (LENS).

**Indirect Hard Tooling Methods**: Role of indirect hard tooling methods in tool production, Fusible metallic cores, 3D Keltool, Cast Aluminum and Zinc Kirksite Tooling, EDM Electrodes, Ecotool.

The Role of Rapid Tooling in Investment-Casting Applications: Introduction, Rapid Tool Making for investment Casting, Rapid tooling for developing Casting Applications, BELL Helicopter 427 Program.

**Unit 4**

**The Role of Rapid Tooling in Sand-Casting Applications**: Sand casting Process, Tool Design and Construction for Sand Casting, Sand Casting Dimensional Control, Tooling Alternative Selection Case Studies. Rapid Tooling in the Medical Device Industry: Introduction, Investment Casting and Conventional Wax Pattern Tooling, Conventional Tooling Manufacture Vs. Rapid Tooling Manufacture, Medical Case studies like Hip Stem and Knee implants.

**Rapid Tooling in the Automotive Industry**: Approaching Niche Vehicle Markets, Accelerating Product Developments, Utilizing Rapid Prototyping and Manufacturing, Machining Laminates, Rapid Prototype Stages, Subsequent Casting Operations, Rapid Tooling Developments, Case Studies. Others: The Future of Rapid Manufacturing and Case studies related to Rapid Tooling other Industrial Applications.

**Unit 5**

**3-Dimensional Data Capture and Medical Scanning Technologies**: Introduction to medical imaging, Human Anatomy, X-Ray technology, Computed Tomography (CT), Basic Components of CT, Different Types of CT Scanners, Magnetic Resonance Imaging (MRI), Ultrasound imaging, 3-D laser scanners, Industrial CT Scanners, 3D reconstruction and Reverse Engineering (RE), Image Reconstruction Procedure, Digital Communication in Medicine (DICOM) format, Types of Artifacts. **Medical Image Processing Software Systems**: Processing of medical data from CT/MRI scan to 3D model in MIMICS, 3D-Doctor, Velocity2Pro, VoXim, SurgiGuide, SimPlant Software, MIMICS software modules, Importing data, thresholding, segmentation, Editing, region growing, volume reduction, 3D Visualization, surgical simulation, Meshing, Measurement tools, Smoothing tools, STL conversion, Morphological operations, Labelling, volume, RP file generation, Practice on Medical Modelling.

**References**

1. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping & Rapid Tooling, D.T. Pham and S.S Dimov, Springer, 2001.
2. Rapid Tooling Technologies and Industrial Applications, Peter Hilton and Paul F Jacobs, Marcel Dekker Inc, New York, 2001.
3. Rapid Tooling Guidelines for Sand Casting, Wanlong Wang, Henry W. Stoll and James G. Conley, Springer, 2010.

4. Understanding Additive Manufacture: Rapid Prototyping, Rapid Tooling and Rapid Manufacture Andreas Gebhardt, Hanser Publishers, 2013.
5. Medical Modelling: The Application of Advanced Design and Rapid Prototyping Techniques in Medicine, Richard Bibb, Dominic Eggbeer and Abby Paterson, Woodhead publishing, 2017.
6. Advanced Manufacturing Technology for Medical Applications, Ian Gibson, John Wiley, 2005.

**Course Outcomes**

At the end of the course, the student will be able to:

CO1: Understand the working principle and process parameters of rapid tooling methods

CO2: Identify the errors during development of tool and select suitable compensatory methods

CO3: Apply suitable tooling methods for any given industrial application

CO4: Design appropriate rapid tools for any given medical and automobile applications

CO5: Apply the concepts of medical imaging and 3D scanning for accurate 3D model re-construction

# Integrated Product Design and Development

**L T P: 3 1 0**

**Course Objective**

To learn about product design and development.

**Particulars**

**Unit 1**

**Introduction:** Product Development and Design Theories-History, Road map to Engineering Design Process-stages, Technology insertion, Organization for design and product development, Business strategies, Working in teams, Assignment of course project.

**Unit 2**

**Problem definition:** Need Identification, Kano diagram, Establishing Engineering Characteristics, Quality Function Deployment (QFD)-, Product Design Specification (PDS), information sources.

**Unit 3**

**Concept Generation and improvement**: Creative methods for design, Functional decomposition and synthesis, Morphological methods, Theory of Inventive Problem solving (TRIZ), Axiomatic Design (AD).

**Unit 4**

**Embodiment Design:** Product Architecture, Configuration and Parametric design Concepts, Ergonomics and Design for Environment, and detailed design, Course project reviews.

**Unit 5**

**Ethical Issues and Team Management:** Ethical issues considered during Engineering design process, Contracts-Breach and discharge, product liability, Precautions by designer to avoid product liability.

**References**

1. Engineering Design, George E Dieter, Publisher, McGraw Hill, 2012, 4th edition
2. Kevin N. Otto, Kristin L. Wood, “Product Design”, Pearson Education, 2004.
3. W. Ernest Eder, S. Hosendl., “Design Engineering”, CRC Press, 2008.

**Course Outcomes**

At the end of the course, the student will be able to:

CO1: Apply product design strategies for the development of innovative products

CO2: Develop new product models by applying the concepts of product design theory and robust design.

CO3: Apply embodiment principles in product development process.

CO4: Develop products by considering the social, environmental and ethical concerns.

# Powders for Additive Manufacturing

**L T P: 3 1 0**

**Course Objective**

To learn about processing and characterization of powders for additive manufacturing.

**Particulars**

**Unit 1**

**General Concepts**: Introduction and History of Powder Metallurgy and powders for additive manufacturing.

**Powder Production Techniques**: Different Mechanical and Chemical methods, Atomisation of Powder, other emerging processes, Performance Evaluation of different Processes, processing of metal powders, production and qualification of polymer powders.

**Unit 2**

**Characterization Techniques**: Particle Size & Shape Distribution, Electron Microscopy of Powder, Inter particle Friction, Compression ability, Powder Structure, Chemical Characterization **Microstructure Control in Powder**: Importance of Microstructure Study, Microstructures of Powder by Different techniques

**Unit 3**

**Powder Shaping**: Particle Packing Modifications, Lubricants & Binders, Powder Compaction & Process Variables, Pressure & Density Distribution during Compaction, isostatic Pressing, Injection Molding, Powder Extrusion, Slip Casting, Tape Casting, Analysis of Defects of Powder Compac**t.**

**Unit 4**

**Metal powders in additive manufacturing**: powders for direct energy deposition, powder for powder bed fusion process, requirements for powders used in additive manufacturing, handling of metal powders.

**Unit 5**

**Sintering**: Theory of Sintering, Sintering of Single & Mixed Phase Powder, Liquid Phase Sintering, Sintering Variables, Modern Sintering Techniques, Physical & Mechanical Properties Evaluation, Structure-Property Correlation Study, Modern Sintering techniques, Defects Analysis of Sintered Components. Application of Powder metallurgy parts, Additive manufactured parts and A few case studies.

**References**


1. Powder Metallurgy Technology, G. S Upadhyaya, Cambridge International Science Publishing, 2002. 2nd Edition.
2. Powder Metallurgy Science, Technology and Materials, Anish Upadhyaya, Gopal Shankar Upadhyaya, Taylor & Francis Group, 2018.
3. Powder Metallurgy- Science, Technology and Applications, P. C. Angelo and R. Subramanian, PHI, New Delhi, 2008.
4. Introduction to Powder Metallurgy, J. S. Hirschhorn, American Powder Metallurgy Institute, Princeton, NJ, 1976.
5. ASM Hand Book, vol. 7: Powder Metallurgy, ASM International
6. Advances in Powder Metallurgy: Properties, Processing and Applications, Isaac Chang, Yuyuan Zhao, Woodhead Publishing Series in Metals and Surface Engineering, Elsevier, 2013.
7. Powder Metallurgy, S. A. Tsukerman, Pergamon publishing, 1965, 1st Edition.


**Course Outcomes**

At the end of the course, the student will be able to:

CO1: Propose manufacturing techniques to produce powders for additive manufacturing applications

CO2: Characterize powders developed from different manufacturing processes

CO3: Identify appropriate compaction techniques to densify powder preforms

CO4: Analyse the sintering mechanism of powder compacts

CO5: Propose methods to develop mechanical components through additive manufacturing techniques

# 3D Printing Machines & Systems

**L T P: 3 1 0**

**Course Objective**

• To understand the construction of basic 3D Printing machines

• To understand the Energy delivery, Material delivery, Nozzle and Heating Systems

• To know the Optical & Optoelectronic components in 3D Printing

• To know the environmental control systems

• To understand the Pre-processing & Post processing techniques in 3D printing

**Particulars**

**Unit 1**

Introduction to 3D Printing Machines: Historical Perspectives, Rapid Prototyping - An Integral Part of Time Compression Engineering, RP Information Workflow. Rapid Prototyping Processes: Classification of Rapid Prototyping Processes, Processes Involving a Liquid - Solidification of a Liquid Polymer, Solidification of an Electroset Fluid: Electrosetting (ES), Solidification of Molten Material, Processes Involving Discrete Particles, Processes Involving Solid Sheets.

**Unit 2**

RAPID PROTOTYPING SYSTEMS Stereolithography Apparatus, Solid Ground Curing Systems, Fused Deposition Modelling Systems, Selective Laser Sintering Systems, Laminated Object Manufacturing Systems, Paper Lamination Technology Laser Engineering Net Shaping Systems.

**Unit 3**

TECHNICAL, TECHNOLOGICAL CAPABILITIES & APPLICATIONS OF RAPID PROTOTYPING TECHNOLOGY Technical Characteristics and Technological Capabilities of Concept: Modellers, 3D Systems ThermoJet™ Printer, Sanders Model Maker II, Z-Corporation Z402 3D Printer, StratasysGenisysXs 3D Printer, JP System, Object Quadra System Applications of Rapid Prototyping Technology: Functional Models, Pattern for Investment and Vacuum Casting, Medical Models, Art Models, Engineering Analysis Models.

**Unit 4**

INDIRECT & DIRECT METHODS FOR RAPID TOOL PRODUCTION Indirect Methods for Rapid Tool Production: Role of Indirect Methods in Tool Production, Metal Deposition Tools, RTV Tools, Epoxy Tools, Ceramic Tools, Cast Metal Tools, Investment Casting, Fusible Metallic Core, Sand Casting, Keltool Process. Direct Methods for Rapid Tool Production: Classification of Direct Rapid Tool Methods, Direct ACESTM Injection Moulds, Laminated Object Manufactured Tools, DTM RapidToo1 Process,

SandForm EOS DirectTool Process, Direct Metal Tooling using 3Dp, Topographic Shape Formation.

**Unit 5**

APPLICATIONS OF RAPID TOOLING TECHNOLOGY & PROCESS OPTIMISATION Insert Design, Insert Finishing, Rapid Tooling Inserts Wear Resistance, Case Studies. RPT Optimisation - Factors Influencing Accuracy - Data Preparation, Errors due to Tessellation, Errors due to Slicing, Part Building, Part Building Errors in the SL Process, Part Building Errors in the SLS Process, Part Finishing, Selection of Part Build Orientation, Orientation Constraints of the SL Process, Orientation Constraints of the SLS Process.

**References**

1. D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Prototyping and Rapid Tooling
2. Springer Science & Business Media Applications of Rapid , 2012.
3. Chee Kai Chua, Kah Fai Leong, 3D Printing and Additive Manufacturing: Principles and Applications: Fourth Edition of Rapid Prototyping
4. Andreas Gebhardt, Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing , Hanser
5. Peter Hilton & Paul Publications, 2012 Jacobs, Rapid Tooling: Technologies and Industrial Applications 2000

**Course Outcomes**

At the end of the course, the student will be able to:

CO1: Understand the construction of basic 3D Printing machines

CO2: Understand the Energy delivery, Material delivery, Nozzle and Heating Systems

CO3: Know the Optical & Optoelectronic components in 3D Printing

CO4: Know the environmental control systems

CO5: Understand the Pre-processing & Post processing techniques in 3D printing

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# SYLLABUS

**For**

## B.TECH.

## (Mechanical Engineering with Minor in Business Administration)

Effective from – Session 2023-24

# Principles of Macro and Micro Economics

**L T P: 3 1 0**

**Course Objective**

- To introduce students to the main analytical tools which are used in economic analysis.
- To introduce students to the main conclusions derived from economic analysis, and develop their understanding of their organizational and policy implications.
- To enable students to understand and participate in debates on economic matters, choosing proper frameworks of economic analysis for specific cases.

**Particulars**

**Unit 1**

**Economics, the economy and tools of economic analysis:**Scarcity. Rationality. The production possibility frontier and opportunity cost. Absolute and comparative advantage. Markets. Microeconomics and macroeconomics. Positive and normative economics. Models and theory.

**Consumer choice:** Preferences, indifference curves and utility function. Utility maximisation and choice. Consumer choice and demand. Comparative statics: income and price changes. Substitution and income effects. The individual demand and elasticity. Complements and substitutes. Cash transfers versus transfers in kind. Inverse demand curve and consumer's surplus.

**The firm:** Firm's objective. Production function, returns to scale, the law of diminishing marginal returns. Cost minimization: isoquants and iso-cost lines. Costs in the short run and in the long run. Firm's decision in the short run. Firm's decision in the long run.

**Unit 2**

**Perfect competition:**Market supply in the short-run. Market demand. Equilibrium in the short run. Entry and exit, short-run and long-run equilibrium. Comparative statics. Equilibrium and Efficiency.

**Monopoly:** Pure monopoly. Natural monopoly. Social cost of monopoly. Regulation of natural monopoly.

**Market structure and imperfect competition:**Monopolistic competition. Basic concepts of game theory. Oligopoly: Cournot duopoly, Bertrand model, Stackelberg model. Strategic entry deterrence.

**Inputs to production:** the labour market. Utility - maximization and the supply of labour. Profit maximization and the demand for labour. Economic rent. Monopsony. Factors affecting labour market equilibrium (unions, minimum wages and others).

**Unit 3**

**General equilibrium and welfare economics:** Exchange economy and Edgeworth box. General

equilibrium. Efficiency in exchange economy. Equilibrium and efficiency: welfare theorems. Equity and efficiency. Market failures: the problem of externalities and possible solutions.

Missing markets and the role of government.

**Market failures:** the problem of externalities and possible solutions. Coase theorem. Government interventions, public goods, taxation; Income distribution, the Gini coefficient and Lorenz curves.

**Introduction to Macroeconomics:** The problem of aggregation, the circular flow of income, leakages and injections, national income accounting, real and nominal gross domestic product (GDP).

Output and aggregate demand: Keynesian cross model.

Actual and potential output, consumption, investment, income determination, equilibrium, the multiplier, the paradox of thrift, consumption and taxation, the government budget, automatic stabilizers (the financing of government), the multiplier and taxation, the role of fiscal policy, imports and exports, the multiplier in an open economy.

**Unit 4**

**Money and banking:** The role of money, real balances, the liquidity preference approach and the demand for money (liquid assets), commercial banks and the supply of money (banks and the various multipliers), central banks and monetary control, equilibrium in the money market.

**Monetary and fiscal policy in the short-run:** Goods market equilibrium and IS curve, equilibrium in the money market and LM curve, the IS-LM model, monetary and fiscal policies in a closed economy.

**Aggregate demand and aggregate supply:** Keynesian and classical assumptions regarding wages and prices, aggregate supply in the long run and the short run, the effects of exogenous demand and supply shocks.

**Inflation:** Inflation targeting, the Taylor rule, the quantity theory of money, the Phillips curve in the long-run and the short-run, stagflation and the role of expectations, costs of inflation.

**Unemployment:** Types of unemployment, voluntary and involuntary unemployment, causes of unemployment, private and social costs, hysteresis.

**Unit 5**

**Open economy macroeconomics:**

The foreign currency market, exchange rate regimes, the balance of payments, capital mobility, the rate of interest and the price of foreign currency. The effects of fiscal and monetary policies under fixed and floating exchange rates with and without capital mobility.

Supply-side economics and economic growth.

Growth in potential output, the steady state, technological progress, capital accumulation, convergence,

endogenous growth, policies to promote growth

**References**

1. Blanchard, O., Amighini, A., &Giavazzi, F. (2013). Macroeconomics: A European Perspective (Vol. 2nd ed). Harlow: Pearson.
2. Intermediate microeconomics : a modern approach, Varian, H. R., 1999
3. Lipsey, R., & Chrystal, A. (2015). Economics. Oxford University Press
4. Mankiw, N. G. (DE-588)120973626, (DE-576)164048383. (2000). Macroeconomics / N. Gregory Mankiw. New York
5. Case, Karl E. & Ray C. Fair, Principles of Economics, Pearson Education, 8th edition, 2007.

**Course Outcomes**

At the end of the course, the student will be able to:

CO1: Students will be able to define the main concepts and describe the models and methods used in economic analysis.

CO2: Students will be able to formulate real-world issues in the language of economic concepts and models.

CO3: Students will be able to apply and use economic concepts and models to analyze real-world issues.

CO4: Students will be able to assess the potential and limitations of the models and methods used in economic analysis.

# Financial Management and IPR

**L T P: 3 1 0**

**Course Objective**

To learn about the financial aspects for managers and about intellectual property rights.

**Particulars**

**Unit 1**

Financial management-an overview, Financial decisions in the firms, the fundamental principles of finance, goals of financial management, building blocks of modern finance.

Risk-return trade off, Organization of finance functions, Emerging role of financial managers' in India, Over view of financial statements – Income statement, Balance Sheet, Cash flow statement, Analysis of financial statements

Financial Planning & forecasting, Tools & techniques of Financial Planning & Forecasting, Sources of finance. Time Value of Money, Future value of a single amount, Present value of a single amount, Future value of Annuity, Present value of Annuity & Perpetuity

**Unit 2**

Capital Budgeting –Concept and overview, Capital budgeting process, Project classification, Techniques of capital budgeting, Investment criteria

Net present value, internal rate of return, Modified Internal rate of return, Benefit cost ratio, Payback period method

**Unit 3**

Accounting rate of return, Investment appraisal in practice, Estimation of project cash flows – overview, Estimation of project cash flows-tools & techniques, Estimation of project cash flows-tools & techniques

Accounting rate of return, Investment appraisal in practice, Estimation of project cash flows – overview, Estimation of project cash flows-tools & techniques, Estimation of project cash flows-tools & techniques

Break-even analysis, some other models and tools of risk analysis, Project selection under risk, cost of Capital-Overview, Cost of debt & preference capital.

**Unit 4**

Cost of equity, Determining the proportions, WACC, WA Marginal cost of capital, Determining the optimum capital budget

Capital structure of firms-An overview, Net income approach, Net operating income approach, Traditional proposition, MM Proposition

Dividend decisions-An overview, Relevance of dividend, Dividend policy formulation, Dimensions of

divined policy, Legal & procedural aspects of dividend decisions

**Unit 5**

Introduction to IPR: Meaning of property, Origin, Nature, Meaning of Intellectual Property Rights, Kinds of Intellectual property rights—Copy Right, Patent, Trade Mark, Trade Secret and trade dress, Design, Layout Design, Geographical Indication, Plant Varieties and Traditional Knowledge.

Patent Rights and Copy Rights— Origin, Meaning of Patent, Types, Inventions which are not patentable, Registration Procedure, Rights and Duties of Patentee, Assignment and licence, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties. Definition &Types of Copy Right, Registration procedure, Assignment &licence, Terms of Copy Right, Piracy, Infringement, Remedies, Copy rights with special reference to software.

**References**


1. Foundations of Financial Management 11th Edition Stanley Block & Geoffrey Hirt Published by McGraw Hill ISBN: 0072842296
2. P.Vijaya Kumar, M.Madana Mohan, G. SyamalaRao:“Financial Management”, Himalaya Publishing House, New Delhi,20130.
3. Rajiv Srivastava, Anil Misra: “Financial Management”, Oxford University Press, New Delhi,2012
4. Brigham,E.F: “Financial Management Theory and Practice”, Cengae Learning, New Delhi, 2013
5. Prasanna Chandra: “Financial Management Theory and Practice”, Tata McGrawHill 2011.
6. I.M. Pandey: “Financial Management”, Vikas Publishers, New Delhi, 2013.
7. RM Srivastava, Financial Management, Himalaya Publishing house, 4th edition.
8. Khan and Jain: Financial Management, Tata McGraw Hill, New Delhi,
9. Intellectual Property Rights and the Law, Gogia Law Agency, by Dr. G.B. Reddy
10. Law relating to Intellectual Property, Universal Law Publishing Co, by Dr. B.L.Wadehra
11. IPR by P. Narayanan
12. Law of Intellectual Property, Asian Law House, Dr.S.R. Myneni.


**Course Outcomes**

At the end of the course, the student will be able to:

CO1: Understand financial planning and forecasting

CO2: Analyse capital budgeting

CO3: Analyse Break Even Analysis

CO4: Understand capital structure of a firm

CO5: Understand the fundamentals of IPR

# Engineering Project Management & Quality Engineering

**L T P: 3 1 0**

**Course Objective**

To learn about the aspect of project management and quality engineering tools.

**Particulars**

**Unit 1**

Importance of Project management: About the Art and Science of Project Management, Project and process, Project and Project Management, Project Management-The Process Context, The Interpersonal and Behavioral Context, Project Management: The Organizational Context. Types of Project. Role of Project Manager -Skill Requirements, Responsibilities and Functional Competencies of the Project Manager, Common Challenges, the value of Introspection and Self-Awareness

Defining a Project - selection, definition, goal. Project Life-cycle model, Project team and stakeholders, Organizational influences, Project management processes and mapping, Project Process flow diagrams, Project idea generation and acceptance. Project analysis and feasibility report. Project Scope: definition and planning, Project Breakdown Structure (WBS).

**Unit 2**

Project Plan- Planning and Scheduling techniques, Resource Scheduling: Resource allocation method, splitting and multitasking, Multi-project resources scheduling, Critical chain scheduling. Project integration management, PERT/CPM and overview of other scheduling methods. Performance measurement and control. Project monitoring and Control.

**Unit 3**

Project Time management, project activity- its definition, sequencing, resource and duration estimation, schedule development and control, Project cost estimation, budget and control. Project risk management. Human resource management- Human aspects of Project Management, Human resource planning, acquire, develop and manage project team and stakeholders, performance reporting.

**Unit 4**

Principle and practices of Quality engineering: Basic definition of quality, new and old culture, dimensions of quality, Deming's philosophy. Quality of leadership: Leadership concept and characteristics, quality council, core value and concept, vision and mission statement, strategic planning. Customer satisfaction: Introduction, customer supplier chain, feedback, translating needs into requirements, customer retention. Involvement of employee: Maslow's Hierarchy of Needs, Herzberg's Two Factor Theory, Employee wants, Empowerment, characteristics of a successful team, recognition

and reward, benefits from employee involvement. Continuous process improvement: Introduction, Input/ out process model, Juran Triology, Plan-Do-Study-Act (PDSA) cycle, Problem solving method. Supplier Partnership: Introduction, Supplier selection, principle of customer/supplier relations, supplier selection, rating and certification, Relationship development. Performance evaluation: Basic concepts,
Quality cost, Cost categories, Optimum cost, Quality cost analysis, Reporting, Quality improvement strategy, Malcolm Baldrige National Quality Award.

**Unit 5**

Statistical process control (SPC): Histogram, Pareto Analysis, Process flow diagram, Cause and effect diagram, check sheet, statistical fundamental, X and R chart, Chart for attributes, scatter diagram. ISO9000& 14000: Introduction, ISO 9000 series standards, elements of ISO/QS 9000, steps to implement quality systems, ISO 14000 series standards, concepts and requirement of ISO 14001, EMS benefits. Benchmarking: Definition, reasons for benchmarking, what to benchmark, planning, studying others, Pitfalls and Criticisms of benchmarking. Quality function deployment: Introduction, benefits of QFD, the voice of the customer, affinity diagram, Building of a house of quality, QFD process. Taguchi's quality engineering: Taguchi's loss function, step and quadratic function, signal- to- noise (S/N) ratio, Orthogonal Array. Liability of products: Introduction, product safety law, product liability law, proof and expert witness, financial loss, future of product liability. Failure mode and effect analysis (FMEA): Introduction, Reliability and its requirement, failure rate, intent of FMEA, FMEA documentation, Stages of FMEA, Design of FMEA document. Management tools: Introduction, forced field analysis, interrelationship digraph.

**References**

1. Heerkens, G. R. Project Management, McGraw-Hill, 2nd edition, 2013.
2. Gray, C. F., Larson, E. W. and Desai G. V. Project Management -The Managerial Process. McGraw Hill Education Private Limited, New Delhi, 4th edition, 2010.
3. Chandra, P. Project Preparation, Appraisal and Implementation. Tata McGraw Hill Publishing Company, New Delhi, 7th edition, 2009.
4. Burke, Rory. Project management - Planning and Control Techniques. John Wiley & Sons, Inc., 5th edition, 2013.
5. Lientz, B. P. and Rea, K. P. Project Management – for 21st Century, Academic Press, 4th edition, 1995.
6. Maylor, H. Project Management. Pearson Education Limited. New Delhi, 3rd edition, 2003.

7. Krishnamoorthi, K.S. and Krishnamoorthi V.R. A First Course on Quality Engineering: Integrating Statistical and Management Methods of Quality (CRC press, Taylor and Francis, 2011).
8. Besterfield, D.H., Besterfield-Michna, C., Besterfiled, G.H., Besterfiled-Sacre, M., Urdhwareshe, H. and Urdhwareshe, R. Total Quality Management, 3/e (Pearson Education Asia, 2011). 3. Pham, H. Recent Advances in Reliability and Quality Engineering (World Scientific, 2001).

**Course Outcomes:**

At the end of the course, the student will be able to:

CO1: Learn about the basics and importance of project management.

CO2: Learn how to plan, schedule, monitor and control a project.

CO2: Learn about project time management concepts.

CO4: Learn about the Principle and practices of Quality engineering.

CO5: Learn to use statistical quality control techniques.

# Organizational Behavior

**L T P: 3 1 0**

**Course Objective**

- To help the students to develop cognizance of the importance of human behaviour.
- To enable students to describe how people behave under different conditions and understand why people behave as they do action.
- To provide the students to analyse specific strategic human resources demands for future
- To enable students to synthesize related information and evaluate options for the most logical and optimal solution such that they would be able to predict and control human behaviour and improve results.

**Particulars**

**Unit 1**

Focus and Purpose: Definition, need and importance of organizational behavior, Nature and scope, Frame work, OB model

**Unit 2**

Individual Behaviour: Attitudes: Characteristics, Components, Formation, Measurement, barriers to change attitude. Perception: Meaning and concept of perception, factors influencing perception, Motivation: Importance, Types, Theories of Motivation, Effects on work behaviour. Personality and value: Types, Factors influencing personality, Theories, Learning, Types of learners, The learning process, Learning theories, Organizational behaviour modification. Misbehaviour: Types, Management Intervention. Emotions: Emotional Labour, Emotional Intelligence, Theories. Impression management, Individual decision making techniques

**Unit 3**

Group Behaviour: Organization structure, Formation, Groups in organizations, Influence, Group dynamics, Group decision making techniques, Team building, Communication, Control, Johari Window

**Unit 4**

Leadership and Power: Meaning, Importance, Leadership styles, Behavioural Theories, Fiedler model, LMX theory and Path Goal theory, Leaders vs Managers, Sources of power, Power centers, Power and Politics.

**Unit 5**

Dynamics of Organizational Behaviour: Organizational culture and climate, Factors affecting organizational climate, Importance, Job satisfaction, Determinants, Measurements, Influence on

behaviour, Stress, Work Stressors, Prevention and Management of stress, Balancing work and Life, Kurt Lewin's–three step model, methods for implementing organizational change.

**References**


1. Stephen P. Robins, Organizational Behavior, / Pearson Education
2. UdaiPareek, Understanding Organizational Behaviour, Oxford Higher Education
3. Margi Parikh and Rajan Gupta, Organizational Behaviour, McGraw Hill Education
4. Fred Luthans, Organizational Behavior, McGraw Hill
5. Schermerhorn, Hunt and Osborn, Organizational behavior, John Wiley
6. Mc Shane & Von Glinov, Organizational Behaviour, McGraw Hill
7. Hellrigal, Slocum and Woodman, Organizational Behavior, Cengage Learning
8. Ivancevich, Konopaske&Maheson, Organizational Behaviour& Management, McGraw Hill


**Course Outcomes**

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

CO1: Understand various methods and terms used different organizational behaviour model.

CO2: Understand individual behaviour like attitude, perception, motivation, personality, misbehaviour and emotions.

CO3: Understand group behaviour, leadership and power.

CO4: Understand dynamics of organizational behaviour and managing change.

# Design for Reliability Engineering

**L T P: 3 1 0**

**Course Objective**

This course teaches the fundamental knowledge and skills of reliability as it pertains to the design, manufacturing, and use of engineered products and systems.

**Particulars**

**Unit 1**

Reliability engineering in the twenty-first century – what is important and what is very important. Reliability and life distributions for reliability analysis. Confidence interval concepts, System reliability modelling, Software for reliability data analysis – e.g. Weibull++ and Block Sim.

**Unit 2**

Product requirements, constrains, and specifications, How to meet reliability objectives, Reliability capability, Parts selection and control and process capability, Design of experiments Life cycle conditions, Health monitoring and prognostics

**Unit 3**

Failure modes, mechanisms, and effects analysis, Product screening and burn-in, Fault tree analysis (FTA) and common mode failures, Physics of failure based reliability assessment, Analyzing product failures and root causes

**Unit 4**

Product qualification and accelerated testing, Software for test data analysis, Sustainment – logistics, spares, maintenance, and contracts, Concept of availability and maintainability, Life cycle costing based on reliability and maintainability principles, Probabilistic design for reliability and factor of safety.

**Unit 5**

Derating and uprating Change and change notification, Data driven (machine learning) reliability prediction methods, Warranty planning and analysis

**References**

1- Kailash C. Kapur and Michael Pecht, “Reliability Engineering”, Wiley Series in Systems Engineering and Management, John Wiley & Sons, New York, NY, 2014. ISBN: 9781118140673. Other References

2- Patrick P. O’Connor and Andre Kleyner, “Practical Reliability Engineering,” 5th Edition, John Wiley & Sons, New York, NY, 2012.

3- Charles E. Ebeling, "An Introduction to Reliability and Maintainability Engineering, Waveland Press, Inc., Illinois, IL, Third Edition, 2019, ISBN: 9781478637349.
4- Wayne B. Nelson, "Applied Life Data Analysis," John Wiley & Sons New York, NY, 1982.
5- E. E. Lewis, "Introduction to Reliability Engineering," 2nd Edition, John Wiley & Sons, New York, NY, 1996.

**Course Outcomes**

1- At the end of this course, students will be able to:
2- CO1: Assess the suitability of the supply chain members to contribute the development, manufacturing, distribution, and support of reliable products.
3- CO2: Understand process capability and process control.
4- CO3: Apply design and analysis tools such as failure modes, mechanisms, and effects analysis; fault tree analysis; design of experiment; and others.
5- CO4: Analyze degradation, failure, and warranty return data to estimate fundamental reliability parameters.
6- CO5: Implement derating, uprating, reliability prediction, and reliability allocation, Plan and implement product testing to assess and achieve reliability.

# Introduction to Business Analytics

**L T P: 3 1 0**

**Course Objective**

Business Analysis for Engineers provides an opportunity for engineering students to understand the language of business both in financial and strategic dimensions. At the end of the course, a student will be able to gain knowledge on basic concepts of accounting & costing, introductory economics, various corporate strategy tools and organizational behaviour.

**Particulars**

**Unit 1**

Introduction to Economy, Macro and Microeconomics fundamentals, Demand & Supply, Pricing Types of Markets Macro/Micro economic indicators, Indian Budget – Overview

**Unit 2**

Introduction to Costing, Introduction to financial statements, Fundamental Accounting concepts – Dual entry concept and other accounting entries, Preparation of financial statements – B/S, I/S and Cash Flow Analysis of financial statements, Types of costs – Economies of scale – Variances, Need for cost competitiveness – case studies for discussions.

**Unit 3**

Business and Organization, Business functions, Role of each function Organizations – Organizational structures, Types of organizations, Issues in handling complexities

**Unit 4**

Introduction to Strategy,what is strategy? Need for Strategy, Vision and Mission Porter's Diamond framework, Porter's 5–forces McKinsey's 7S Model, BCG Matrix, Value chain analysis, Case studies and discussions

**Unit 5**

Exploring Data and Analytics on Spreadsheets, Descriptive Analytics, Inferential Analytics

**References**

1. Accounting Principles – Robert Anthony & James Reece, IR WIN, 2001
2. Competitive Strategy – Techniques for Analysing Industries and Competitors Michael E Porter, Free Press.
3. Competitive Advantage of Nations – Michael E. Porter, Free Press
4. Economics & Public Policy – Romulo Neri, AIM Publications, 2001.

**Course Outcomes**

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

CO1: Be familiar with economy, macro and micro economics, Indian budget etc.

CO2: Learn and understand the concepts of Costing, financial statements, fundamental accounting etc.

CO3:Be familiar about organization functions, structures and types etc.

CO4: Get introduced to strategy, its need and relevant case studies.

CO5: Understand the concepts of Descriptive and Inferential Analytics.

# Operations Management

**L T P: 3 1 0**

**Course Objective**

- Understand the fundamental, practical science of Operations Management
- Explore the interface between operations and other business functions
- Examine how these principles operations management can be employed in both tactical and strategic decision making in firms
- Develop ability to analyze and address problem related to the design, planning, control, and improvements of manufacturing and service operations
- To provide a set of foundational skills useful for more advanced courses in Operations

**Particulars**

**Unit 1**

Historical Evolution Operations as a source of competitive Advantage Operations Management Definition Interface with other management functions Link Between Operations and Finance Productivity and Productivity Measures

**Unit 2**

Operations Strategy NPD Strategic Capacity Management Project Management

**Unit 3**

Process selection Product-process matrix Process mapping Throughput Time, Cycle time Little's Law Waiting Lines, Queuing Theory Process Simulation

Capacity Analysis Overall Equipment Effectiveness Bottleneck analysis Basic Layouts and their designing

**Unit 4**

Process Improvement Quality Management Evolution of Quality Management and Contribution of quality Gurus Six Sigma, SQC, SPC Systematic Problem Solving Methodology Lean Operations

**Unit 5**

Single period, Multi-period models Quantity DiscountsSales& Operations Planning Process Aggregate Planning CRP, MRP, ERP Scheduling, TOC

**References**

1. Chase, R.B., Ravi Shankar & Jacobs, F.R. (2018), Operations & Supply Management. 15th Edition, McGraw Hill

2. Ravi Anupindi, Sunil Chopra et al (2013) Managing Business Process Flows: Principles of Operations Management, Pearson
3. Edward Pound, Jeffrey Bell, Mark Spearman(2014) Factory Physics for Managers_ How Leaders Improve Performance in a Post-Lean Six Sigma World-McGraw-Hill Education
4. Russell & Taylor, Operations Management along Supply Chain, Wiley
5. Slack N, Chambers S, Johnston R (2010) Operations management 6th ed_ Prentice Hall
6. Krajewski, Lee J and Ritzman, Larry P., Operations Management: Processes and Value Chains, Pearson

**Course Outcomes**

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

CO1: Appreciate Operations management processes and address the questions that an organization faces in its choice of products, manufacturing technology, utilization of capacity, management of quality, costing, sourcing etc.

CO2: Develop intuitive understanding of various principles of Operation Management

CO3: Lays the foundation for their career in designing and managing business processes besides developing insights about strategic and tactical aspects of operations.

CO4: Become familiar with spreadsheets, optimization solvers, and discrete event simulation tools.

**VEER MADHO SINGH BHANDARI UTTARAKHANDTECHNICALUNIVERSITY**

*(Formerly Uttarakhand Technical University, Dehradun Established by Uttarakhand State Govt. wide Act no. 415 of 2005)*
*Suddhowala, PO-Chandanwadi, Premnagar, Dehradun, Uttarakhand (Website- www.uktech.ac.in)*

# SYLLABUS

**For**

## B.TECH

## (Mechanical Engineering with Minor in Energy System Engineering)

Effective from – Session 2023-24

# Wind Energy Conversion Systems

**L T P: 3 1 0**

**Course Objective**

- To learn the design and control principles of Wind turbine.
- To understand the concepts of fixed speed and variable speed, wind energy conversion systems.
- To analyze the grid integration issues.

**Unit 1**

**Introduction**: Components of WECS-WECS schemes, Power obtained from wind, simple momentum theory, Power coefficient-Sabinin's theory, Aerodynamics of Wind turbine.

**Unit 2**

**Wind Turbines:** HAWT, VAWT, Power developed, Thrust, Efficiency, Rotor selection, Rotor design considerations, Tip speed ratio, No. of Blades, Blade profile, Power Regulation, yaw control, Pitch angle control, stall control, Schemes for maximum power extraction.

**Unit 3**

**Fixed Speed Systems:**Generating Systems, Constant speed constant frequency systems, Choice of Generators, Deciding Factors, Synchronous Generator, Squirrel Cage Induction Generator,Model of Wind Speed, Model wind turbine rotor, Drive Train model, Generator model for Steady state and Transient stability analysis.

**Unit 4**

**Variable Speed Systems:** Need of variable speed systems, Power-wind speed characteristics, Variable speed constant frequency systems synchronous generator, DFIG, PMSG, Variable speed generators modeling, Variable speedvariable frequency schemes.

**Unit 5**

**Grid Connected Systems**: Wind interconnection requirements, low, voltage ride through (LVRT), ramp rate limitations, and supply of ancillary services for frequency and voltage control, current practices and industry trends wind interconnection impact on steady-state and dynamic performance of the power system includingmodeling issue.

**References**

1. L.L.Freris "Wind Energy conversion Systems", Prentice Hall, 1990
2. S.N.Bhadra, D.Kastha,S.Banerjee,"Wind Electrical Sytems",Oxford University Press,2010.
3. Ion Boldea, "Variable speed generators", Taylor & Francis group, 2006.
4. E.W.Golding "The generation of Electricity by wind power", Redwood burn Ltd.,

Trowbridge,1976.

5. N. Jenkins," Wind Energy Technology" John Wiley & Sons,1997

6. S.Heir "Grid Integration of WECS", Wiley 1998.

**Course Outcomes**

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

CO1: Learn the design and control principles of Wind turbine.

CO2: Understand the concepts of fixed speed and variable speed.

CO3: Understand wind energy conversion systems.

CO4: Analyze the grid integration issues.

# Thermodynamic Analysis of Industrial Systems

**L T P: 3 1 0**

**Course Objective**

The objective this course is to provide an insight of fundamentals and salient features of major energy conversion systems using the concepts of Thermal Engineering.

**Particulars**

**Unit-1**

Steam power cycles: Steam Power plant and its components, site selection, Carnot Vapour Power Cycle, Rankine cycle, Rankine Cycle with Reheat, Superheat, and Regeneration, Plant efficiency, Cogeneration.

**Unit-2**

Gas Turbines: Gas turbine plant and its components, Brayton cycle, Classification, Analysis of Closed and Open cycle Gas Turbine plants, Methods of improving performance, Intercooler, Regeneration and Reheating, Applications.

**Unit-3**

Internal Combustion Engines: Basic components and nomenclature, Classification, working principles of 2-stroke & 4-stroke SI and CI, Engines, Air-standard and Real cycles, Fuels, Stoichiometric Air-Fuel ratio, Combustion: Detonation and Knocking, Carburetion, Injection, Ignition and cooling systems, Parameters of performance, Exhaust emissions.

**Unit-4**

Refrigeration: Gas Refrigeration system, Vapour compression cycle, Effect of sub-cooling and superheating, Multistage systems, Cascade systems, Vapour Absorption cycle, Refrigerants

**Unit-5**

Air-conditioning: Psychrometric properties, Psychrometric chart, Psychrometric processes, Components of Air conditioning system, Classification of Air conditioning systems.

**Text Books:**

1. T. D. Eastop, A. McConkey, “Applied Thermodynamics for Engineering Technologists”, Latest Edition, Pearson India.

2. P. K. Nag, “Power Plant Engineering”, 4thEdition, McGraw Hill, 2014.

3. Wilbert F. Stoecker and J.W. Jones, “Refrigeration and Air Conditioning”, McGrawHill.

4. John B. Heywood, “Internal Combustion Engine Fundamentals, McGraw Hill.

5. V. Ganesan, “Internal Combustion Engines”, McGraw Hill.
6. V. Ganesan, “Gas Turbines” – McGrawHill.
7. H. I. H. Saravanamuthoo, H. Cohen, G. F. C. Rogers, “Gas Turbine Theory”, 5th Edition, Pearson.

**Course Outcomes**

At the end of the course the student will able to

**CO1:** Understand the concepts of a Steam power plant.

**CO2:** Comprehend the concepts a Gas turbine plant.

**CO3:** Acquire the knowledge of the Internal Combustion engine components.

**CO4:** Appreciate the concepts of Refrigeration and their applications.

**CO5:** Analyze the psychometric properties and processes used in Air Conditioning systems.

# Conversion of Energy in Buildings

**Course Objective**

The course aims to equip the participants with fundamental understanding, Knowledge and Skills to contribute in the practice of Energy Efficient Buildings in Cities and Move towards related UNSDGs. Articulate the Elements of Energy Efficiency in Buildings and its importance for all.

**Unit 1**

Need for Building Energy Efficiency: Introduction to Energy Efficient Buildings, Definitions and Components, Historical overview.

Building Energy Performance Benchmarks: Heat Exchange & Building Energy Consumption, Building Energy Use Performance Analysis, Energy Performance Metrics, Indicators& Measures.

**Unit 2**

Energy Efficiency in New Buildings: Passive Energy Efficiency Systems, Micro Climate & Thermal Comfort, Energy Performance Based Building Design.

Energy Retrofit of Existing Buildings: Energy Conservation in Buildings-Moving Towards Net Zero, Energy Efficient Building Envelope Retrofit, Active Energy Retrofit Systems.

**Unit 3**

Energy Efficient Building Envelope: Energy Efficient Roofing & Wall Systems, Energy Efficient Fenestrations & Glazing Technology, Low Embodied Energy Materials & Technology.

Building Energy Simulation: Tools for Energy Performance Measurement, Energy Simulation Using eQuest or Equivalent Software, Design Decisions based on Building Simulation.

**Unit 4**

Building Automation for Energy Efficiency: Introduction to Intelligent Buildings, Automating Building Service Systems for Energy Optimization, Components of Building Management Systems (BMS)

Renewal Energy Use: Introduction to Renewable Energy Use in Buildings, Calculation of Solar Energy Applications for Energy Efficiency

**Unit 5**

National & International Energy Rating Systems: Introduction to Sustainability & Energy Rating Systems, Details of LEEDS, GRIHA, IGBC & other Rating Systems.

**References**

1. McVeigh, J. C. "Solar passive building: Science and design: By MS Sodha, NK Bansal, PK Bansal, A. Kumar and MAS Malik, Pergamon Press, Oxford, 1986, 491 pp." (1987): 525
2. Williams, James Richard. *Passive solar heating*. Univ. of Idaho, 1983.

3. Balcomb, J. Douglas, and Robert William Jones. *Passive Solar Design Handbook: Volume Three, Passive Solar Design Analysis*. Los Alamos National Laboratory, 1982.
4. Congress, Indian Buildings. *Practical handbook on energy Conservation in Buildings*. Nabhi Publication, 2008.
5. Sayigh, A. A. M., ed. *Energy Conservation in Buildings: The Achievement of 50% Energy Saving: An Environmental Challenge?*Newnes, 2012.

**Course Outcomes:**

On the completion of this course the students will be able to:

CO1: Acquire fundamental understanding about energy efficient buildings.

CO2: Acquire understanding about energy efficient new buildings and their design aspects.

CO3: Learn about various building energy simulation tools.

CO4: Learn and apply the concepts of building automation for energy efficiency.

CO5: Gain understanding about National & International Energy Rating Systems.

# Materials and Devices for Energy Conversion

**Course Objectives**

- To understanding the concepts of energy materials and their characterizations andapplications in energy devices.
- To analyze the material design and relate to photovoltaic device, fuel cell systems andenergy storage devices.
- To develop an attitude of innovation/creativity towards material design for variousenergy harvesting devices.

**Unit 1**

Device fabrication technologies: diffusion, oxidation, photolithography, sputtering, physicalvapor deposition, chemical vapor deposition (CVD), plasma enhanced CVD (PECVD), hot wire CVD (HWCVD).

**Unit 2**

High efficiency solar cells, PERL Si solar cell, III-V high efficiency solar cells, GaAs solar cells, tandem and multi-junction solar cells, solar PV concentrator cells and systems, III-V, II-VIthin-film solar cells;

**Unit 3**

Amorphous silicon thin-film (and/or flexible) technologies, multijunction (tandem) solar cells, organic/flexible solar cells, polymer composites for solar cells,Spectral response of solar cells, quantum efficiency analysis, dark conductivity, I-VCharacterization.

**Unit 4**

Introduction to material characterization: Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), X-ray diffraction (XRD), Raman spectroscopy, Atomic force microscopy (AFM); device fabrication and characterization.

**Unit 5**

Materials and devices for energy storage; Batteries, Carbon Nano-Tubes (CNT), fabrication ofCNTs, CNTs for hydrogen storage, CNT-polymer composites, ultra-capacitor; Polymermembranes for fuel cells, PEM fuel cell, Acid/alkaline fuel cells.

**Text Books**

1. Robert F. P. (2002). Advanced Semiconductor Fundamentals, 2nd Edition, Pearson Duncan
2. W. B., Dermot O., and Richard I. W. (2011). Energy Materials, 1st Edition, Wiley

**Reference Books**

1. 1.Fahrenbruch A. L. and Bube R. H. (1983); Fundamentals of Solar Cells: PV Solar Energy Conversion, Academic Press
2. Tom M. and Luis C. (2005). Solar Cells: Materials, Manufacture and Operation, 1st Edition, Elsevier Science
3. Christoph B. Ullrich S. and Vladimir D. (2014). Organic Photovoltaics: Materials, Device Physics, and Manufacturing Technologies, 2nd Edition, Wiley-VCH
4. San P. J. and Pei K. S. (2013). Nanostructured and Advanced Materials for Fuel Cells, 1st Edition, CRC Press
5. Daniel C. and Besenhard J. O. (2011). Handbook of Battery Materials, 1st Edition WileyVCH

**Course Outcomes:**

On the completion of this course the students will be able to:

CO1: Understand the concepts of energy materials and their characterizations andapplications in energy devices.

CO2: analyze the material design and relate to photovoltaic device, fuel cell systems and energy storage devices.

CO3: Develop an attitude of innovation/creativity towards material design for variousenergy harvesting devices.

CO4: Learn and apply the different material characterization techniques.

CO5: Learn about the materials and devices for energy storage.

# Solar Photovoltaics: Fundamentals, Technology and Applications

**Course Objectives**

- To develop a comprehensive technological understanding in solar PV system components.
- To provide in-depth understanding of design parameters to help design and simulate the performance of a solar PV power plant.
- To pertain knowledge about planning, project implementation and operation of solar PV power generation.

**Unit 1**

Introduction to course, Review of Semiconductor Physics, Charge carrier generation and recombination, p-n junction model and depletion capacitance, Current voltage characteristics in dark and light.

**Unit 2**

Device Physics of Solar Cells, Principle of solar energy conversion, Conversion efficiency, Single, tandem multi-junction solar cells, Numerical solar cell modeling, Numerical solar cell modeling, Crystalline silicon and III-V solar cells, Thin film solar cells: Amorphous silicon, Quantum Dot solar cells.

**Unit 3**

Introduction to Dye Sensitized Solar Cells, Fabrication of Dye Sensitized Solar Cells, Design of novel dyes, Design of solid electrolytes materials, Counter electrode engineering.

**Unit 4**

Introduction to Organic Solar Cells, Physics of Bulk Heterojunction(BHJ) Solar Cells, Morphology and charge separation in BHJ, Design of low bandgap polymers, Perovskite Solar Cells, Fabrication of perovskite solar cells, Photophysics in perovskite solar cells, Stability in perovskite solar cells, Lead free perovskite solar cells

**Unit 5**

Photovoltaic system engineering, Thermo- Photovoltaic generation of electricity, Concentration and storage of electrical energy, Photovoltaics modules, system and application, Green energy building, Nanomaterials for photovoltaics, PV panels with nanostructures, Band gap engineering and optical engineering, Photo thermal cells, Energy Economy and management.

**References:**

1. Jasprit Singh, “Semiconductor Devices, Basic Principles”. Wiley, 2001
2. Jenny Nelson, “The Physics of Solar Cells”, Imperial College Press, 2003

3. Stephen J.Fonash, “Solar Cell Device Physics”, 2nd edition, Academic Press, 2003
4. A .Luque and S.Hegedus, :Handbook of Photovoltaic Science &Engineering”., Wiley Tsakalakos, L.; “Nanotechnology for Photovoltaics”, CRC

**Course Objectives:**

On the completion of this course the students will be able to:

CO1:Gaincomprehensive technological understanding in solar PV system components.

CO2: Acquire in-depth understanding of design parameters to help design and simulate the performance of a solar PV power plant.

CO3: Gain knowledge about planning, project implementation and operation of solar PV power generation.

# Energy Resource, Environment and Economics

**Course Objective**

The main objective of environmental economics is to maintain a balance between economic development and environmental quality. In order to achieve it, environmental economists have to explore the various socio-economic possibilities to reduce pollution and uplift the standard of living of the people.

**Unit 1**

Energy Flow Diagram, Global Trends in Energy Use, India and World- Disaggregation by supply, end use, Energy and Environment, The Kaya Identity, Emission Factor.

Energy and Quality of Life, Energy Inequality, Energy Security, Introduction to Country Energy Balance assignment.

**Unit 2**

Energy Economics - Simple Payback Period, Time Value of Money- discount rate, Criteria for Assessing Energy Projects –(Net Present Value (NPV), Benefit/Cost Ratio (B/C), Inflation, Internal Rate of Return (IRR).

Resources & Reserves Growth Rates in Consumption, Estimates of Duration of Fossil Fuels, McKelveyDiagram, Peak oil, Hubbert's model.

**Unit 3**

Materials used in renewable energy (Kuznet's Curve, Betting on the planet, Simon's Change), Non-Renewable Energy Economics (Hotelling's Rule), Preferences and Utility, Utility and Social Choice, Public and private goods / bads, Demand curves, Externalities.

**Unit 4**

Financing Energy – Debt/ Equity- Sources of funds, innovative financing models, Input Output Analysis, Primary Energy Analysis, Net Energy Analysis, Examples, Energy Cost of Energy, Life Cycle Analysis of Bioenergy

**Unit 5**

Net Energy Examples, Energy Policy, Energy Policy Examples, Practice problems solution.

**Reference Books:**

1. GEA, 2012: Global Energy Assessment – Toward a Sustainable Future, Cambridge University Press, Cambridge, UK and New York, NY, USA and the International Institute for Applied Systems Analysis, Laxenburg, Austria.

2. Conrad, J. M., Resource Economics, 2nd Edition, Cambridge University Press, New Delhi, 2010.
3. Tester J.W., Drake E.M., Driscoll M. J., Golay, M.W, Peters, W.A.,Sustainable Energy Choosing Among Options, PHI Learning Private Limited,New Delhi, 2009.
4. J.M. Conrad and C.W. Clark, Natural Resource Economics, Cambridge University Press (1987).
5. Charles Kolstad, Environmental Economics, Vol. 1, Oxford University Press (1999).

**Course Outcomes:**

On the completion of this course the students will be able to:

CO1: Learn how to maintain a balance between economic development and environmental quality.

CO2: Learn various socio-economic possibilities to reduce pollution.

CO3: Put efforts to uplift the standard of living of the people.

CO4: Learn and apply the concepts of economics.

CO5: Gain understanding about energy resourcesand their effect on environment.

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***Suddhowala, PO-Chandanwadi, Premnagar, Dehradun, Uttarakhand (Website- www.uktech.ac.in)***

# SYLLABUS

**For**

## B.TECH

## (Mechanical Engineering with Minor in Industry Operations Management)

Effective from – Session 2023-24

# Quality and Portfolio Management

**L T P: 3 0 0**

**Course Objectives**

The course should enable the students to:

- Understand the concept of Quality and quality management.
- Understand the control charts and its use.
- Understand and use the concept of reliability.
- Be familiar with the concept of portfolio management.
- Be familiar with the concept of mutual funds and strategic commodities.

**Particulars**

**Unit-1**

Quality Concepts: Evolution of Quality Control, concept change, Modern concept. Manufacturing Quality: Methods and techniques for manufacture, inspection and control of product, quality in sales and services.

Quality Management: Organization structure and design, quality function, economics of quality value and contribution, quality cost, optimizing quality cost.

**Unit-2**

Control Charts, Theory of control charts, measurement range, construction and analysis of R charts, process capability study, use of control charts. Attributes of Control Chart, Defects, construction and analysis of charts, improvement by control chart, variable sample size, construction and analysis of C charts

**Unit-3**

Defects diagnosis and prevention defect study, identification and analysis of defects, correcting measure, factors affecting reliability, MTTF, calculation of reliability, building reliability in the product, evaluation of reliability, interpretation of test results, reliability control, maintainability, zero defects, quality circle.

**Unit-4**

Introduction to Portfolio Management – Measurement of Expected Risk and Returns of Portfolio, Alternative measures of Risk, Asset Classes, Risk Premia, and Asset Allocation, Basic and advanced Asset Allocation Techniques ,Asset Selection: Equity, Fixed Income Investments (Equity Asset Class Characteristics, Equity Portfolio Risk, Fixed Income Asset Class Characteristics, Roles of Duration, Convexity, Fixed Income Portfolio Value Distributions), Introduction to Risk – Return Tradeoff,

Measures, Analysis, Determinants of Required Rates of Return and Relationship between Risk and Return.

**Unit-5**

Introduction to Mutual Funds, Alternative Investments (Private Equity, Hedge Funds, Venture Capital, REITs), Strategic Commodities: Oil, Gold, Risk Management (Managing portfolio risk, Equity portfolios and risk management, Fixed income portfolios and risk management), Introduction to Indian Stock Markets, Stock Market Indices, Indices.

**Text Books:**


1. Lt. Gen. H. Lal, "Total Quality Management", Eastern Limited.
2. Greg Bounds, "Beyond Total Quality Management", McGraw Hill, 1994. Menon, H.G, "TQM in New Product manufacturing", McGraw Hill.
3. Investment Analysis and Portfolio Management by Reilly and Brown, Cengage Learning, India Ed.
4. Investment Analysis and Portfolio Management by Prasanna Chandra.
5. Investments by ZviBodie, Alex Kane, Alan Marcus and Pitabas Mohanty.
6. Security Analysis and Portfolio Management by Donald Fisher and Ronald Jordan Maginn, John L. and Donald L. Tuttle (MT).
7. Managing Investment Portfolios: A Dynamic Process. 3rd Ed. CFA Institute Investment Series. Wiley and Sons


**Course Outcomes**

At the end of the course, student will able to

**CO1:** Apply quality and quality management concepts to industrial production.

**CO2:** Use the control charts for quality control during industrial production.

**CO3:** Implement the concepts of reliability.

**CO4:** Understand the basics of portfolio management.

**CO5:** Understand the concept of mutual funds and strategic commodities.

# Introduction to Statistical Tools and Techniques

**L T P: 3 1 0**

**Course Objectives**

The course should enable the students to:

- Perform basic analysis of data using statistical methods.
- Perform simple inference of system parameters from measured data
- Perform simple performance analysis of network or switch models
- Analyze the reliability of interconnected systems
- Perform a significance test to verify assumptions based on measured data
- Make decisions based on statistical data.

**Particulars**

**Unit-1**

Data; displaying distributions; describing distributions; density curves and normal distributions; the R language for statistical computing and graphics.

Relationships; scatterplots; correlation; least-squares regression; data analysis for two-way tables.

**Unit-2**

Producing data; random numbers; random experiments; basic combinatorics; classical probability; Probability space; conditional probability & independence; Bayes rule.

**Unit-3**

Random variables; distributions; probability mass function; uniform, geometric and Poisson distributions; probability density; exponential and normal distributions; Midterm; expectation; variance; joint distribution; correlation; law of large numbers.

**Unit-4**

The sampling distribution of a sample mean; sampling distributions for counts and proportions. Introduction to inference; estimating with confidence; tests of significance; power and inference as a decision.Inference for distributions; Inference for regression.

**Unit-5**

Analysis of Variance: One Way Classification: ANOVA for fixed effect model, ANOVA for Random Effect Model, Two-way Classification (one observation per cell): ANOVA for fixed effect model, ANOVA for Random Effect Model.

Design of Experiments: Completely Randomised Design, Randomised Block Design, Latin Square Design, their statistical analysis and variance of estimates, Analysis of Covariance.

**Text Books:**

1. Moore, McCabe & Craig, "Introduction to the Practice of Statistics", 8th Edition, Freeman, 2014.
2. Medhi, J., Stochastic Processes, New Age International.
3. Montgomery, Introduction to Statistical Quality Control, John Wiley and Sons.

**Reference Books:**

1. Populis, A., Random Variables and Stochastic Processes, Tata McGraw Hill.
2. Bhuyan, K. C., Multivariate Analysis and Its Applications, New Central Book Agency.

**Course Outcomes**

At the end of the course, student will able to

**CO1:**Gain basic understanding of probabilistic and statistical methods and the knowledge of the application of such methods.

**CO2:**Learn to apply these tools to other business models based on statistical data, including inference and hypothesis testing.

**CO3:**Be introduced to the statistical methods.

**CO4:** Analyze the reliability of interconnected systems.

**CO5:** Make decisions based on statistical data.

# Production Planning and Control

**Course Objectives:**

• To understand the various components and functions of production planning and control such as work study, product planning, process planning, production scheduling, Inventory Control.

• To know the recent trends like manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

**Unit 1**

**Introduction**: Objectives and benefits of planning and control-Functions of production control-Types of production- job- batch and continuous-Product development and design-Marketing aspect - Functional aspects- Operational aspect-Durability and dependability aspect aesthetic aspect. Profit consideration-Standardization, Simplification & specialization- Break even analysis-Economics of a new design.

**Unit 2**

**Work Study**: Method study, basic procedure-Selection-Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards.

**Unit 3**

**Product Planning and Process Planning**: Product planning-Extending the original product information-Value analysis-Problems in lack of product planning-Process planning and routing-Pre requisite information needed for process planning- Steps in process planning-Quantity determination in batch production-Machine capacity, balancing- Analysis of process capabilities in a multi-product system.

**Unit 4**

**Production Scheduling**: Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules-Gantt charts-Perpetual loading-Basic scheduling problems - Line of balance – Flow production scheduling- Batch production scheduling-Product sequencing – Production Control systems-Periodic batch control-Material requirement planning kanban – Dispatching-Progress reporting and expediting- Manufacturing lead time-Techniques for aligning completion times and due dates.

**Unit 5**

**Inventory Control and Recent Trends in PPC**: Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures. Two bin system - Ordering cycle system-Determination of Economic order quantity and economic lot size- ABC analysis - Recorder procedure-Introduction to

computer integrated production planning systems- elements of JUST IN TIME SYSTEMS-Fundamentals of MRP II and ERP.

**Books:**

1. James. B. Dilworth, "Operations management – Design, Planning and Control for manufacturing and services" Mcgraw Hill International edition 1992.
2. MartandTelsang, "Industrial Engineering and Production Management", First edition, S. Chand and Company, 2000.

**Reference Books:**

1. Chary. S.N., "Theory and Problems in Production & Operations Management", Tata McGraw Hill, 1995.
2. Elwood S.Buffa, and Rakesh K.Sarin, "Modern Production / Operations Management", 8th Edition John Wiley and Sons, 2000.
3. Jain. K.C. & Aggarwal. L.N., "Production Planning Control and Industrial Management", Khanna Publishers, 1990.
4. KanishkaBedi, "Production and Operations management", 2nd Edition, Oxford university press, 2007.
5. Melynk, Denzler, " Operations management – A value driven approach" Irwin Mcgraw hill.
6. Norman Gaither, G. Frazier, "Operations Management" 9th Edition, Thomson learning IE, 2007
7. Samson Eilon, "Elements of Production Planning and Control", Universal Book Corpn.1984

UpendraKachru, " Production and Operations Management – Text and cases" 1st Edition, Excel books 2007

**Course Objectives:**

On the completion of this course the students will be able to:

CO1:Get introduce with basic concepts of PPC.

CO2: Understand and apply the concept of work study.

CO3: Gain knowledge about product and process planning.

CO4: Understand the concepts of production scheduling.

CO5: Learn about inventory control and recent trends in PPC.

# Introduction to Industry 4.0/5.0 and Six Sigma

**Course Objectives**

- To impart basic idea in Industry 4.0/5.0.
- To provide students with good depth of knowledge of designing Industrial 4.0 Systems for various application.
- To identify and reduce errors and increase the efficiency of business processes by using Six Sigma.

**Unit 1**

Introduction: Sensing & actuation, Communication-Part I, Part II, Networking-Part I, Industry 4.0: Globalization, The Fourth Revolution, LEAN Production Systems.

Industry 4.0: Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Cybersecurity in Industry 4.0, Basics of Industrial IoT: Industrial Processes-Part I, Part II,Industrial Sensing & Actuation.

**Unit 2**

IIoT-Introduction, Industrial IoT: Business Model and Referece, Architerture: IIoT-Business Models-Part I, Part II, IIoT Reference Architecture-Part I, Part II, Industrial IoT- Layers: IIoT Sensing-Part I, Part II, IIoT Processing-Part I, Part II, IIoTCommunication-Part I.

**Unit 3**

Industrial IoT- Layers: IIoT Communication, IIoT Networking-Part I, Part II, Part III.,Industrial IoT: Big Data Analytics and Software Defined Networks:IIoT Analytics - Introduction, Machine Learning and Data Science Part I, Part Il.

**Unit 4**

Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management, Industrial IoT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs inIndustries, Real case studies.

**Unit 5**

The Basics of Six Sigma, Meanings of Six Sigma, General History of Six Sigma & Continuous Improvement, Deliverables of a Lean Six Sigma Project, The Problem Solving Strategy Y = f(x), Voice of the Customer, Business and Employee, Six Sigma Roles & Responsibilities, The Fundamentals of Six Sigma, Defining a Process, Critical to Quality Characteristics (CTQ's), Cost of Poor Quality (COPQ), Pareto Analysis (80:20 rule), Basic Six Sigma Metrics

**Reference Books:**

1. P. Kaliraj, T. Devi, Higher Education for Industry 4.0 and Transformation to Education 5.0
2. Alasdair Gilchrist. Industry 4.0: The Industrial Internet of Things, Apress Publications.
3. Pyzdek, Thomas, and Paul Keller. Six sigma handbook. McGraw-Hill Education, 2014.
4. Gilchrist, Alasdair. Industry 4.0: the industrial internet of things. Apress, 2016.

**Course Objectives:**

On the completion of this course the students will be able to:

CO1:Gainbasic idea in Industry 4.0/5.0.

CO2: Acquire knowledge of designing Industrial 4.0 Systems for various applications.

CO3: Identify and reduce errors.

CO4: Increase the efficiency of business processes by using Six Sigma.

CO5: Gain understanding about IoT and IIoT.

# Industrial Psychology

**Course Objective**

The aim of undergoing this course is to develop an awareness of the major perspectives underlying the field of Industrial Psychology and understanding for the potential Industrial Psychology has for society and organizations now and in the future.

**Unit 1**

Introduction: The role of the psychologist in industry, the field of occupational Psychology: Study of behaviour in work situation and applications of Psychological principles to problems of selection, Placement, Counselling and training.

**Unit 2**

Design of Work Environments: Human engineering and physical environment techniques of job analysis, Social environment: Group dynamics in Industry Personal psychology, Selection, training, placement, promotion, counselling, job motivations, job satisfaction. Special study of problem of fatigue, boredom and accidents.

**Unit 3**

Understanding Consumer Behavior: Consumer behaviour, study of consumer preference, effects of advertising, Industrial morale: The nature and scope of engineering psychology, its application to industry.

**Unit 4**

Work Methods: Efficiency at work, the concept of efficiency, the work curve, its characteristics, the work methods; hours of work, nature of work, fatigue and boredom, rest pauses. The personal factors; age abilities, interest, job satisfaction, the working environment, noise, illumination, atmospheric conditions, increasing efficiency at work; improving the work methods, Time and motion study, its contribution and failure resistance to time and motion studies, need for allowances in time and motion study.

**Unit 5**

Work and Equipment Design: Criteria in evaluation of job-related factor, job design, human factors, Engineering information, input processes, mediation processes, action processes, methods design, work space and its arrangement, human factors in job design. Accident and Safety: The human and economic costs of accidents, accident record and statistics, the causes of accidents situational and individual factors related to accident reduction.

**References:**

1. Miner J.B. (1992) Industrial/Organizational Psychology. N Y : McGraw Hill.
2. Blum & Naylor (1982) Industrial Psychology. Its Theoretical & Social Foundations CBS Publication.
3. Aamodt, M.G. (2007) Industrial/Organizational Psychology : An Applied Approach (5th edition) Wadsworth/Thompson : Belmont, C.A.
4. Aswathappa K. (2008). Human Resource Management (fifth edition) New Delhi : Tata McGraw Hill.

**Course Outcomes:**

On the completion of this course the students will be able to:

CO1: Gain an awareness of the major perspectives underlying the field of Industrial Psychology.

CO2: Acquire understanding for the potential Industrial Psychology for the society.

CO3: Learn about design of work environments.

CO4: Learn about consumer behaviour.

CO5: Gain understanding about work methods and equipment design

# Industrial Economics, Ergonomics & IPR

**Course Objectives**

- To explain the psychology of human behavior as it relates to workplace safety.
- Identify ergonomic hazards.
- Recommend appropriate controls, and relate the human and workplace factors which contribute to ergonomic hazards.

**Unit 1**

Ergonomics: Definition, Application, Brief History, Effectiveness and Cost-Effectiveness of Ergonomics Human Factors and Ergonomics, Systems of the Human Body, Anatomy of Spine and Pelvis Related to Posture Biomechanics, Muscular System, Ergonomics and the Musculoskeletal System, Costs of Back Injuries,

**Unit 2**

Muscular Work and Nervous Control of Movements, Types of Muscular Work, Muscular Fatigue, Types of Muscle Contractions, Measurement of Muscular Strength, Anthropometry: Definition, Terminology, Myth of the Average Human, Principles of Universal Design, Anthropometric Measurements.

**Unit 3**

Design of Workplaces and Hand Tools, Work Design Analysis, Designing for Hand Use, Types of Injuries and Disorders. Work-Related Musculoskeletal Disorders, Types of Work-Related MSD's, Task-related Factors, Personal Risk Factors, Impact on Industry, Ergonomic Program forWMSD's.

**Unit 4**

Heavy Work and Evaluating Physical Workloads and Lifting, Heavy Work, Manual Material Handling & Lifting, Classification and Risks, NIOSH Lifting Guidelines, Job Demands and Workplace Stress, Mental Fatigue/Shift-work Fatigue.

**Unit 5**

Information Ergonomics: Controls, and Displays, Mental Workload Measurement, Primary and Secondary Task Performance, Controls and Displays (Types), Control Layout and Design, How to Implement an Ergonomic Program, Management and Employee Involvement, Setting Up the Ergonomics Program, Problem Identification, Hazard Prevention and Control, Training.

**References:**

1. Introduction to Ergonomics by Robert Bridger

2. Global Ergonomics by Scott, P.A.; Charteris, J.; Bridger, R.S.
3. Industrial Safety and Health Management by Rieske, David W., Asfahl, C. Ray
4. Principles of Industrial Safety by Joel M. Haight; Jeffery C. Campi in; Chritopher A. Janicak; Anjan K. Majumder; Linda S. Rowley; Kathy
5. Practical Guide to Industrial Safety by Nicholas P. Cheremisinoff

**Course Outcomes:**

On the completion of this course the students will be able to:

CO1: Understand the psychology of human behavior.

CO2: Identify ergonomic hazards.

CO3: Recommend appropriate controls.

CO4: Relate the human and workplace factors which contribute to ergonomic hazards.

CO5: Use the concept of ergonomics at workplace

# Financial Mathematics

**Course Objectives**

- To focuses on the mathematical properties and relations between concepts of financial and currency markets in investment and other economic activities.
- To be able to address issues related to globalization of financial markets, development and feasibility of financial transactions, the increasing complexity of portfolio investments, analyzing and forecasting market developments etc.
- To understanding of advanced economics concepts as well as knowledge of how the financial and banking sectors operate.

**Unit 1**

Mathematical introduction, Growth and decay curves, Simple interest, bank discount.

**Unit 2**

Compound interest, discrete compounding, Compounding frequency of interest, Economic equivalence.

**Unit 3**

Method of comparison of alternatives, Project balance, Credit and loan, Cost of credit and amortization.

**Unit 4**

Depreciation and depletion, Breakeven analysis, Leverage, Stocks and bonds, Valuation of stocks and bonds.

**Unit 5**

Mutual funds, Options, Cost of capital and ratio analysis, Decision under risk &uncertainty, Risk premium, Portfolio diversification.Life Insurance, Endowment, and annuities, Insurance policies.

**Reference Books:**

1. Marek Capinski and Tomasz Zastawniak, “Mathematics for Finance”, Springer.
2. AmbadNazriWahidudin, “Financial Mathematics and its Applications”, Ventus Publishing ApS
3. S. R. Pliska (2002). “Introduction to Mathematical Finance: Discrete Time Models”. Blackwell Publishers Inc.

**Course Outcomes:**

On the completion of this course the students will be able to:

CO1: Learn mathematical properties and relations between concepts of financial and currency markets in investment and other economic activities.

CO2: Learn and address issues related to globalization of financial markets, development and

feasibility of financial transactions.

CO3: Learn and address issues related tothe increasing complexity of portfolio investments, analyzing and forecasting market developments etc.

CO4: Learn and understand advanced economics concepts.

CO5: Gain understanding about how the financial and banking sectors operate.

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# SYLLABUS

**For**

## B.TECH

## (Mechanical Engineering with Minor in Robotics and Automation)

Effective from – Session 2023-24

# Mechanics of Robotics

**L T P: 3 1 0**

**Course Objective**

The objectives of this course are

- Identify robots and its peripherals for satisfactory operation and control of robots for industrial and non-industrial applications.
- Learn algorithmic approaches, mathematical models, and computational and motion control methods applicable to robotic manipulator system

**Particulars**

**Unit 1**

Robot-Basic concepts, Need, Law, History, Anatomy, specifications. Robot configurations-cartesian, cylinder, polar and articulate. Robot wrist mechanism, Precision and accuracy of robot.

End effectors-Classification, Types of Mechanical actuation, Gripper design, Robot drive system Types, Position and velocity feedback devices-Robot joints and links-Types, Motion interpolation.

**Unit 2**

Robot kinematics – Basics of direct and inverse kinematics, Robot trajectories, 2D and 3D Transformation-Scaling, Rotation, Translation Homogeneous transformation. Control of robot manipulators – Point to point, Continuous Path Control, Robot programming

Sensors in robot – Touch sensors-Tactile sensor – Proximity and range sensors. Force sensor-Light sensors, Pressure sensors, Introduction to Machine Vision and Artificial Intelligence.

**Unit 3**

Effector: locomotion, and manipulation. Serial and parallel manipulators. Descriptions, Transformations and homogeneous transformation matrix.

Manipulator (serial manipulator) kinematics: Kinematic parameters, different notations, Denavit-Hartenberg (DH) representation, arm matrix. Forward and inverse kinematics. Analytical and numerical solutions.

Differential (velocity) kinematics, velocity propagation, forward differential kinematics and inverse differential kinematics.

**Unit 4**

Jacobian matrix and Manipulator statics: Mapping between configuration-space to operational-space. Jacobian matrix and Pseudo inverse concepts.

Introduction to workspace singularities.Manipulator statics: Conservation of energy or power, the mapping between operation-space to configuration-space inputs examples

Motion dynamics: Forward and inverse dynamics. Lagrangian (Lagrange-Euler) and Newton-Euler formulations. Examples

**Unit 5**

Dynamic modeling of robotic manipulators and computer-based numerical simulations.

Path and Trajectory. Configuration (joint) space trajectory and operational (task) space trajectory generations.

Joint space and task-space control schemes.

**References**


1. Mikell P. Groover, Mitchell Weiss, Roger N Nagel, Nicholas G Odrey, “Industrial Robotics Technology, Programming and Applications”, Tata –McGraw Hill Pub. Co., 2008.
2. Deb.S.R and Sankha Deb, "Robotics Technology and Flexible Automation", Tata McGraw Hill Publishing Company Limited, 2010.
3. Klafter.R.D, Chmielewski.T.A, and Noggin’s., “Robot Engineering: An Integrated Approach”’, Prentice Hall of India Pvt. Ltd., 1994.
4. Fu.K.S, Gonzalez.R.C&Lee.C.S.G, “Robotics control, sensing, vision and intelligence”, Tata-McGraw Hill Pub. Co., 2008
5. Yu. “Industrial Robotics”, MIR Publishers Moscow, 1985.


**Course Outcomes**

At the end of this course, students are able to

CO1: list and explain the basic elements of industrial robots

CO2: analyse robot kinematics and its control methods and classifythe various sensors used in robots for better performance

CO3: Recognize and analyze the basic mechanical and electrical systems concerning robots

CO4: Analyze and design the basic robotic systems

CO5: Implement and investigate the performance of various control techniques to the robotic manipulators

# Industrial Robotics and Automation

**L T P: 3 1 0**

**Course Objective**

The objectives of this course are

- To develop the student's knowledge in various robot structures and their workspace.
- To develop student's skills in performing spatial transformations associated with rigid body motions and robot systems.
- To provide the student with knowledge of the singularity issues associated with the operation of robotic systems.
- To provide the student with some knowledge and analysis skills associated with trajectory planning and robot control.

**Particulars**

**Unit 1**

Introduction: Concept and scope of automation: Socio economic impacts of automation, Types of Automation, Low Cost Automation

Fluid Power: Fluid power control elements, Standard graphical symbols, Fluid power generators, Hydraulic and pneumatic Cylinders - construction, design and mounting; Hydraulic and pneumatic Valves for pressure, flow and direction control.

**Unit 2**

Basic hydraulic and pneumatic circuits: Direct and Indirect Control of Single/Double Acting Cylinders, designing of logic circuits for a given time displacement diagram & sequence ofoperations, Hydraulic & Pneumatic Circuits using Time Delay Valve & Quick Exhaust Valve, Memory Circuit & Speed Control of a Cylinder, Troubleshooting and "Causes & Effects of Malfunctions" Basics of Control Chain, Circuit Layouts, Designation of specific Elements in a Circuit.

**Unit 3**

Fluidics: Boolean algebra, Truth Tables, Logic Gates, Coanda effect. Electrical and Electronic Controls: Basics of Programmable logic controllers (PLC), Architecture & Components of PLC, Ladder Logic Diagrams

Transfer Devices and feeders: Classification, Constructional details and Applications ofTransfer devices, Vibratory bowl feeders, Reciprocating tube, Centrifugal hopper feeders

**Unit 4**

Robotics: Introduction, Classification based on geometry, control and path movement, Robot

Specifications, Robot Performance Parameters, Robot Programming, Machine Vision, Teach pendants, Industrial Applications of Robots

**Unit 5**

Robot Programming: Using Sensors and Actuators with ROS, SCORBOT structure, joint movements, work envelop, motors, encoders, microswitch, transmission, gripper, SCORBOT programming, IS-14533: 2005 Manipulating industrial robots - Performance criteria related test methods, Mobile Robot Programming, Industrial Robot Programming.

**References**


1. Robotics, Vision and Control: Fundamental Algorithms in MATLAB® - Peter Corke, Springer Tracts in Advanced Robotics, Volume 73, 2011
2. Learning ROS for Robotics Programming - Aaron Martinez & Enrique Fernández, Packt Publishing, September 2013
3. Robotics for Engineers -YoramKoren, McGraw Hill International, 1st edition, 1985.
4. Industrial Robotics-Groover, Weiss, Nagel, McGraw Hill International, 2nd edition, 2012.
5. Robotics, control vision and Intelligence-Fu, Lee and Gonzalez. McGraw Hill International, 2nd edition, 2007.
6. Introduction to Robotics- John J. Craig, Addison Wesley Publishing, 3rd edition, 2010.
7. Fluid Power with Applications-Anthony Esposito, Peason, Sixth Addition.
8. Pneumatic Systems, Principles and Maintenance- SR Majumdar, 2011 Edition.
9. Industrial Robotics, Technology, Programming, and applications- MikellP.Groover.
10. Computer Based Industrial Control- Krishna Kant, EEE-PHI,2nd edition,2010
11. An Introduction to Automated Process Planning Systems- Tiess Chiu Chang & Richard A. Wysk.
12. Engineering Metrology and Measurements – N.V. Raghavendra, L. Krishnamurthy, 2018 Edition.


**Course Outcomes:**

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

CO1: Students will demonstrate knowledge of the relationship between mechanical structures of industrial robots and their operational workspace characteristics.

CO2: Students will demonstrate an ability to apply spatial transformation to obtain forward kinematics equation of robot manipulators.

CO3: Students will demonstrate an ability to solve inverse kinematics of simple robot manipulators.

CO4: Students will demonstrate an ability to obtain the Jacobian matrix and use it to identify singularities.

CO5: To understand robot programming.

# Programmable Logic Controller Applications

**L T P: 3 1 0**

**Course Objective**

The objectives of this course are

- To introduce the basic features, programming methods and applications of Micro controllers
- To study about programming in microcontroller
- Discuss different applications in microcontroller
- To know about the design of systems using PLC is introduced in detail.
- To know about the applications in PLC

**Particulars**

**Unit 1**

INTRODUCTION TO MICROCONTROLLER 8051 Architecture:–Memory map-Addressing modes, I/O Ports–Counters and Timers–Serial dataI/O–Interrupts–Instruction set,, Data transfer instructions, Arithmetic and Logical Instructions, Jump and Call Instructions , Assembly Language Programming tools.

**Unit 2**

MICROCONTROLLER PROGRAMMING 8051 Assembly Language Programming-Block transfer, arithmetic operations, Code conversion, Time delay generation, Interrupt programming, Lookup table techniques

**Unit 3**

MICROCONTROLLER APPLICATIONS Interfacing of Keyboards–Interfacing of Display Devices–Pulse measurement–Analog to Digital and Digital to Analog Converter–Interfacing Hardware Circuit–Serial Data CommunicationNetwork Configuration.

**Unit 4**

PROGRAMMABLE LOGIC CONTROLLERS Introduction—Principles of operation–PLC Architecture and specifications–PLC hardware components Analog & digital I/O modules , CPU & memory module–Programming devices–PLC ladder diagram, Converting simple relay ladder diagram in to PLC relay ladder diagram. PLC programming Simple instructions–Manually operated switches–Mechanically operated a Proximity switches-Latching relays.

**Unit 5**

APPLICATIONS OF PROGRAMMABLE LOGIC CONTROLLERS. Timer instructions-On delay, Off delay, Cyclic and Retentive timers, Up /Down Counters, control instructions–Data manipulating

instructions, math instructions; Applications of PLC–Simple materials handling applications, Automatic control of warehouse door, Automatic lubrication of supplier Conveyor belt, motor control, Automatic car washing machine, Bottle label detection and process control application.

**References**


1. 1.Muhammad Ali Mazdi ,J.G. Mazdi & R.D .Mc Kinlay "The 8051 Micro controller & Embedded systems Using assembly & C " 2nd Edition Pearson Education , Inc ,2006
2. Udayasankara.v & Mallikarjuna swamy .M.S ,'8051 Microcontroller, Hardware, Software & Applications ,Tata McGraw Hill Education Pvt Limited. New Delhi ,2009.
3. Gary Dunning , 'Introduction to Programmable Logic Controllers'' Thomson Learning, 2001
4. Singh. B.P., "Microprocessors and Microcontrollers", Galcotia Publications (P) Ltd, First edition, New Delhi, 1997.
5. Parr, "Programmable Controllers: An Engineers Guide", 3rd Edition, Elsevier, Indian Reprint, 2013
6. Valdes-Perez, Microcontrollers: Fundamentals and Applications with PIC, Taylor & Francis, Indian Reprint, 2013.
7. Bolton , "Programmable Logic Controllers" 5th Edition Newnes, ,2009


**Course Outcomes**

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

CO1: Learn the basic of microcontroller

CO2: Learn the programming in microcontroller.

CO3: Know about the different applications of microcontroller

CO4: Learn about the design of systems using Programmable Logic Controllers

CO5: Know about the different applications of Programmable Logic Controllers

# Modeling and Design of Robots

**L T P: 3 1 0**

**Course Objective**

This course contains kinematic and dynamic modeling of planar robots using MATLAB and SimMechanics. It also includes control of planar robots using Simulink and xPC Target, as well as mechatronics and robotics projects using Arduino. These course materials can be used partially or fully in robotics, control design, mechatronics system, and capstone design classes.

**Particulars**

**Unit 1**

**Analysis of Planar Robots**

Position Analysis with MATLAB, Jacobian Analysis with MATLAB, Dynamics Analysis with MATLAB.

**Unit 2**

**Sim Mechanics**

Forward dynamics simulation practice of a 2-DOF serial robot, Inverse dynamics simulation of planar robot, Simulink models for simulation practice.

**Unit 3**

**Control**

Introduction to xPC Target and speedgoat controller, Development of robot manipulators and controllers, Simulink models for control practice.

**Unit 4**

**Projects**

How to use Arduino Mega 2560,Input/output interface program, Position control of DC motors (AX-12W), 2-DOF robot arm control project (AX-12A), Walking robot project using Arduino Mega 2560, 2-DOF haptic device project.

**Unit 5**

**AI and Machine Learning in Robotics**

Socio-Economic aspect of robotisation. Economical aspects for robot design, Safety for robot and standards, Introduction to Artificial Intelligence, AI techniques, Need and applications of AI, Use of Machine learning in Robotics.

**References**


1. S. K. Saha, Introduction to Robotics 2e, TATA McGraw Hills Education (2014)
2. AsitavaGhoshal, Robotics: Fundamental concepts and analysis, Oxford University Press (2006)
3. Dilip Kumar Pratihar, Fundamentals of Robotics, Narosa Publishing House, (2019)
4. R. K. Mittal, I. J. Nagrath, Robotics and Control, TATA McGraw Hill Publishing Co Ltd, New Delhi (2003)
5. S. B. Niku, Introduction to Robotics – Analysis, Contro, Applications, 3rd edition, John Wiley & Sons Ltd., (2020)
6. J. Angeles, Fundamentals of Robotic Mechanical Systems Theory Methods and Algorithms, Springer (1997)
7. MikellGroover, Mitchell Weiss, Roger N. Nagel, Nicholas Odrey, AshishDutta, Industrial Robotics 2nd edition, SIE, McGraw Hill Education (India) Pvt Ltd (2012)
8. R. D. Klafter, Thomas A. Chmielewski, and MechaelNegin, Robotic Engineering – An Integrated Approach, EEE, Prentice Hall India, Pearson Education Inc. (2009)
9. J. J. Craig, "Introduction to Robotics: Mechanics and Control", 3rd edition, AddisonWesley (2003)


**Course Outcomes:**

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

CO1: Understand relationship between joint space and Cartesian space

CO2: Plan trajectory of robot to environment reach the destination with controlled

CO3: Develop robot manipulators

CO4: Use Arduino Mega 2560

CO5: Acquire awareness of AI and Machine learning in robotics

# Programming for Automation and Robotics

**L T P: 3 1 0**

**Prerequisite:** Knowledge of Sensors Technology, Robot Drive Systems

**Course Objective**

The primary objective of robot programming is to make the robot understand its work cycle. The program teaches the robot the following:

• The path it should take

• The points it should reach precisely How to interpret the sensor data

• How and when to actuate the end-effector

• How to move parts from one location to another, and so forth

**Particulars**

**Unit 1**

Robot programming-Introduction-Types- Flex Pendant- Lead through programming, Coordinate systems of Robot, Robot controller- major components, functions-Wrist Mechanism-Interpolation Interlock commands- Operating mode of robot, Jogging-Types, Robot specifications- Motion commands, end effectors and sensors commands.

**Unit 2**

VAL Language Robot Languages-Classifications, Structures- VAL language commands motion control, hand control, program control, pick and place applications, palletizing applications using VAL, Robot welding application using VAL program-WAIT, SIGNAL and DELAY command for communications using simple applications.

VAL-II programming-basic commands, applications- Simple problem using conditional statementsSimple pick and place applications-Production rate calculations using robot.

**Unit 3**

RAPID language basic commands- Motion Instructions-Pick and place operation using Industrial robot-manual mode, automatic mode, subroutine command based programming. Move master command language-Introduction, syntax, simple problems.

**Unit 4**

AML Language - General description, elements and functions, Statements, constants and variablesProgram control statements-Operating systems, Motion, Sensor commands-Data processing.

**Unit 5**

Robot cycle time analysis-Multiple robot and machine Interference-Process chart-Simple problemsVirtual robotics, Robot studio online software- Introduction, Jogging, components, work planning, program modules, input and output signals-Singularities-Collision detection-Repeatability measurement of robot-Robot economics. AML Language-General description, elements and functions, Statements, constants and variables-Program control statements-Operating systems, Motion, Sensor commandsData processing.

**References**

1. Cameron Hughes Tracey Hughes, Robot Programming: A Guide to Controlling Autonomous Robots, 1/e First Edition, 2016, ISBN: 9789332577442
2. S. R. Deb, Robotics Technology and Flexible Automation, 2010. McGraw Hill ISBN: 9780070077911
3. Mikell. P. Groover, Industrial Robotics: Technology, Programming, and Applications 2nd Edition, McGraw Higher Ed. 2012, ISBN: 9781259006210,
4. Industrial Robotics Technology, Programming and Applications, McGraw Hill Co, 1995. 5) Robotics Lab manual, 2007.

**Course Outcome:**

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

CO1: Explain robot programming methods

CO2: Understand the components of robot programming

CO3: Develop simple programmes to simulate robot movements

CO4: Develop robot programmes for specific application

CO5: Describe the safety rules in robot handling

# Artificial Intelligence for Robotics and Automation

**L T P: 3 1 0**

**Pre-requisites**: Engineering mathematics-III, statistics and Numerical Methods, Sensors Technology

**Course objective**

AI provides robots with adequate computer vision and motion control to better understand the environment and act accordingly. Similarly, machine learning conditions the robots in such a way that with timely evolution, they learn from their own mistakes, thus preventing constant human intervention and parallel effort.

**Particulars**

**Unit 1**

Introduction to artificial intelligent techniques Goals of AI in manufacturing, tools for AI such as Search algorithm, Mathematical optimization, Evolutionary computation, fuzzy logic, Probabilistic methods for uncertain reasoning such as Bayesian network, Hidden Markov model, Kalman filter, Decision theory and Utility theory, statistical learning methods, support vector machines, neural networks, expert systems

**Unit 2**

Handling uncertainty and learning: Non-monotonic reasoning, probabilistic reasoning, use of certainty factors, fuzzy logic, Concept of learning, learning automation, genetic algorithm, learning by inductions, neural network, Unsupervised learning- K-Means clustering, Boltzmann machine, Supervised learning-classification algorithms, support vector machine.

**Unit 3**

Search algorithms in AI: Algorithms for uninformed and informed search, Heuristics search: hill climbing, branch and bound, best first search, Metaheuristics: Simulated annealing, Tabu search, ant colony optimization, real coded genetic algorithm. Machine vision in robotics: Machine vision algorithms, Imaging based automatic sorting and inspection, image processing, imaging based robot guidance.

**Unit 4**

Applications of intelligent systems for mobile Robot Motion Planning, Path Planning Robot Control in DynamicEnvironments, Task Based Hybrid Closure Grasping Optimization for Autonomous Robot Hand. Accurate Motion Control of Fast Mobile Robots, obstacle avoidance.

**Unit 5**

Artificial intelligence in flexible automation Applications of various intelligent systems for FMS functional segmentation schemes including control, real time scheduling, tool management, process

planning, route optimization for AS/RS systems.

**References**


1. Steger, Carsten, Markus Ulrich, Christian Wiedemann. Machine Vision Algorithms and Applications (2nd ed.). Wiley, 2018. ISBN 978-3-527-41365-2.
2. Mikell P Groover, Automation, Production System and Computer Integrated Manufacturing, Prentice Hall, Publications, 2016. ISBN 9789332549814
3. Bhattacharya S., Artificial Intelligence, Laxmi Publications, Ltd., 2008, ISBN9788131804896
4. Chopra Rajiv, Artificial Intelligence, S. Chand Publishing, 2012, ISBN9788121939485
5. Pawar P. J., Evolutionary Computations for Manufacturing, Studium Press, 2019, ISBN: 978-93-8504652-0
6. Jain N, Artificial Intelligence: making a system intelligent, 2018, ISBN: 9788126579945


**Course Outcomes**:

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

CO1: Select appropriate artificial intelligence method/algorithm to handle various issues in robotics

CO2: Demonstrate various algorithms used in artificial intelligence

CO3: Apply artificial intelligence algorithms to robotics problems

CO4: Compare the performance of AI algorithms

CO5: Build solution methodology to solve complex problems in flexible automation

# Industrial Pneumatics, Hydraulics, E-pneumatics

**L T P: 3 1 0**

**Pre-requisites**: Systems in Mechanical Engineering

**Course objective**

This course provides a comprehensive introduction to fluid power, including both oil hydraulics and pneumatics.

**Particulars**

**Unit 1**

Introduction to fluid power and automation Introduction to oil hydraulics and pneumatics, their structure, advantages and limitations. Properties of fluids, Fluids for hydraulic systems, governing laws. Hydraulic pumps and actuators Pumps Classification of pumps, Pumping theory of positive displacement pumps, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps, Pump performance characteristics, pump Selection factors, problems on pumps. Design of reservoir capacity. Classification cylinder and hydraulic motors, Linear Hydraulic Actuators [cylinders], single and double acting cylinder, Mechanics of Hydraulic Cylinder Loading, mounting arrangements, cushioning, special types of cylinders, problems on cylinders, construction and working of rotary actuators such as gear, vane, piston motors, Hydraulic Motor Theoretical Torque, Power and Flow Rate, Hydraulic Motor Performance, problems, symbolic representation of hydraulic actuators (cylinders and motors).

**Unit 2**

Control Components in hydraulic system Classification of control valves, Directional Control Valves- Symbolic representation, constructional features of poppet, sliding spool, rotary type valves solenoid and pilot operated DCV, shuttle valve, check valves, Pressure control valves - types, direct operated types and pilot operated types. Flow Control Valves -compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation.

**Unit 3**

Hydraulic Circuit Design and Analysis Control of Single and Double -Acting Hydraulic Cylinder, Regenerative circuit, Pump Unloading Circuit, Counter balance Valve Application, Hydraulic Cylinder Sequencing Circuits, Automatic cylinder reciprocating system, Speed Control of Hydraulic Cylinder and motors, Safety circuit, Accumulators, types, construction and applications with circuits, Intensifier circuits and their applications, Proportional control valves and servo valves.

**Unit 4**

Introduction to Pneumatic system Introduction to Pneumatic Control: Definition of pneumatic system, advantages, limitations, applications, Choice of working medium. Characteristic of compressed air. Structure of Pneumatic control System, fluid conditioners and FRL unit. Pneumatic Actuators: Linear cylinder - Types, Cascade design of Pneumatic circuit, Use of Logic gates - OR and AND gates in pneumatic applications.

**Unit 5**

Electro-hydraulics and electro-pneumatic systems PLC based electro-hydraulic systems, PLC programming using ladder logic for automation and robotics applications, Electro- Pneumatic Control: Principles - signal input and out put, pilot assisted solenoid control of directional control valves, Use of relay and contactors. Control circuitry for simple applications.

**References**

1. Mujumdar S.R., Pneumatic Systems, Tata McGraw Hill, 2002 Edition. ISBN: 9780074602317
2. Bolton W., Mechatronics Electronic Control Systems in Mechanical and Electrical Engineering, Pearson, Education (Singapore) Pvt Ltd., ISBN 81-7808-339-6.
3. Industrial hydraulics manual by Vickers, Inc.
4. Fluid Power: Generation, Transmission and Control, Wiley, 2018, ISBN: 9788126539543
5. Peter Rohner, Industrial hydraulic control, Hydrauluc Supermarket, 2005, ISBN 978-0958149310

**Course Outcomes**:

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

CO1: Exemplify the basic principles of Industrial fluid power.

CO2: Select and specify various components for hydraulic and pneumatic systems.

CO3: Execute PLC program for electro-hydraulic circuit applications

CO4: Organize hydraulic and pneumatic circuits for given application

CO5: Evaluate the hydraulic and pneumatic systems based on various evaluation criteria