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 & Automation Engineering)

2nd Year

Effective from – Session 2023-24

B.TECH. (MECHANICAL & AUTOMATION) Curriculum Structure

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	MAT-001	DC	Engineering Thermodynamics	3	1	0	30	20	50	100		150	4
4	MAT-002	DC	Materials Engineering	3	1	0	30	20	50	100		150	4
5	MAT-003	DC	Fluid Mechanics & Fluid Machines	3	1	0	30	20	50	100		150	4
6	MAP-001	DLC	Materials Engineering & Testing Lab	0	0	2		25	25		25	50	1
7	MAP-002	DLC	Fluid Mechanics & Fluid Machines Lab	0	0	2		25	25		25	50	1
8	MAP-003	DLC	Machine Drawing & Solid Modelling Lab	0	1	2		25	25		25	50	1
9	MAP-004	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	50			**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

* For Lateral entry admitted students, need to complete a mini project during the 3rd semester course and its evaluation will be at the end of 3rd semester in place of Internship-I/ Mini Project-I (MAP-004).

 # 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, McGraw Hill.
3. Peter V.O'Neil: Advanced Engineering Mathematics, Cengage Learning,7 th ed.
4. B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, 44th ed.
5. T.Veerarajan: Engineering Mathematics (for semester III), McGraw Hill, 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 **(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.

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 - 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 (MAT-001)

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 **(6 Hrs)**

Introduction to Thermodynamics: 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 **(8 Hrs)**

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

Pure Substances: 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 **(10 Hrs)**

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

Thermodynamic Relations, Availability and Irreversibility: 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. Jones, J. (1996). Dugan. Re, Engineering Thermodynamics, 3ª edition, United States of America, Editorial Prentice Hall.
5. 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 (MAT-002)

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 **(8 Hrs)**

Crystal Structure: 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 **(9 Hrs)**

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

Alloys, Substitutional and Interstitial Solid Solutions- Phase Diagrams: 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 **(8 Hrs)**

Heat Treatment of Steel: 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. Callister Jr, 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 (MAT-003)

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 **(8 Hrs)**

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

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

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

Unit 4 **(8 Hrs)**

Hydraulic Turbines:- 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 **(8 Hrs)**

Centrifugal and Positive Displacement Pumps: 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 (MAP-001)

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. Callister Jr, 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 (MAP-002)

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 Modelling Lab (MAP-003)

L T P: 0 1 2

Course Objectives

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 (MAP-004)

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, Create Space 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",1stEdition, 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)", 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 & AUTOMATION)													
SEMESTER-IV													
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 / AHT-007	HSC	Universal Human Values /Technical Communication	3 / 2	0 / 1	0 / 0	30	20	50	100		150	3
2	MAT-004	DC	Mechanics of Machines	3	1	0	30	20	50	100		150	4
3	MAT-005	DC	Switching Theory and Logic Design	3	1	0	30	20	50	100		150	4
4	MAT-006	DC	Strength of Materials	3	1	0	30	20	50	100		150	4
5	MAT-007	DC	Manufacturing Science and Technology -I	3	1	0	30	20	50	100		150	4
6	MAP-005	DLC	Switching Theory and Logic Design Lab	0	0	2		25	25		25	50	1
7	MAP-006	DLC	Manufacturing Science and Technology -I Lab	0	0	2		25	25		25	50	1
8	MAP-007	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*

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 (MAT-004)

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, 4thEdition, 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.

Switching Theory and Logic Design (MAT-005)

L T P: 3 1 0

Course Objectives

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

- Acquire knowledge about Number Systems and Codes.
- Acquire the knowledge of Logic Systems and Circuits.
- Obtain the platform for studying Digital Systems and Computer Architecture.
- Acquire the knowledge of Counters and Shift Registers.
- Gain knowledge about Fault Detection and Location

Unit 1 **(8 Hrs)**

Number Systems and Codes:-Decimal, Binary, Octal and Hexadecimal Number systems, Codes- BCD, Gray Code, Excess-3 Code, ASCII, EBCDIC, Conversion between various Codes.

Switching Theory: - Boolean Algebra- Postulates and Theorems, De‘ Morgan‘s Theorem, Switching Functions- Canonical Forms- Simplification of Switching Functions- Karnaugh Map and Quine Mc-Clusky Methods.

Unit 2 **(10 Hrs)**

Combinational Logic Circuits:-Review of basic gates- Universal gates, Adder, Subtractor ,Serial Adder,

Parallel Adder- Carry Propagate Adder, Carry Look-ahead Adder, Carry Save Adder, Comparators, Parity Generators, Decoder and Encoder, Multiplexer and De-multiplexer, ALU, PLA and PAL.

Integrated circuits: -TTL and CMOS logic families and their characteristics. Brief introduction to RAM and ROM.

Sequential Logic Circuits: -Latches and Flip Flops- SR, D, T and MS-JK Flip Flops, Asynchronous Inputs.

Unit 3 **(8 Hrs)**

Counters and Shift Registers:-Design of Synchronous and Asynchronous Counters:- Binary, BCD, Decade and Up/Down Counters , Shift Registers, Types of Shift Registers, Counters using Shift Registers- Ring Counter and Johnson Counter.

Synchronous Sequential Circuits:-State Tables State Equations and State Diagrams, State Reduction and State Assignment, Design of Clocked Sequential Circuits using State Equations.

Unit 4 **(8 Hrs)**

Finite State Machine-capabilities and limitations, Mealy and Moore models-minimization of completely specified and incompletely specified sequential machines, Partition techniques and merger chart methods-concept of minimal cover table.

Algorithmic State Machine: Representation of sequential circuits using ASM charts synthesis of output and next state functions, Data path control path partition-based design.

Unit 5 **(8 Hrs)**

Fault Detection and Location: Fault models for combinational and sequential circuits, Fault detection in combinational circuits; Homing experiments, distinguishing experiments, machine identification and fault detection experiments in sequential circuits.

Text Book:

1. ZyiKohavi, ―Switching & Finite Automata Theory‖, TMH, 2nd Edition
2. Morris Mano, Digital Logic and Computer Design‖, Pearson
3. R.P. Jain, ―Modern Digital Electronics‖, TMH, 2nd Ed,

Reference Books:

1. A Anand Kumar, ―Fundamentals of Digital Logic Circuits‖, PHI
2. Taub ,Helbert and Schilling, ―Digital Integrated Electronics‖, TMH

Course Outcomes

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

CO1: Know about the Number Systems and Codes.

CO2: Demonstrate the knowledge of Logic Systems and Circuits.

CO3: Gain knowledge about Digital Systems and Computer Architecture.

CO4: Demonstrate the knowledge of Counters and Shift Registers.

CO5: Demonstrate the knowledge about Fault Detection and Location.

Strength of Material (MAT-006)

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. HibbelerR.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 (MAT-007)

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. P N 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.

Switching Theory and Logic Design Lab (MAP-005)

L T P: 0 0 2

Course Objective

The course should enable the students to:

- To provide practical experience in using gates, Flip-Flop etc.
- Prepare them to carry out the experimental investigation and analysis.
- Familiarize with working of different types of gates, Flip-Flop, counters etc.
- Understand the basics of Switching Theory and Logic Designby working models and experiments.

Particulars

List of experiments (Minimum 8 experiments of the followings)

1. Realize all gates using NAND & NOR gates
2. Realize Half Adder, Full Adder, Half subtracter, Full subtracter
3. Realize a BCD adder
4. Realize a Serial Adder
5. Realize a four bit ALU
6. Realize Master-Save J K Flip-Flop, using NAND/NOR gates
7. Realize Universal Shift Register
8. Realize Self-Starting, Self Correcting Ring Counter
9. Realize Multiplexer and De-Multiplexer
10. Realize Carry Look ahead Adder / Priority Encoder
11. Simulation of PAL and PLA
12. Simulation Mealy and Moore State machines

Reference Books:

1. A Anand Kumar, ―Fundamentals of Digital Logic Circuits‖, PHI
2. Morris Mano, Digital Logic and Computer Design‖, Pearson
3. ZyiKohavi, ―Switching & Finite Automata Theory‖, TMH, 2nd Edition

Course Outcomes

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

CO1: Understand the basics of working of using gates, Flip-Flop etc.

CO2: Carry out the experimental investigation and analysis.

CO3: Familiarize with the working of different types of gates, Flip-Flop, counters etc.

CO4: Demonstrate the basics of Switching Theory and Logic Design by hands-on experiments

Manufacturing Science and Technology – I Lab (MAP-006)

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. Fabrication of part using powder metallurgy process.
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 (MAP-007)

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",1stEdition, 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

SYLLABUS

For

B.TECH

(Mechanical & Automation Engineering)

3rd Year

Effective from – Session 2024-25

B.TECH. (MECHANICAL & AUTOMATION)												
SEMESTER-V												
Sl. No.	Subject Codes	Category	Subject	Periods			Evaluation Scheme					Subject Total	Credit
							Sessional Exam			ESE			
				L	T	P	CT	TA	Total	TE	PE		
1	MAT-008	DC	Mechatronics	3	1	0	30	20	50	100		150	4

2	MAT-009	DC	Robotics	3	1	0	30	20	50	100		150	4
3	MAT-010	DC	Manufacturing Science and Technology -II	3	0	0	30	20	50	100		150	3
4	MAT-XXX	DE	Departmental Elective - 1	3	1	0	30	20	50	100		150	4
5	MAT-XXX	DE	Departmental Elective - 2	3	0	0	30	20	50	100		150	3
6	MAP-008	DLC	Mechatronics Lab	0	0	2		25	25		25	50	1
7	MAP-009	DLC	Robotics Lab	0	0	2		25	25		25	50	1
8	MAP-010	DLC	Manufacturing Science and Technology -II Lab	0	0	2		25	25		25	50	1
9	MAP-011	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	
11	GP-05	NC	General Proficiency						50			50	
			Total	**17**	**3**	**8**						**950**	**22**
12		**Minor Course (Optional)**		3	1	0	30	20	50	50		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**
MAT-011	Industrial Engineering & Management	MAT-016	Refrigeration and Air Conditioning
MAT-012	Instrumentation & Control	MAT-017	Optimization Techniques in Engineering
MAT-013	Advanced Strength of Material	MAT-018	Finite Element Method
MAT-014	Advanced Fluid Mechanics	MAT-019	Advanced Welding Technology
MAT-015	Heat & Mass Transfer	MAT-020	Process Planning & Cost Estimation

Mechatronics (MAT-008)

L T P: 3 1 0

Course Objectives

The course should enable the students to:

- Understand the fundamentals of Mechanical, Electrical, Hydraulic and Pneumatic Actuation systems.
- Learn the basic hardware and software elements used for proper and successful operation of various equipments.
- Understand the fundamentals and concepts of Digital Electronics and Systems.
- Acquire the knowledge of sensors, transducers and their applications.
- Learn about System Interfacing, Data Acquisition and PLC.

Particulars

Unit 1 **(8 Hrs)**

Mechanical Actuating Systems: Types of motion, Degrees of freedom, constraints, Kinematic Chains, Cam, Gear and gear trains, Ratchet and pawl Belt drive, chain drive, Bearing, pre loading.

Hydraulic & Pneumatic Actuation Systems: Fluid power systems, hydraulic systems, Pneumatic systems, system structure and signal flow, hydraulic pumps and Pressure Control Valves and regulation, air compressors and treatment, Cylinders, Direction Control Valves, Process control valves, Rotary Actuators, Accumulators, Amplifiers, and Pneumatic Sequencing Problems.

Unit 2 **(10 Hrs)**

Electrical Actuation Systems: Switching Devices, Mechanical Switches – SPST, SPDT, DPDT, keypads; Relays, Electronic sensors, Diodes, Thyristors, Transistors, solenoid operating Valve, Solenoid Operated Hydraulic and Pneumatic Valves, Electro-Pneumatic Sequencing Problems. Control of DC Motors, Permanent Magnet DC Motors, Bush less Permanent Magnet DC Motors, AC Motors and speed controls, Stepper Motors and Controls, Servo Motors.

Digital Electronics and Systems: Number Systems, Binary Mathematics, Boolean Algebra, Gates and Integrated Circuits Like 7408, 7402, Karnaugh Maps, Application of Logic Gates as: Parity Generators, Digital Comparators, BCD to Decimal Decoders, Flip Flops and applications, sequential logic, Microprocessor and microcontrollers, programming, instruction set, assembly language, C programming for Intel 8051 / 8082 micro-controller.

Unit 3 **(10 Hrs)**

Sensors, Transducers and Application: Performance Terminology, Static and Dynamic Characteristics, Displacement, Position and Proximity Sensors, Potentiometer Sensors, Strain Gauge Element, LVDT, Optical Encoders, Pneumatic Sensors, Hall Effect Sensors, Tachogenerators, Strain Gauge Load Cell, Thermostats, Photo Darlington. Interfacing Sensors in Mechatronic System.

System Interfacing and Data Acquisition: Data acquisition systems, Data loggers, SCADA, Interfacing requirements, Buffers, Darlington Pair, Handshaking, Serial and Parallel Port Interfacing, Peripheral Interface Adapters, Analog to Digital Conversion, Digital To Analog Conversion, Sample and Hold Amplifiers, Multiplexers, Time Division Multiplexing, Digital Signal Processing, Pulse Modulation, Component Interconnection and Impedance Matching, Interfacing Motor drives. Electrical power supply and protection.

Unit 4 **(8 Hrs)**

Introduction to Signal Conditioning: Signal Conditioning Processes, Inverting Amplifiers, Non Inverting Amplifiers, Summing, Integrating, Differential, Logarithmic Amplifiers, Comparators, Amplifiers Error, Filtering, wheatstone Bridge, Temperature Compensation, Thermocouple Compensation.

Programmable Logic Controllers: Programmable logic controllers (PLC) Structure, Input / Output Processing, principles of operation, PLC versus computer, Programming Languages, programming using Ladder Diagrams, Logic Functions, Latching, Sequencing, Timers, Internal Relays And Counters, Shift Registers, Master and Jump Controls, Jumps, Data Movement, Code Conversion, Data handling and manipulation, selecting a PLC.

Unit 5 **(8 Hrs)**

Case Studies: Mechatronic approach to design, Boat Auto pilot, high speed tilting train, automatic car park system, coin counter, engine management system, autonomous mobile system, antilock brake system control, Auto-Focus Camera, Printer, Domestic Washing Machine, Optical Mark Reader, Bar Code Reader and Pick and Place robot Arm, Using PLC for extending and retracting a pneumatic piston and two pneumatic pistons in different combinations, control of vibrating machine, control of process tank, control of conveyor motor, detecting, sorting and packaging unit.

Text Books:

1. W. Bolton, ―Mechatronics – Electronic control systems in Mechanical & Electrical Engineering‖, Pearson Education Ltd., 2003.

2. K. P. Ramachandran, G.K. Vijayaraghavan, M.S. Balasundaram, Mechatronics - Integrated Mechanical Electronic Systems, Wiley;

Reference Books:

1. Joji P, Pneumatic Controls, Wiley.
2. Dan Necsulescu, Mechatronics, Pearson
3. David G Alciatore, Michael B Histand, ―Introduction to Mechatronics and measurement systems‖, Mc Graw Hill Education.
4. A Smaili, F Mrad, ―Mechatronics – Integrated Technologies for Intelligent Machines, Oxford Higher Education.
5. NitaigourPremchand Mahalik, ―Mechatronics Principles, Concepts & Application‖, Tata McGraw Hill Publishing Co.Ltd., 2003.

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.

Robotics (MAT-009)

L T P: 3 1 0

Course Objectives

The course should enable the students to:

- Understand the fundamentals of Robot Technology.
- Learn about the robot kinematics and robot differential motion.
- Learn about the robot dynamics and end effectors.
- Learn about robots applications for manufacturing.
- Learn about robots industrial applications.

Particulars

Unit-1 **(8 Hrs)**

Fundamentals of Robot Technology: Robot definition, automation and robotics, Robot anatomy, Work volume, Drive systems. Control systems and dynamic performance. Accuracy and repeatability. Sensors and actuators used in robotics. Machine Vision, Robot configurations, Path control. Introduction to robot languages. Applications; Types (Mobile, Parallel); Serial: Cartesian, Cylindrical, etc.; Social Issues.

Unit-2 **(8 Hrs)**

Robot Kinematics: Mapping, Homogeneous transformations, Rotation matrix, Forward Kinematics (DH Notation) and inverse kinematics: Closed form solution.

Robot Differential Motion: Linear and Angular velocity of rigid link, Velocity along link, Maipulator jacobian, Statics: Use of jacobian.

Unit-3 **(8 Hrs)**

Robot Dynamics: Lagrangian Mechanics, Lagrangian Formulation and numericals. Dynamics, Newton-Euler Recursive Algorithm, Simulation. Euler-Lagrange Equations of motion/Any one other formulation like using Decoupled Natural Orthogonal Complements (DeNOC)

End effectors: Mechanical and other types of grippers. Tools as end effectors. Robot and effector interface. Gripper selection and design.

Unit-4 **(8 Hrs)**

Applications for Manufacturing: Flexible automation. Robot cell layouts. Machine interference. Other considerations in work cell design. Work cell control, interlocks. Robot cycle time analysis. Mechanical design of robot links.

Unit-5 **(8 Hrs)**

Robot Applications: Industrial applications of robots, Medical, Household, Entertainment, Space,

Underwater, Defense, Disaster management. Typical applications of robots in material transfer, machine loading/unloading; processing operations; assembly and inspection. Applications, Micro and Nanorobots, Future Applications.

Text Books:

1. R.K. Mittal, I.J. Nagrath, ―Robotics & Control‖, Tata McGraw & Hills, 2005.
2. Mikell P Groover, Mitchell Weiss ―Industrial Robotics: Technology, Programming and Application‖ Tata McGraw & Hills, 2009.
3. Saha, S.K., Introduction to Robotics, 2nd Edition, McGraw-Hill Education, New Delhi, 2014

Reference Books:

1. John J.Craig; ―Introduction to Robotics Mechanics & Control‖, Pearson Education, 2004.
2. Robert J. Schilling, ―Fundamentals of Robotics, analysis & Control‖, Prentice Hall (I) P. Ltd., 2002
3. Mark W. Spong, Seth Hutchinson, M. Vidyasagar ―Robot Modeling and Control‖ John Wiley 2nd Ed
4. J Srinivasan, R.V.Dukkipati, K. Ramji, ―Robotics control & programming‖, Narosa.
5. Ghosal, Ashitava, ―Robotics: Fundamental Concepts and Analysis,‖ Oxford University Press, 2006
6. M. Murray, M., Li, Zexiang, Sastry, S.S., ―A Mathematical Introduction to Robotic Manipulation,‖ CRC Press, 1994
7. Tsai, L.W., ―Robot Analysis: The Mechanics of Serial & Parallel Manipulators,‖ Wiley 1999
8. Niku, S. B., ―Introduction to Robotics: Analysis, Systems, Applications‖, Prentice Hall, 2001

Course Outcomes

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

CO1: Apply fundamentals of Robot Technology.

CO2: Explain and apply the robot kinematics and robot differential motion.

CO3: Gain knowledge about robot dynamics and end effectors.

CO4: Apply robots technology in applications for manufacturing.

CO5: Apply robots technology in various industrial applications.

Manufacturing Science and Technology – II (MAT-010)

L T P: 3 1 0

Course Objective

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 **(9 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 **(9 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.

Reference Books:

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)- Pearson India, 2014.
2. Ghosh and A. K. Malik (2010) Manufacturing Science, East West Press Private Limited New Delhi.
3. P N Rao, “Manufacturing Technology”, Tata McGraw Hill, 2017.
4. Modern Machining Processes by P.C. Pandey & H.S. Shan.
5. Manufacturing science by Degarmo, Wiley India.
6. Manufacturing Process by Sontosh Bhatnagar, 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 (MAT-011)

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 (MAT-012)

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. Servomechanism. 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 (MAT-013)

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 (MAT-014)

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.

Heat and Mass Transfer (MAT-015)

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.

DEPARTMENTAL ELECTIVE - 2

Refrigeration and Air Conditioning (MAT-016)

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 **(9Hrs)**

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 **(9Hrs)**

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.

Optimization Techniques in Engineering (MAT-017)

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 of India 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 (MAT-018)

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 (MAT-019)

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, Spray welding /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 (MAT-020)

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.

Mechatronics Lab (MAP-008)

L T P: 0 0 2

Course Objectives

The course should enable the students to:

- Provides the necessary background to understand the fundamental concepts of mechatronics.
- Study DC valves and actuators to develop pneumatic circuits.
- Acquire the knowledge of sensors, transducers and their applications.
- Analyze the theoretical knowledge and apply it in conducting experiments of mechatronics.

Particulars

List of experiments (minimum 08 of the following)

1. Study of DC valves and actuators and develop pneumatic circuits to sequence A+A-,A+B+A-B-;
2. Develop Electro –pneumatic sequencing circuits in sequence - A+A-, A+B+A-B-;
3. Develop pneumatic circuits to sequence A+A- B+B-, A+B+C+A-B-C-; A+B+B-A-;
4. Develop Electro –pneumatic sequencing circuits in sequence - A+A-B+B-; A+B+B-A-;
5. Study a simulation software for simulating ladder diagram for a PLC and make AND/OR/NAND/ NOR / XOR logic.
6. Simulate ladder diagram on a PLC software for using flags, latch(s), timer(s), counter(s), registers.
7. Wire an industrial PLC and program it for AND/ OR/ NAND / XOR logic.
8. Wire and industrial PLC and program for using flags, latch(s), timer(s),counter(s),Integers.
9. Program a 8051 / 8052 microcontroller to use input and output ports;
10. Program a 8051 / 8052 microcontroller to run a stepper motor;
11. Program a 8051 / 8052 microcontroller to use a dc motor;
12. Program a 8051 / 8052 microcontroller to use a servo motor;
13. Introduction to SCADA and HMI programming

Reference Books:

1. Joji P, Pneumatic Controls, Wiley.
2. Dan Necsulescu, Mechatronics, Pearson
3. David g Alciatore, Michael B Histand, ―Introduction to Mechatronics and measurement systems, McGraw Hill Education.

4. A Smaili, F Mrad, ―Mechatronics – Integrated Technologies for Intelligent Machines, Oxford Higher Education.
5. Nitaigour Premchand Mahalik, ―Mechatronics Principles, Concepts & Application‖, Tata McGraw Hill Publishing Co.Ltd., 2003.

Course Outcomes

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

CO1: Demonstrate the fundamental concepts of mechatronics.

CO2: Develop pneumatic circuits using DC valves and actuators.

CO3: Apply the knowledge of sensors, transducers in industrial applications.

CO4: Conduct and demonstrate experiments of mechatronics lab.

Robotics Lab (MAP-009)

L T P: 0 0 2

Course Objectives

The course will enable the student to:

- Learn about the programing of robot components.
- Understand concepts related to robotic arm, end effectors etc.
- Learn about different sensors used with robots.
- Learn MATLAB for simulating a robot function.

Particulars

List of Experiments (minimum 08 of the following)

1. Study of robotic arm, end effectors and its configuration and introduction to any software (such as workspace) used to simulate or program a robot;
2. Program / simulate a robot for moving on a path;
3. Program / simulate a robot for pick and place operation;
4. Program / simulate a robot for welding operation;
5. Program / simulate a robot for water jet machining;
6. Program / simulate a robot for saving it from striking any other object in workspace;
7. Program / simulate two robots working together;
8. Make a 3R robot and simulate its motion.
9. Use a microcontroller to program simple toy robot / model robot;
10. Micro controller program to use different sensors and further move toy robot(s) / model robot;
11. Use MATLAB / Scilab. Any other software to program numericals (Robot Arm kinematics) taught in class.
12. Use MATLAB / Scilab and other robot specific software like Robo-Analizer for the study of kinematic and dynamics of 3R robots.
13. Demos of a real robot; Introduce Virtual Robotics Lab. in ADAMS or SimMechanics of MATLAB.

Note:

A course on Robotics must use one or more software to not only visualize the motion and characteristics of robots but also to analyzer/synthesize/design robots for a given application (say, as class projects). Typical software which can be used are as follows:

- RoboAnalyzer (Developed by IIT Delhi; http://www.roboanalyzer.com)

- Virtual Labs. (Developed by IIT Kharagpur; http://vlabs.iitkgp.ernet.in/moodle/)
- MATLAB, its modules Simulink and SimMechanics (http://www.mathworks.com)
- Mathematica: Symbolic software (http://www.wolfram.com)
- Multi Bondgraph (http://bondgraph.org)
- ADAMS (by MSC software; http://www.mscsoftware.com)
- RerurDyn (by Function Bay, Korea; http://www.functionbay.co.kr)

Course Outcomes

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

CO1: Write a code for different robot components.

CO2: Demonstrate the concepts related to robotic arm, end effectors etc.

CO3: Gain knowledge about different sensors used with robots.

CO4: Code in MATLAB for simulating a robot function.

Manufacturing Science and Technology-II Lab (MAP-010)

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 (MAP-011)

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.

B.TECH (MECHANICAL & AUTOMATION)													
SEMESTER-VI													
Sl. No	**Subject Codes**	**Category**	**Subject**	**Periods**			**Evaluation Scheme**					**Subject Total**	**Credit**
							Sessional Exam			**ESE**			
				L	**T**	**P**	**CT**	**TA**	**Total**	**TE**	**PE**		
1	MAT-021	DC	Operation Research	3	1	0	30	20	50	100		150	4
2	MAT-022	DC	Design of Machine Elements	3	1	0	30	20	50	100		150	4
3	MAT-023	DC	Manufacturing Automation	3	1	0	30	20	50	100		150	4
4	MAT-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	MAP-012	DLC	MATLAB Programming for Mechanical Engineers	0	0	2		25	25		25	50	1
7	MAP-013	DLC	Automation Lab	0	0	2		25	25		25	50	1
8	MAP-014	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	
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* To be completed at the end of sixth semester (during Summer Break) & its evaluation/credit to be added in seventh semester.													

Departmental Elective - 3	
MAT-024	Experimental Stress Analysis
MAT-025	Machine Tool Design
MAT-026	Fuels and Combustion
MAT-027	Precision Engineering
MAT-028	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 (MAT-021)

L T P: 3 1 0

Course Objectives

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 Education.
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 (MAT-022)

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.

Manufacturing Automation (MAT-023)

L T P: 3 1 0

Course Objectives

The course will enable the student to:

- Acquire a brief exposure to automation principles and control technologies.
- Get introduce with the concept of fixed automation using transfer lines.
- Be train in the programmable automation such as CNC and industrial robotics.
- Gain knowledge on the use of numerical control and robotics.
- Gain knowledge on the use of automated material handling, storage and data capture.

Particulars

Unit 1 **(8 Hrs)**

Manufacturing Operations: Automation in production systems, principles and strategies, Product/production relationships, Production concepts and mathematical models, manufacturing economics.

Unit 2 **(9 Hrs)**

Control Technologies: Automated systems – elements, functions, levels, Continuous Vs discrete control, Computer process control, Sensors, Actuators, ADC, DAC, Programmable logic controllers – ladder logic diagrams.

Unit 3 **(8 Hrs)**

Transfer Lines: Automated production lines – applications, Analysis – with and without buffers, automated assembly systems, line unbalancing concept.

Unit 4 **(9 Hrs)**

Numerical Control and Robotics: NC - CNC – Part programming – DNC – Adaptive control – Robot anatomy – Specifications –End effectors – Industrial applications.

Unit 5 **(6 Hrs)**

Automated Handling and Storage: Automated guided vehicle systems, AS/RS, Carousel storage, Automatic data capture - Bar code technology.

Reference Books:

1. Mikell P.Groover, Automation, "Production Systems and Computer Integrated Manufacturing" PHI, 2008.
2. Mikell P.Groover, Emory W. Zimmers, Jr., "CAD/CAM: Computer - Aided Design and Manufacturing", PHI, 2007

Course Outcomes

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

CO1: Understand the requirements of automation in manufacturing systems.

CO2: Demonstrate knowledge in the techniques of machinery automation, shop floor automation.

CO3: Select material handling systems for automated industries.

CO4: Gain basic knowledge in CAD systems.

DEPARTMENT ELECTIVE-3

Experimental Stress Analysis (MAT-024)

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 photoelasticity 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 Photoelasticity: 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 (MAT-025)

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 guideways, 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 Guideways, Power Screws and Spindles: Functions and Types of Guideways, Design of Guideways, Design of Aerostatic Slideways, Design of Anti-Friction Guideways, Combination Guideways, 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 (MAT-026)

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.
4. 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 (MAT-027)

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 (MAT-028)

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.

OPEN ELECTIVE -1

Total Quality Management (AHT-011)

LTP: 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 Hrs)**

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 Hrs)**

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 Hrs)**

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 Hrs)**

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 Hrs)**

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 Behaviour 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 (MAP-012)

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.

Automation Lab (MAP-013)

L T P: 0 0 2

Course Objectives

The course will enable the student to give hands on experience on:

- CNC programming on Lathe machine.
- CNC programming on Milling machine.
- Programming of Robotics
- Programming of PLC

Particulars

List of experiments (Minimum 8 of the following)

1. Part programming and Machining of Simple Turning using CNC Lathe
2. Part programming and Machining of Taper Turning using CNC Lathe
3. Part programming and Machining using Multiple Turning cycle in CNC Lathe
4. Part programming and Simulation of Thread Cutting using CNC Lathe
5. Part programming and Machining of Contour using CNC Milling Machine
6. Part programming and Machining of Circular Pocket using CNC Milling Machine
7. Part programming and Machining of Rectangular Pocket using CNC Milling Machine
8. Part programming and Machining using Mirroring Cycle in CNC Milling Machine
9. Programming Exercise for Robots
10. Programming of PLC using Ladder Logic Diagram

Reference Books:

1. Mikell P.Groover, Automation, "Production Systems and Computer Integrated Manufacturing" PHI, 2008.
2. Mikell P.Groover, Emory W. Zimmers, Jr., "CAD/CAM: Computer - Aided Design and Manufacturing", PHI, 2007

Course Outcomes

After this course students will be capable of:

CO1: Performing CNC programming using G-code and M-code.
CO2: Performing programming for controlling the robots.
CO3: Performing programming PLC using ladder Logic Diagram.

List of Equipment for a Batch of 30 Students

1. CNC Lathe
2. CNC Milling Machine
3. Pick and Place Robot
4. PLC Trainer

Project Stage - I (MAP-014)

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 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 & Automation Engineering)

4th Year

Effective from – Session 2025-26

B.TECH. (MECHANICAL & AUTOMATION)													
SEMESTER-VII													
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 -1 / HSMC-2	3	1	0	30	20	50	100		150	3
2	MAT-XXX	DE	Departmental Elective-4	3	0	0	30	20	50	100		150	3
3	MAT-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	MAP-015	DLC	Project Seminar	0	0	2			50			50	1
6	MAP-016	DLC	Project Stage -II	0	0	4			100			100	2
7	MAP-017	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			Open Elective (Optional)	3	1	0	30	20	50	50		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**
MAT-29	Power Plant Engineering	MAT-034	Robotics and automation
MAT-30	Automation Engineering	MAT-035	Viscous Flow Theory
MAT-31	TQM & Reliability Engineering	MAT-036	Modern Automated and Intelligent Vehicles
MAT-32	Design of Jigs & Fixtures	MAT-037	Advance Materials for Robotics
MAT-33	Flexible Manufacturing System	MAT-038	Computational Fluid Dynamics

HSMC-1	AHT-015	Rural Development, Administration and Planning
HSMC-2	AHT-016	Project Management & Entrepreneurship

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 (McClellend'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 (MAT-029)

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.
- Get an 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.

Automation in Engineering (MAT-030)

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.

TQM and Reliability Engineering (MAT-031)

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,4th Edition 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.

Design of Jigs, Fixture and Press Tools (MAT-032)

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 (MAT-033)

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 ", Addison Wesley 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 (MAT-034)

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 manipulators and 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

Viscous Flow Theory (MAT-035)

L T P: 3 0 0

Course Objective

To impart knowledge about various viscous flow theory and solve relevant problems.

Particulars

Unit 1

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

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

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

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

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.

Modern Automated and Intelligent Vehicles (MAT-036)

L T P: 3 1 0

Course Objectives

The course should enable the students to:

- Understand working of Connected, automated and intelligent vehicles.
- Acquire knowledge related to Sensor Technology for Advanced Driver Assistance Systems.
- Study fundamentals of Wireless Technology.
- Know about recent driver assistance system technology and recent development in automated technology.

Particulars

Unit 1 **(06 Hrs)**

Introduction to Connected, automated and Intelligent cars: Automotive Electronics Overview, Advanced Driver Assistance Electronic Systems, Connected Car Technology: Connectivity Fundamentals, Navigation and Other Applications, Connected Car Display Technology.

Unit 2 **(06 Hrs)**

Connected and Autonomous Vehicle Technology: Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs, Basic Cyber-Physical System Theory and Autonomous Vehicles Autonomous Vehicles: Driverless Car Technology, Moral, Legal, Roadblock Issues, Technical Issues, Security Issues.

Unit 3 **(08 Hrs)**

Sensor Technology for Advanced Driver Assistance Systems: Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, Impaired Driver Technology: Driver Impairment Sensor

Technology, Sensor Technology for Driver Impairment Detection, Transfer of Control Technology.

Unit 4 **(10 Hrs)**

Overview of Wireless Technology: Wireless System Block Diagram and Overview of Components, Transmission Systems – Modulation/Encoding, Receiver System Concepts – Demodulation/Decoding, Signal Propagation Physics, Basic Transmission Line and Antenna Theory, Wireless System Standards and Standards Organizations: Wireless Networking and Applications to Vehicle Autonomy: Basics of Computer Networking – the Internet of Things, Wireless Networking Fundamentals, Integration of Wireless Networking and On-Board Vehicle Networks.

Unit 5 **(10 Hrs)**

Recent Driver Assistance System Technology: Basics of Theory of Operation, Applications – Legacy, Applications – New, Applications – Future, Integration of ADAS Technology into Vehicle Electronics, System Examples, Role of Sensor Data Fusion, Recent Driver Assistance System Technology applied in various automobile companies dealing with Non-Passenger Car, mini project to apply knowledge of various technologies related to connected vehicles.

Reference Books:

1. Electric & Hybrid Vehicles, A.K. Babu, Khanna Publishing House
2. Automotive Fuel Technology-Electric, Hybrid and Fuel-Cell Vehicles: Jack Erjavec & Jeff Arias
3. Electric and Hybrid Vehicles: Design Fundamentals: Iqbal Husain
4. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory and Design: Mehrdadehsani, Yimingao, AliEmadi.
5. Mullett, Wireless Telecommunications Systems and Networks, Thomson – Delmar Learning, ISNB#1-4018-8659-0, 2006.
6. Mullett, Basic Telecommunications: The Physical Layer, Thomson – Delmar Learning, ISBN#1-4018-4339-5, 2003

Course Outcomes

Upon completion of this course the students can able to understand

CO1: To equip students with a solid foundation in advanced automotive technologies.

CO2: To enabling them to contribute to the design, development, and implementation of electric and hybrid vehicles,

CO3: To connect systems, and autonomous driving technologies.

CO4: Deep understanding of sensor technologies, control systems, and the integration of electronics in modern vehicles.

CO5: The scope for careers in the rapidly evolving automotive industry.

Advance Material for Robotics (MAT-037)

L T P: 3 1 0

Course Objective

The course should enable the students to:

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

Particulars

Unit 1 **(9 Hrs)**

Advanced Metallic Materials- Fundamental principles of advanced materials and application of advanced materials to robotics using a multidisciplinary science based approach. Liquid-solid transformation-Nucleation and kinetics of growth, interface morphologies, nonequilibrium freezing, segregation. Nucleation in the solid state transformations, diffusion in solid state, diffusion equations for steady state and transient conditions, Strengthening methods and mechanisms.

Unit 2 **(8 Hrs)**

Structural Materials for Robots – Aluminium, copper, magnesium, steel, nickel and titanium alloys. Recent advances in materials development- Hi-Entropy alloys, functionally gradient materials, shape memory alloys, metallic composite for soft robotics, computational metamaterials.

Unit 3 **(9 Hrs)**

Composites in Robotics- Types of matrices and reinforcements, principles, properties and applications, stretchable elastomeric sensor and ionic polymer for robotics, kevlar, biodegradable smart materials, macroscopic composites, three-dimensional, periodic cellular architecture. Special processing techniques of material for robotics.

Unit 4 **(12 Hrs)**

Introduction to thin film sand sensor material, energy material and refractory materials and characterization. Materials characterization techniques for advanced and robotic material – Recap of mechanical, metallurgical, chemical and thermal methods. Instrumentational methods – Scanning electron microscopy, transmission electron microscopy and energy dispersive analyses, X-ray diffraction, atomic force microscopy, Field array NDT techniques for futuristic materials, surface patterning techniques.

Reference Books:

1. Bhushan Bharat, "Springer Handbook of Nanotechnology", Springer, 2017
2. SohelRana and Raul Fangueiro, "Advanced Composite Materials for Aerospace Engineering: Processing, Properties and Applications", Woodhead Publishing, 2016.
3. Rowe Jason, "Advanced Materials in Automotive Engineering", Woodhead Publishing, 2016.
4. Cantor Brian, Hazel Assender and Patrick Grant, "Aerospace Materials", CRC Press, 2015.
5. Park Joon and Roderic S. Lakes, "Biomaterials: an Introduction", Springer Science & Business Media, 2007.
6. Cao Guozhong, "Nanostructures & Nanomaterials: Synthesis, Properties &Applications", Imperial College Press, 2004.
7. Michio Inagaki Feiyu Kang Masahiro Toyoda Hidetaka Konno, "Advanced Materials Science and Engineering of Carbon", 1st Edition, Butterworth-Heinemann, 2013, ISBN: 9780124077898
8. Gaskell, David R., "Introduction to Metallurgical Thermodynamics", McGraw Hill, 1973
9. W. D. Callister, "Materials Science and Engineering: An Introduction", John Wiley & Sons, 2007.
10. C. Kittel, "Introduction to Solid State Physics" Wiley Eastern Ltd, 2005.
11. Michael Shur, "Physics of Semiconductor Devices", Prentice Hall of India, 1995.
12. Charles P Poole Jr., and Frank J. Ownes, "Introduction to Nanotechnology", John Wiley Sons, Inc., 2003.
13. M. H. Loretto, "Electron Beam Analysis of Materials", Chapman and Hall, 1984.
14. Seymour and Carraher, " Polymer chemistry", Marcel Dekker, 2003Sam Zhang, Lin Li and Ashok Kumar,
15. "Materials Characterization Techniques", CRC Press, (2008)

Course Outcomes

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

CO1: Gain knowledge about thermodynamics of nucleation and strengthening mechanisms.

CO2: Analyze metallic, functional and polymer materials and its processing.

CO3: Acquire knowledge in high performance materials and techniques for robotics.

CO4: Analyze structure properties, and performance using advanced material characterization techniques.

Computational Fluid Dynamics (MAT-038)

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.

Project Seminar (MAP-015)

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 (MAP-016)

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 (MAP-017)

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.

B.TECH. (MECHANICAL & AUTOMATION)													
SEMESTER-VIII													
Sl.No.	**Subject Codes**	**Category**	**Subject**	**Periods**			**Evaluation Scheme**					**Subject Total**	**Credit**
							Sessional Exam			**ESE**			
				L	**T**	**P**	**CT**	**TA**	**Total**	**TE**	**PE**		
1	ATH-XXX	HSC	HSMC-2 /HSMC-1	3	0	0	30	20	50	100		150	3
2	MAT-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	MAP-020	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			Open Elective (Optional)	3	1	0	30	20	50	50		150	4

	Departmental Elective - 6
MAT-039	Modelling & Simulation
MAT-040	3D Printing &Rapid Prototyping
MAT-041	Reliability and Maintenance Engineering
MAT-042	Project Management
MAT-043	Renewable Energy systems

Open Electives offered by the department in 7th and 8th Semester for other department students:

Open Elective-2	MAT-044	Reliability and Maintenance Engineering
Open Elective-3	MAT-045	Project Management
Open Elective-4	MAT-046	Six Sigma
Note: Mechanical & Automation 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 (MAT-039)

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.

3D Printing and Rapid Prototyping (MAT-040)

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 **(8 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 **(8 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 Cofer Newnes
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.

Reliability and Maintenance Engineering (MAT-041)

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 Management (MAT-042)

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. Prasanna Chandra, "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.

Renewable Energy System (MAT-043)

L T P: 3 0 0

Course Objectives

The course will enable the students to:

- Gain an understanding about the basics of energy systems.
- Learn about the implementation of solar energy systems concepts.
- Gain the knowledge about micro and small hydro energy systems.
- Learn and understand about the concepts of biomass energy systems.
- Learn about the concepts of ocean and wind energy systems.

Particulars

Unit 1 **(8 Hrs)**

Introduction: Energy and development, energy demand and availability, energy crisis, conventional and non-conventional, renewable and non-renewable energy resources, environmental impact of conventional energy usage, basic concepts of heat and fluid flow useful for energy systems.

Unit 2 **(8 Hrs)**

Solar Energy Systems: Solar radiations data, solar energy collection, storage and utilization, solar water heating, air heating, power generation, refrigeration and air conditioning, solar energy system economics.

Unit 3 **(8 Hrs)**

Micro and Small Hydro Energy Systems: Resource assessment of micro and small hydro power, micro, mini and small hydro power systems, economics, pump as turbine, special engines for low heads, velocity head turbines, hydrams, water mills.

Unit 4 **(8 Hrs)**

Biomass Energy Systems: Availability of biomass- agro, forest, animal, municipal and other residues, bioconversion technologies, cooking fuels, biogas, producer gas, power alcohol from biomass, power generation, internal combustion engine modifications and performance, system economics.

Unit 5 **(8 Hrs)**

Ocean Energy Systems: Ocean temperature energy conversion system (OTEC), Wave energy systems, Tidal power systems.

Wind Energy Systems: Wind data, horizontal and vertical axis wind mills, wind farms, performance and economics of wind energy.

Reference Books:

1. Boyle, G. “Renewable Energy”, 2nd Ed., Oxford University Press.
2. Da Rosa, A. V. “Fundamentals of Renewable Energy Processes”, 2nd Ed., Academic Press.
3. Hodge, B. K., “Alternative Energy Systems and Applications”, John Wiley & Sons.
4. Sukhatme, S.P. and Naik, J.K., “Solar Energy”, 3rd Ed., Tata McGraw Hill.
5. Duffie, J.A. and Beckman, W.A., “Solar Engineering of Thermal Processes”, John Wiley & Sons.

Course Outcomes

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

CO1: List and generally explain the main sources of energy and their primary applications in the world.

CO2: Describe the different solar energy systems.

CO3: Discuss remedies/potential solutions related to micro and small hydro energy systems.

CO4: Describe and use the biomass energy systems and technologies.

CO5: Describe/illustrate basic ocean and wind energy systems.

OPEN ELECTIVE - 2

Reliability and Maintenance Engineering (MET-044)

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

Unit 1 **(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.

OPEN ELECTIVE - 3
Project Management (MAT-045)

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 (MAT-046)

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 (MAP-018)

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.