B. Tech. Programme Structure

First Semester					
Theory					
Sl. No	**Category**	**Subject Code**	**Subject Name**	**L-T-P**	**Credit**
1	BSC	19FY1BS01T/ 20FY1BS01T/ 19FY1BS02T	Physics (2019 Batch)/ Physics (2020 Batch)/ Chemistry	3-0-0	3
2	BSC	19FY1BS03T	Mathematics-I	3-0-0	3
3	ESC	19FY1ES01T/ 19FY1ES02T/ 20FY1ES02T	Basic Electrical Engineering/ Basic Electronics Engineering (2019 Batch)/ Basic Electronics Engineering (2020 Batch)	2-0-0	2
4	ESC	19FY1ES03T/ 19FY1ES04T	Basic Mechanical Engineering/ Basic Civil Engineering	2-0-0	2
5	HSMC	19FY1HS01T	English	2-0-0	2
6	MC	19FY1MC01T	Induction Training (21 Days)		0
Total Credit (Theory)					**12**
Practical					
1	BSC	19FY1BS01L/ 19FY1BS02L	Physics Lab/ Chemistry Lab	0-0-2	1
2	ESC	19FY1ES01L/ 19FY1ES02L	Basic Electrical Engineering Lab / Basic Electronics Engineering Lab	0-0-2	1
3	ESC	19FY1ES03L/ 19FY1ES04L	Basic Mechanical Engineering Lab/ Basic Civil Engineering Lab	0-0-2	1
4	ESC	19FY1ES05L/ 19FY1ES06L	Engineering Graphics & Design / Workshop or Manufacturing	0-0-2	1
5	HSMC	19FY1HS01L	English Language Lab	0-0-2	1
Total Credit (Practical)					**5**
Total Semester Credit					**17**

Subject Code: 19FY1BS01T	Subject Name: Physics	L-T-P:3-0-0	Credit: 3

Course Objectives:

1. Understand and apply the knowledge to analyze the fundamental physics behind their courses in higher semester.
2. Do project works based on theoretical as well as experimental research.
3. Use the knowledge of Physics for Industrial development.
4. Generate fundamental knowledge needed for the future technological advances that will continue to drive the economic engines of the society.
5. Create an exciting intellectual adventure that inspires young mass and expands the frontiers of their knowledge about Nature.

Syllabus

Module-1 **(8 Hours)**

Oscillation & Waves:

Simple Harmonic Oscillation: velocity of motion, acceleration, time period, frequency, phase; damped harmonic oscillation: Wave equation of damped vibration, logarithmic decrement, quality factor, relaxation time; Forced oscillation, resonance, velocity resonance and amplitude resonance, coupled oscillation, Normal coordinates and normal frequencies, In-phase and out-of-Phase Oscillation, Concept of wave and wave equation, reflection and transmission of longitudinal waves at boundaries (Concepts).

Module - 2 **(10 Hours)**

Optics:

Concept of interference, two sources interference pattern, Bi-prism, Fringe width, uses of biprism, Newton's ring; measurement of wavelength and refractive index. Diffraction: Huygen's

principle, Fresnel's Diffraction and Fraunhoffer's diffraction, Half period zone, Zone plate, construction, principle, multiple foci, comparison of zone plate with convex lens, Fraunhofer's diffraction of Single slit, intensity distribution.

Module - 3 **(10 Hours)**

Laser and Fiber Optics:

Atomic excitation and energy states, Interaction of external energy with atomic energy states, Absorption, spontaneous emission and stimulated emission, Population inversion, Pumping mechanism, optical pumping, Electrical Pumping, Components of laser system, active medium, population inversion (All concepts only, not details), Ruby laser, Helium-Neon laser, Semiconductor laser (basic concepts, and Engineering application only, mechanism not required), Structure of optical fibre, Principle of propagation and numerical aperture (concept only, derivation not required), Acceptance angle, classification of optical fibre (Single mode and Multi mode, SIN and GRIN), FOCL (Fiber Optic Communication Link)

Solid State Physics:

Crystalline and Amorphous solid, unit cell, lattice parameter, Miller Indices, Reciprocal Lattice (Only concept), Bragg's law, Concept of fermions and Bosons and their distribution Functions, Band theory of Solids (Qualitative), Classification of materials: metals, semiconductor and insulator in terms of band theory.

Module - 4 **(8 Hours)**

Electromagnetism:

(Student will be familiarized with some basic used in vector calculus prior to Development of Maxwell's electromagnetic wave equations. No proof of theorems and laws included in this unit expected- statement and interpretation should sufficient.) Introduction; Scalar and vector fields, Gradient of Scalar Field, divergence and curl of Vector Field, Gauss divergence theorem, Stokes theorem (Only statements, no proof), Gauss's law of electrostatics in free space and in a medium

(Only statements), Faraday's law of electromagnetic induction (Only statements), Displacement current, Ampere's circuital law, Maxwell's equation in Differential and Integral form, Electromagnetic wave equation in E and B, Electromagnetic Energy, Poynting theorem and Poynting vector (no derivation).

Module - 5 **(10 Hours)**

Quantum Physics:

Elementary concepts of quantum physics formulation to deal with physical systems. Need for Quantum physics- historical overviews (For concept), Einstein equation, de- Broglie Hypothesis of matter waves, Compton Scattering, Pair production (no derivation), Uncertainty Principle, Application of Uncertainty Principle, Non-existence of electrons in the Nucleus, Ground state energy of a harmonic oscillator. Basic features of Quantum Mechanics: Transition from deterministic to Probabilistic, Wave function, probability density, Normalization of wave function (Simple problem), observables and operators, expectation values (Simple problem), Schrodinger equation- Time dependent and time independent equation.

Course Outcomes:

1. Memorize the Definitions, statements of physics.
2. Understand and explain different laws of physics governing our physical world.
3. Analyze the theoretical concepts mathematically as well as graphically.
4. Apply and interpret the knowledge to experimental application.

Text Books:

1. Malik and Singh, Engineering Physics, McGraw Hill.
2. Chattopadhay and Rakshit, Practical of physics
3. C. L. Arora, Practical Physics

Subject Code: 19FY1BS02T	Subject Name: Chemistry	L-T-P: 3- 0- 0	Credit: 3

Course Objectives:

1. To understand the basics of quantum mechanical concepts and spectroscopy.
2. To predict the bulk properties and processes using thermodynamic considerations.
3. To understand the fundamental concepts on fuels and corrosion chemistry.
4. To know the Basic concepts of electro-chemistry

Syllabus

Module-1 **(10 Hours)**

Quantum Chemistry and Spectroscopy:

Introductory concepts of wave-mechanical model for atom, Electromagnetic radiation, dual nature of matter, Uncertainty principle. Operators in quantum mechanics, Postulates of quantum mechanics, Schrodinger Wave Equation, Particle in a box model (1D), Energy levels.

Spectroscopy:

Introductory idea on rotational and vibrational spectroscopy: Principle and applications to diatomic molecules. Beer's-Lambert Law: Principles and applications of UV-Visible Molecular Absorption Spectroscopy; Chromophores, Auxochrome, applications on quantitative analysis. Effect of conjugation on chromophores, solvent effect, Absorption by aromatic systems.

Module-2 **(8 Hours)**

The phase rule:

Introduction to free energy and Claussius Clapeyron equation. Statement of Gibb's phase rule(derivation not required) and explanation of the terms involved, Phase diagram of one component system – water and sulfur system, Condensed phase rule, Eutectic system, Phase diagram of two component system –Bi-Cd, and Fe-C system.

Module-3 **(8 Hours)**

Fuels:

Classification of fuels, calorific value. (Determination by Dulong's formula), G.C.V. and N.C.V., Solid fuels: Analysis of coal. Liquid fuels: Classification of petroleum, Refining of petroleum, Cracking (Mechanism not required), Knocking in IC engines, Cetane and Octane numbers. Unleaded petrol, Synthetic petrol, Power alcohol. Gaseous Fuel: Producer gas, Water gas, LPG, CNG. Combustion Calculation.

Module-4 **(8 Hours)**

Electrochemistry:

Electrochemical cell, Electrode potential, Reference electrodes (Hydrogen, Calomel), EMF, Relation between EMF and Thermodynamic parameter, Nernst's Equation and it's applications: EMF, pH measurement (using Hydrogen and calomel electrode), Solubility product. Concentration cell, Lead storage cell, H2-O2 Fuel cell.

Module-5 **(6 Hours)**

Corrosion:

Chemical and Electrochemical corrosion, galvanic series, Types of corrosion: Galvanic corrosion, Differential aeration corrosion (Pitting, Crevice water line corrosion), Stress corrosion (caustic embrittlement in boilers), Factors affecting corrosion, Corrosion control: metal coatings (Galvanizing and Tinning) Corrosion inhibitors, cathodic protection.

Course Outcomes:

1. Understand the basics of quantum mechanical concepts and spectroscopy.
2. Understand and analyze phase transition and know the conditions of different stable and metastable phase equilibria for both single and binary system.
3. Analyze the quantitative aspects of different kinds of fuel and their combustion and know the properties of different natural and synthetic fuels.
4. To know the basic principles electrochemistry and mechanism of corrosion.

Text Books:

1. Wiley Engineering Chemistry, Second edition, Willey publication, 2013, New Delhi

2. P.C. Jain & M. Jain, Engineering Chemistry, 16th edition, Dhanpat Rai Publication, 2015, New Delhi.

Reference Books:

1. Colin N Banwell; Elaine M McCash, Fundamentals of Molecular Spectroscopy, 5th Edition, Tata McGraw Hill Education, 2013, New Delhi.
2. A.N. Acharya and B. Samantaray, Textbook on Applied Chemistry, 1st Edition, Pearson India, Education, 2017, Noida
3. A. K. Chandra, Introductory to Quantum Chemistry, 4th Edition, Tata McGraw Hill Education, 2013, New Delhi.
4. B. R. Puri, L. R. Sharma & M. S. Pathania, Principles of Physical Chemistry, 47th Edition, Vishal Publishing Co., 2017, New Delhi
5. B. L. Tembe, Kamaludddin and M. S. Krishan, Engineering Chemistry (NPTEL web-book).
6. Payal B. Joshi and Shashank Deep, Engineering Chemistry, 1st Edition, Oxford University Press, 2019, New Delhi.

Digital Learning Resources:

Course Name	Engineering Chemistry-1
Course Link	https://nptel.ac.in/courses/122/101/122101001/
Course Instructor	IIT, Bombay

Subject Code: 19FY1BS03T	Subject Name: Mathematics-I	L-T-P: 3-0-0	Credit: 3

Course Outcomes:

On completion of this course, students are able to:

1. Apply the knowledge of matrix algebra for solving system of linear equations and compute the inverse of matrices.
2. To develop the essential tool of matrices to compute Eigen values and Eigen vectors required for matrix Diagonalization process.
3. Apply the knowledge of calculus, Gamma & Beta functions for analyzing engineering problems.
4. Obtain a power series of convergent functions with basic knowledge of convergent sequence and series.
5. Apply the knowledge of periodic function, Fourier series, cosine & sine series analyzing engineering problems.

Syllabus

Module-1 **(8 Hours)**

LinearAlgebra:

Basic concepts of Matrix and its operation, Rank of a Matrix, Inverse of matrices (by Gauss-Jordan Method). Solution of system of linear equations (by Gauss Elimination and Gauss - Jordan). Examples of Vector Spaces.

Module-2 **(8 Hours)**

Linear Algebra:

Eigen values and Eigen vectors of a Matrix with their properties. Symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew Hermitian and Unitary matrices. Similar matrices, Diagonalization of Matrices.

Module-3 **(8 Hours)**

Beta&GammaFunction and VectorCalculus:

Beta & Gamma function. Scalar Field, Vector Field, Vector differential Operator, Gradient, divergent, Laplacian and Curl and properties, Directional derivatives.

Module-4 **(8 Hours)**

Application of Differential Calculus

Maximum, minimum and saddle points of one variable functions. Rolle's mean value, Lagrange mean value and Cauchy mean value theorems and its use Taylor's and Maclaurin's Theorem. Power series for exponential, trigonometric and logarithm functions, curvature.

Module-5 **(10 Hours)**

Fourier Series and transform

Fourier series, Fourier transform, Periodic function, Even and Odd function, Fourier series for arbitrary period. Half range series (Cosine series and sine series).

Course Outcomes:

On completion of this course, students are able to:

1. Apply the knowledge of matrix algebra for solving system of linear equations and compute the inverse of matrices.
2. To develop the essential tool of matrices to compute Eigen values and Eigen vectors required for matrix diagonalization process.
3. Apply the knowledge of calculus, Gamma & Beta functions for analyzing engineering problems. .
4. Obtain a power series of convergent functions with basic knowledge of convergent sequence and series.
5. Apply the knowledge of periodic function, Fourier series, cosine & sine series analyzing engineering problems.

Text Books:

1. Shanti Narayan and Mittal, Differential Calculus, 3rd Edition, S. Chand, 1989, New Delhi

2. E. Kreyszig, Advanced Engineering Mathematics, 10th Edition, Willey, 2010, Columbus, Ohio

Reference Books:

1. B. S. Grewal, Higher Engineering Mathematics, 42nd Edition, Khanna Publication, 2017, New Delhi
2. Debashis Datta, Text Books of Engineering Mathematics, NEW AGE International Publication, 2006
3. Kanti Bhushan Datta, Mathematical Methods of Science and Engineering, 1st edition, Cengage Learning India, 2012

Subject Code:	Subject Name:	L-T-P: 3-0-0	Credit: 3
19FY1ES01T	Basic Electrical Engineering		

Course Objectives:

1. Understand the basics of the Electrical Engineering
2. Able to Identify design and solve the engineering problems
3. Acquire the knowledge and use the concepts in the practical field of Electrical Engineering, Research as well as in project

Syllabus

Module- 1 **(8 Hours)**

DC Circuits:

Circuit laws: Methods of analyzing an electric circuit, Ohm's law, Kirchoff's laws, node voltage, mesh current, Superposition, Thevenin, Maximum power transfer theorem and Norton theorems, Star-Delta Conversion.

Module-2 **(8 Hours)**

Single Phase and Three Phase AC Circuits:

Single phase A.C circuit: Phasor representation, average, effective, peak and rms values, j operator, impedance and admittance calculation. Analysis of single-phase ac circuits consisting of R, L, C, series RL, RC, RLC and calculation of Real power, reactive power, apparent power, power factor.

Three phase circuit:

Three phase emf generation, phase sequence, delta-star and star-delta conversions, and voltage and current relations in star and delta connections. Three phase interconnections: Solution of the three phase circuits with balanced load conditions, measurement of power in three phase circuits.

Module- 3 **(6 Hours)**

Magnetic Circuits:

Magnetic Circuits: MMF, flux, reluctance, inductance, magnetic field, B-H characteristics and hysteresis loss, series and parallel magnetic circuits.

Module- 4 **(6 Hours)**

Electrical Machines:

Transformers (Single Phase): Construction, operation, impedance reflection, phasor diagram, transformer on no-load & on load and performance testing.

DC machines: EMF Equation, torque equation, types of D.C. machine, methods of Excitation, speed control.

Module- 5 **(6 Hours)**

Basic of Ammeter and Voltmeter:

Measuring instruments: Absolute and secondary instrument, indicating and recording instrument, Derivation for Deflecting Torque of PMMC, MI (attraction and repulsion types), Electro Dynamometer and Induction Type Ammeters and Voltmeters.

Course Outcomes:

After completion of this course the students will be able to:

1. Analysis of Resistive Circuits and Solution of resistive circuits with independent sources.
2. Two Terminal Element Relationships for inductors and capacitors and analysis of magnetic circuit.
3. Analysis of Single Phase & Three Phase AC Circuits, the representation of alternating quantities and determining the power in these circuits
4. Analysis of construction, connection and testing of single-phase transformer
5. Acquire knowledge about the constructional details and principle of operation of dc machines
6. Acquire knowledge about the working of dc machines as generators and motors

Text Books

1. Abhijit Chakrabarti, Sudipta Nath, Chandan Kumar Chanda, Basic Electrical Engineering, 2nd Edition, McGraw Hill Companies, 2009, New Delhi.
2. Rizzoni, Principles and Applications of Electrical Engineering, 5th Edition, McGraw Hill Education, 2017.

Reference Books

1. N. K. De and D. Sarkar, Basic Electrical Engineering, 1st Edition, University Press, 2015.

Digital Learning Resources:

Course Name	Basic Electrical Engineering
Course Link	https://nptel.ac.in/courses/108/106/108106172/
Course Instructor	Prof.Nagendra Krishnapura, Department of Electrical Engineering, IIT Madras

Subject Code:	Subject Name:	L-T-P: 2-0-0	Credit : 2
19FY1ES02T	Basic Electronics Engineering		

Course Objectives:

1. Develop an understanding of the characteristics and operation of modern semiconductor devices and their applications.
2. Understand the basics of operational amplifier and its applications.
3. Acquire the knowledge of basic logic gates and analyze its application to different combinational logic circuits.

Syllabus

Module - 1 **(10 Hours)**

Introduction to Semiconductors: Extrinsic and intrinsic semiconductor, doping, p-type and n-type semiconductor

Junction Diodes: Principle of operation, Diode Current Equation, V-I characteristics, AC and DC Resistance, Equivalent circuit of Diode, Breakdown Mechanism, Zener and Avalanche diode Applications: Clippers, clampers, rectifiers and voltage multiplier circuits. Zener diode as voltage regulator.

Module - 2 **(8 Hours)**

Bipolar Junction Transistors (BJTs): Types and Basic Principle of Operation, Modes of Operation, Configuration and characteristics: CB, CE and CC, Current amplification factors, Common Emitter configuration: Current Relationship IB, IC, IE, ICBO and ICEO, application as an amplifier, Limits of operation.

Module - 3 **(6 Hours)**

Field Effect Transistor: Construction and operation of N-Channel and P-Channel JFET, Shockley's Equation, Transfer characteristics, Output Characteristics, JFET as voltage control resistor, channel resistance (rd), trans-conductance (gm), Comparison of BJT and JFET.

Metal-Oxide Semiconductor FET: Construction and Operation of D-type and E-type MOSFET, Channel Current, Characteristics and its various region of operation.

Module - 4 **(6 Hours)**

Operational Amplifiers (OP-AMP): The Ideal OP-AMP, Equivalent circuit, different modes of operation: inverting, non-inverting and differential mode, virtual ground, general concept of feedback, Op-amps with feedback, different closed loop configuration and calculation of its gain.

Module - 5 **(10 Hours)**

Digital Electronic Principles: Digital Electronic Principles: Introduction, Binary digits, Logic levels and Digital waveforms, Introduction to basic Logic operation, Number system, Decimal numbers, Binary numbers, Decimal-to-Binary conversion, Simple binary arithmetic, Logic Gates, Boolean algebra and Combinational Logic Circuits: The inverter, The AND, OR, NAND NOR, Exclusive-OR and Exclusive-NOR gate, Boolean operations and expressions, Laws and Rules of Boolean algebra, De Morgan's theorem, Boolean analysis of logic circuits, Standard forms of Boolean expressions, Boolean expression and truth table. Basic combinational logic circuits, Implementation of combinational logic, the universal properties of NAND and NOR gates, Basic adders.

Course Outcomes:

1. Understand the basic characteristics of semiconductor materials, principle of operation of a p-n junction diode and its use in different circuit design.
2. Understand the construction, operation and characteristics of different types of transistors and their biasing details to be used in practical applications.

3. Analyze operational amplifier circuits by understanding its characteristics and configuration detail.
4. Gain the knowledge of logic gates and its application using Boolean algebra in the field of combinational circuit design.

Text Books:

1. Electronic Devices Circuit Theory - by Robert L. Boylestad 11th Edition, Pearson Publication, 2014.
2. Digital Design by M. Morris Mano, 5th Edition, Pearson Publication, 2016.

Subject Code:	Subject Name:	L-T-P: 2-0-0	Credit : 2
20FY1ES02T	Basic Electronics Engineering		

Course Objectives:

1. Develop an understanding of the characteristics and operation of modern semiconductor devices and their applications.
2. Understand the basics of operational amplifier and its applications.
3. Acquire the knowledge of basic logic gates and analyze its application to different combinational logic circuits.

Syllabus

Module-1 **(6 Hours)**

Introduction to Semiconductors, Principle of operation of Junction Diodes, V-I characteristics of Junction Diode, Diode Current Equation, AC and DC Resistance of Diode, Equivalent circuit of Diode, Applications of Diode-Clipper and Rectifier circuits.

Module-2 **(6 Hours)**

Bipolar Junction Transistors (BJTs):

Types and Basic Principle of Operation, Modes of Operation and Configurations, Common Emitter Characteristics, Requirement of Biasing, DC Biasing (Fixed bias and Voltage Divider), Load line Analysis, Basic characteristics of a voltage amplifier.

Module-3 **(6 Hours)**

Field Effect Transistors (FETs):

JFET-types, Operations and their Characteristics; MOSFET-types, Operations and their Characteristics; Concept of transconductance gm and channel resistance rd,Current Equations in FETs.

Module -4 **(4 Hours)**

Operational Amplifiers (OP-AMP):

The Ideal OP-AMP, Common Mode Rejection ratio (CMRR), Inverting and Non-Inverting configurations as amplifiers.

Module-5 **(5 Hours)**

Digital Electronic Principles:

Binary digits, Logic levels, Basic Logic Operations, Laws and Rules of Boolean algebra, Logic Gates - AND, OR, NOT, NAND, NOR, XOR and XNOR gate, De Morgan's theorem, Minterms and Maxterms, Standard forms of Boolean expressions, Universal properties of NAND and NOR gates, Function implementation using different Gates.

Course Outcomes:

1. Understand the basic characteristics of semiconductor materials, principle of operation of a p-n junction diode and its use in different circuit design.
2. Understand the construction, operation and characteristics of different types of transistors and learn to solve basic BJT DC circuits.
3. Analyze the basic operational amplifier circuits by understanding its characteristics and configuration details.
4. Gain the knowledge of basic logic gates and its application in functional implementation using Boolean algebra.

Text Books:

1. Robert L. Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, 11th Edition, Pearson Publication, 2014, New Delhi.
2. M. Morris Mano, Michael D. Ciletti, Digital Design, 5th Edition, Pearson Publication, 2016, New Delhi.

Reference Books:

1. Adel S. Sedra and Kenneth C. Smith, Microelectronic circuits, 7th Edition, Oxford University Press, 2006, New Delhi.

2. David A. Bell, Electronic Devices and Circuits, 5th Edition, Oxford University Press, 2010, New Delhi.
3. Thomas L. Floyd, Digital Fundamentals, 11th Edition, Pearson Publication, 2015, New Delhi.

Digital Learning Resources:

Course Name	Basic Electronics Engineering
Course Link	https://nptel.ac.in/courses/117/103/117103063/
Course Instructor	Prof. Chitralekha Mahanta, Department of Electronics and Communication Engineering, IIT Guwahati

Course Name	Basic Electronics Engineering
Course Link	https://nptel.ac.in/courses/108/101/108101091/
Course Instructor	Prof. Mahesh B. Patil, Department of Electrical Engineering, IIT Bombay

Subject Code:	Subject Name:	L-T-P: 2- 0- 0	Credit: 2
19FY1ES03T	Basic Mechanical Engineering		

Course Objectives:

1. Define System, Properties, Process, State, Cycle, various forms of energies, enthalpy
2. Explain the working principles of Air compressors, Steam Power Plant, Refrigerators, Heat pump and I.C. Engines Hydraulic Turbine and Pump.
3. Describe the working principles of Belt, Rope, Gear drives, coupling, clutch and brakes.
4. Describe about various machining process.
5. Discuss the working principle of Temperature, pressure, velocity, flow, strain, force, torque measurements.
6. Calculate the temperature and pressure at different states of a system.

Syllabus

Module-1 **(8 Hours)**

Basics of thermal and fluid science:

Systems, Properties, Process, State, Cycle, Internal energy, Enthalpy, Zeroth Law, basic modes of heat transfer, Properties of ideal gas, Fluid properties, Pascal's law, Buoyancy.

Module-2 **(8 Hours)**

Engineering materials:

Classification of engineering materials. Mechanical properties of Steel, Aluminium, Plastics and composites.

Module-3 **(8 Hours)**

Basic manufacturing process processes:

Casting and forming (Drawing, Forging, Extrusion) (working principles with Fastening Schematic diagram only), Joining process

Module-4 **(8 Hours)**

Power transmission devices:

Belt, Rope, Gear drives. Coupling, clutch, brakes, Cam. (Basics, applications, advantages and limitations only).

Module-5: **(8 Hours)**

Application of thermal and fluid science:

Air compressors, Steam Power Plant, Refrigerators, Heat pump, I.C. Engines and heat exchangers, Hydraulic turbine and Pump, (basics). (Brief description of different components of above mentioned systems and working principles with Schematic diagram only)

Course Outcomes:

1. Understand basics of thermodynamics and components of a thermal power plant.
2. Identify engineering materials, their properties, manufacturing methods encountered in engineering practice.
3. Understand basics of heat transfer, refrigeration and internal combustion engines.
4. Understand mechanism of power transfer through belt, rope, chain and gear drives.
5. Understand functions and operations of manufacturing process.

Text Books:

1. Pravin Kumar, Basic Mechanical Engineering, Second Edition, Pearson Education, 2018, New Delhi.
2. R. Israni, P. K. Shah, N. C. Nayak, Basic Mechanical Engineering, Second Edition, BS Publications, 2019, New Delhi.
3. S T Murthy, Text book of Elements of Mechanical Engineering, Third Edition, I. K. International Publishing House Pvt. Limited, 2010, New Delhi

Reference Books:

1. P. Chattopadhaya, Engineering Thermodynamics, 2nd Edition, Oxford University Press,

2015, New Delhi.

2. P. K. Nag, Engineering Thermodynamics, 4th Edition, Tata McGraw-Hill Publishing Company, 2008, New Delhi.
3. J K Kittur and G D Gokak, Elements of Mechanical Engineering, 1st Edition, Willey, 2015, New Delhi.
4. B. Agrawal, C M Agrawal, Basic Mechanical Engineering, 1st Edition, Willey-India, 2008, New Delhi.

Digital Learning Resources:

Course Name	Basic Thermodynamics
Course Link	https://nptel.ac.in/courses/112/105/112105123/
Course Instructor	Prof. S.K. Som, Department of Mechanical Engineering, IIT Kharagpur

Course Name	Introduction to Fluid Mechanics
Course Link	https://nptel.ac.in/courses/112/105/112105269/
Course Instructor	Prof. Suman Chakraborty, Department of Mechanical Engineering, IIT Kharagpur

Subject Code:	Subject Name:	L-T-P: 2- 0- 0	Credit: 2
19FY2ES04T	Basic Civil Engineering		

Course Objectives:

1. To understand the properties of common building materials.
2. To learn functional planning of building.
3. To understand the concepts of stress and strain of structural members.
4. To learn the various methods of surveying.
5. To understand public water supply system.

Syllabus

Module-1 **(8 Hours)**

Basics of Civil Engineering, Broad disciplines of Civil Engineering; Structural Engineering, Geotechnical Engineering, Water Resources Engineering, Transportation Engineering.Construction materials: Bricks: Qualities of a good brick, Classification of bricks. Types of cement and their uses, various field and laboratory tests on cement, Ingredients of cement concrete, Grades of concrete, workability of concrete.

Module-2 **(6 Hours)**

Functional planning of building:

General principles of site selection, site plan, principles of planning of buildings, open air spaces, floor area ratio, requirement of parts of buildings, lighting and ventilation, functional aspects various rooms, Building bye laws, Orientation of building, Components of building and their purpose.

Module--3 **(8 Hours)**

Structural mechanics:

Stress, Strain, Hooke's Law, Stress-Strain diagram, Young's modulus, Bulk modulus, Shear modulus of rigidity, Poisson's ratio. Parallel forces in a plane: General case of parallel forces, Center of parallel forces in a plane

Module-4 **(8 Hours)**

Surveying:

Linear measurement and chain survey: Use of chains and tapes for measurement of correct length of lines. Prismatic Compass: Bearing Systems and Conversions, Local Attraction.

Module-5 **(6 Hours)**

Water resources engineering:

Necessity and objectives of public water supply schemes; population growth and forecast – estimating the quantity of water required.

Course Outcomes:

After completion of the course the student will able to

1. Compare the properties of building materials.
2. Planning and design of building.
3. Understand the concepts of stress and strain of structural members.
4. Use of various surveying instruments and mapping.
5. Estimate the quantity of water required for a project.

Text Books:

1. S. Gopi "Basic Civil Engineering", Pearson Education India.
2. S. S. Bhavikatti, "Basic Civil Engineering", New age international.

Reference Books:

1. M. S. Palanichamy "Basic Civil Engineering", 3rd Edition, Tata McGraw-Hill, 2000, India.

Digital Learning Resources:

Course Name	Building Material and Construction
Course Link	https://nptel.ac.in/courses/105/102/105102088/
Course Instructor	Dr. B. Bhattacharjee, Department of Civil Engineering, IIT Delhi

Subject Code:	Subject Name:	L-T-P:	Credit:
19FY1HS01T	English	2- 0- 0	2

Course Objectives:

1. To learn communication technologies to communicate effectively by developing exceptional textual, visual and non-verbal communication abilities.
2. To draft effective formal written business messages in various formats and styles.
3. To learn the skills to effectively deliver formal oral presentations to a variety of audiences in multiple contexts.
4. To be acquainted with the soft skills and various selection procedures adopted by the recruiters.

Syllabus

Module-1 **(8 Hours)**

Basics of communication skills:

Significance of communication, The process and factors of communication (the communication loop), Difference between General and Technical Communication, Verbal communication and its principles, Non-verbal communication, Paralingustics, The importance of audience & purpose.

Module-2 **(10 Hours)**

Basics of English pronunciation & soft skills:

Introduction to English pronunciation with the IPA chart, Received Pronunciation, problems of Indian English, Professional presentations, Group Discussion, Interview etiquette, Leadership skills

Module-3 **(6 Hours)**

Brush up your grammar & vocabulary:

Parts of speech &Tense, Voice Change, Direct and Indirect Speech, Concord, Parallelism, Word formation- root words, synonyms, antonyms, homonyms & homophones, Common errors in English Grammar

(N.B. – Instead of teaching, this unit should be taught by assigning activities to the students in the class)

Module-4 **(6 Hours)**

Basics of reading and writing skills:

Reading Skill: Types of reading, Sub-skills of reading: Skimming, Scanning, Reading comprehension, Writing Skill: Steps to writing, Describing, Defining, Classifying and Providing examples or evidence, Empathetic and Result Oriented Writing.

Module-5 **(10 Hours)**

Professional writing:

Paragraph, Letter, Memos & Circulars, Reports, Proposals, e-mails & CV

Course Outcomes:

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

1. Become adept in their use of the spoken word in interpersonal communication, small group interaction and public speaking.
2. Use an appropriate style and format to write letters (formal and informal), prepare result oriented reports, prepare CVs and draft business documents.
3. Gather and prepare information and apply it to persuade or articulate one's own point of view clearly and efficiently.
4. Evaluate the employability market, identify the organizations to get good placements and broaden career plans by developing all-round personality.

Reference Books:

1. Sanjay Kumar and Pushp Lata, Communication Skills, Oxford University Press
2. Meenakshi Raman & Sangeeta Sharma, Technical Communication, Principle and Practice, Oxford University Press
3. M. Ashraf Rizvi, Effective Technical Communication, Tata McGraw – Hill.
4. Meenakshi Raman & Prakash Singh, Business Communication, Oxford
5. Urmila Rai and S M Rai, Communication for Management, HPH
6. Sengupta, Business and Managerial Communication, PHI
7. P. Mehra, Business Communication for Managers, Pearson
8. Soft Skills K Alex, S Chand

Suggested Readings:

1. Manual of English Grammar and Composition. J. C. Nesfield Forgotten Books
2. Practical English Usage. Michael Swan. OUP.
3. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press.
4. A Course in English phonetics by T. R. Kansakar , ORIENT LONGMEN Press.
5. A Communicative Grammar of English, Leech, Geoffrey & Jan Svartvik, , Longman.

Subject Code:	Subject Name:	L-T-P: 0- 0-2	Credit : 1
19FY1BS01L	Physics Lab		

Course Objectives:

Co-relate the theory with experiment.

Group project works based on as experimental physics knowledge

Create an exciting intellectual adventure with experimental skill.

List of Experiments

(A student is expected to perform ten experiments form the list given below.)

1. Determination of Young's modulus by Searle'smethod.
2. Determination of Rigidity modulus by staticmethod.
3. Determination of surface tension by capillary risemethod.
4. Determination of acceleration due to gravity by Barpendulum.
5. Determination of wave length of light by Newton's ringapparatus.
6. Determination of wavelength of laser source by diffraction gratingmethod.
7. Determination of grating element of a grating plate.
8. Plotting of characteristic curve of a PN junctiondiode.
9. Plotting of characteristic curves ofBJT.
10. Study of HallEffect.
11. Study of RCcircuit.
12. Determination of unknown resistance using MeterBridge.
13. Energy gap determination by Four-Probemethod.
14. Determination of Young's modulus by bending ofbeams.
15. Verification of laws of vibration of string using sonometer.

Course Outcomes:

1. Learn basics of measuring instruments and its expt. Applications.
2. Observe and evaluate hands on skill on experimental physics.

Books:

1. B. B. Swain, A Complete Course in Practical Physics, 1st Edition, Kalyani Publication.
2. C. L. Arora, Practical Physics, S. Chand Publication.

Subject Code:	Subject Name:	L-T-P: 0- 0-2	Credit: 1
19FY1BS02L	Chemistry lab		

Course Objectives:

1. To understand the water quality parameter
2. Quantitative analysis of some standard compound
3. Instrumental methods for quantitative analysis

List of Experiments

(A student is expected to perform ten experiments form the list given below.)

1. Determination of amount of sodium hydroxide and sodium carbonate in a mixture.
2. Determination of partition coefficients of iodine between toluene and water.
3. Determination of percentage of available chlorine in a sample of bleaching powder.
4. Determination of dissolved oxygen in a sample of water.
5. Determination of strength of acids in a mixture using pH meter.
6. Determination of total hardness of water by EDTA method.
7. Determination of strength of colored substance using colorimeter.
8. Determination of strength of acids in a mixture using Conductance Bridge.
9. Determination of surface tension of given sample using Stalagnometer
10. Determination of Viscosity of a supplied sample(s) by Ostwald's Viscometer.
11. Determination molecular weight of polymer by viscosity method.
12. Determination of rate constant of acid catalyzed ester hydrolysis.
13. Determination of Flash point of given oil by Pensky-Marten's flash point apparatus.
14. Determination of critical solution temperature of Phenol-Water system.
15. Determination of Calorific value of a fuel using Bomb calorimeter.

Course Outcomes:

1. Analyze the water quality parameter including dissolved oxygen, Hardness, and chlorine content.

2. Analyze qualitatively different compounds using analytical equipments like, pH meter, Conductivity meter, Colorimeter etc.
3. Qualitative analysis of liquid sample through viscosity and surface tension measurement.

Books:

1. S. K. Bhasin, Sudha Rani, Laboratory manual on Engineering Chemistry, 1st Edition, Dhanpat Rai Publication, 2012, New Delhi.
2. S. Ratan, Experiments in Applied Chemistry, 3rd Edition, S. K. Kataria and Sons, 2011, New Delhi

Subject Code:	Subject Name:	L-T-P: 0- 0-2	Credit: 1
19FY1ES01L	Basic Electrical Engineering Lab		

Course Objectives:

1. To enhance understanding of electrical engineering circuit analysis concepts including: Thevenin's theorem, Norton's theorem, Superposition Theorem
2. To get the knowledge of phasor representation, power and power factor measurement of electrical circuit
3. To know the concept of B-H Curve of the magnetic materials and to know the functionality of the transformer with their losses by conducting suitable tests on it.
4. To Apply knowledge of DC generators and motors in various applications and able to know the uses of starter

List of Experiments

1. V-I Characteristics of Incandescent (Filament) Lamp
2. Voltage and Power measurement of a Fluorescent Lamp
3. Verification of DC Network Theorems (Superposition, Thevenin's& Norton's Theorem)
4. Calculation of current, voltage and power in series R-L-C circuit excited by single phase AC supply and calculation of power factor
5. Measurement of power and power factor in a three phase AC circuit by using Two-Wattmeter method
6. Connection and testing of a Single-Phase Energy Meter
7. O.C & S.C Test on Single phase Transformer
8. Starting and Speed Control of a D.C. Shunt Motor
9. Study of B-H curve by using by using CRO

Course Outcomes:

After completion of this course the students will be able to:

1. Determine the DC network analysis with the use of theorems and their applicability for the practical application.
2. Know the fundamentals magnetic field theory, able to apply the laws of magnetic field for the transformer and also determination of its losses by conducting suitable tests
3. Understand the concept of Phasor representation and Power factor measurement of AC circuit
4. Analyze the performance of D.C machines and it various practical applications.

Subject Code:	Subject Name:	L-T-P: 0- 0-2	Credit: 1
19FY1ES02L	Basic Electronics Engineering Lab		

Course Objectives:

1. Understand the measurement techniques using basic measuring instruments.
2. Expose to characteristics and testing of various electronics components.
3. Assemble and test different circuits using diode and op-amps.
4. Verify the truth table of basic logic gates

List of Experiments

(Any ten Experiments out of 12 should be performed)

1. Study of digital multi-meters, CROs and function generators.
2. Familiarization and testing of different electronic components (Active & Passive).
3. Study of the V-I characteristics of P-N junction diode and calculation of DC & AC resistance.
4. Construction of half-wave rectifier with & without capacitive Filter and verify the output waveforms using CRO and calculation of efficiency and ripple factor.
5. Constructions of full wave rectifier circuits with & without capacitive Filter and verify the output waveforms using CRO and calculation of efficiency and ripple factor.
6. Design a Zener based voltage regulator to verify the load regulation.
7. Construction of positive and negative clipper circuits and study of their output waveforms by CRO.
8. Study of both input and output V-I characteristics of a Common Emitter configuration.
9. Study of output V-I characteristics of an n-channel JFET and define the pinch off voltage from it.
10. Design of inverting and non-inverting amplifiers using Op-Amp and compare the theoretical and practical gain values.

11. Truth table verification of logic gates.
12. Verification of universal properties of NAND and NOR gates.

Course Outcomes:

1. Identify and test basic electronics components using test and measuring instruments.
2. Design, assemble and test of diode characteristics and its application in circuits.
3. Design and testing of op-amp based configurations.
4. Familiarization and testing of basic logic gates.

Subject Code:	Subject Name:	L-T-P: 0- 0-2	Credit: 1
19FY1ES03L	Basic Mechanical Engineering Lab		

Course Objectives:

1. To understand basic working principle of power plant, IC engine and. refrigerator
2. To study various parts in Automobile
3. To give complete knowledge about power transmission.
4. To study the measurement of the fluid characteristics

List of Experiments:

1. Model study of Fire Tube Boilers and Water Tube Boilers.
2. Model study of Two stroke I.C. Engine.
3. Model study of Four stroke I.C. Engine.
4. Model study of Refrigerator
5. Model study of Water Turbines.
6. Model study of Water pumps.
7. Study of Gears and Gear trains.
8. Verification of Bernoulli's Theorem and its application to Venturimeter.
9. Calibration of Bourdon Tube Pressure gauge and measurement of pressure using manometers.
10. Model study of Automobile Parts.
11. Determination of velocity ratio of belt drive

Course Outcomes:

1. Understand basics of thermodynamics and components of a thermal power plant
2. Understand basics of refrigeration, air conditioners and internal combustion engines..
3. Understand mechanism of power transfer through belt, rope, chain and gear drives .
4. Understand the measurement of pressure and energy.

Subject Code:	Subject Name:	L-T-P: 0- 0-2	Credit: 1
19FY1ES04L	Basic Civil Engineering Lab		

Course Objectives:

1. To understand the shape, size and strength of properties
2. To understand the properties of cement and concrete.
3. To calculate the support reaction of different beams
4. To know the methods of surveying
5. To know the plan of a building

List of Experiments:

1. Shape, size and compressive strength test of brick
2. Consistency Test of Cement
3. Setting time of cement
4. Workability test of concrete: Slump test
5. Cube test of concrete (nominal mix)
6. Experiment on calculation of support Reactions of a simply supported beam.
7. Experiment on calculation of support Reactions of an overhanging beam.
8. Chain traversing through obstacles
9. Compass surveying to find out the Bearing of a Line.
10. Line plan of a two BHK building in a plot.

Course Outcomes:

After completion of the course the student will be able to

1. Have knowledge about the different test of brick.
2. Compare the properties of building materials.
3. Able to calculate the support reaction of any beam

4. Able to perform different method of surveying
5. Able to prepare the plan of any building.

Subject Code:	Subject Name:	L-T-P: 0-0-2	Credit: 2
19FY1ES05L	Engineering Graphics & Design		

Course Objectives:

1. The main objective of engineering graphics & design course is to develop the drawing communication skills, individual and team work, and usage of the modern tools. The main purpose of this course is to develop the visualization skills through understanding of the engineering components and their functions.
2. To learn use of different types of drawing instruments and drawing standards.
3. To learn orthographic projections of points, lines and diverse planes.
4. To learn orthographic projection of solids, section of solids, and development of lateral surfaces.
5. To learn isometric projection of solids for different regular solid shapes.

Syllabus:

Module-1 (6 Hrs.)

Importance of graphics in engineering applications – Use of drafting instruments. BIS conventions and specifications. Size, layout and folding of drawing sheets – Lettering and dimensioning; Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle. Drawing of tangents and normal to the above curves.

Module-2 **(8 Hrs.)**

Orthographic Projections:

Introduction, Definitions - Planes of projection, reference line and conventions employed, Projections of points in all the four quadrants, Projections of straight lines (located in First quadrant/first angle only),True and apparent lengths, True and apparent inclinations to reference planes 2 – Sheets

Module-3 **(8 Hrs.)**

Orthographic Projections of Plane Surfaces (First Angle Projection Only):

Introduction, Definitions–projections of plane surfaces–triangle, square, rectangle, rhombus, pentagon, hexagon and circle, planes in different positions by change of position method only 1-Sheet

Module-4 **(10 Hrs.)**

Projections of Solids (First Angle Projection Only):

Introduction, Definitions – Projections of right regular tetrahedron, hexahedron (cube), prisms, pyramids, cylinders and cones in different positions. 2-Sheets

Sections and Development of Lateral Surfaces of Solids:

Introduction, Section planes, Sections, Section views, Sectional views, Apparent shapes and True shapes of Sections of right regular prisms, pyramids, cylinders and cones resting with base on HP. 2 – Sheet

Module-5 **(8 Hrs.)**

Isometric Projection (Using Isometric Scale Only):

Introduction, Isometric scale, Isometric projection of simple plane figures, Isometric projection of tetrahedron, hexahedron(cube), right regular prisms, pyramids, cylinders, cones, spheres, cut spheres. 2-Sheets

Course Outcomes:

1. Familiar with drawing instruments, BIS codes, letter writing and dimensioning.
2. Understand the concepts of orthographic projections and draw the projection of points and lines.
3. Draw the orthographic projection of different planes using first angle projection.
4. Do orthographic projection of solids, sections of solids, and development of their lateral surfaces in first angle projection.
5. Understand and draw the isometric projection of solid entities.

Suggested Books:

1. N. D. Bhatt & V. M. Panchal, Engineering Drawing, Charotar Publishing House, Gujarat.
2. S. Trymbaka Murthy, Computer Aided Engineering Drawing, I. K. International Publishing House Pvt. Ltd., New Delhi.
3. N. S. Parthasarathy and Vela Murali, Engineering Drawing, Oxford University Press.
4. K. R. Gopalakrishna, Engineering Graphics, Subash Publishers, Bangalore.
5. J. Luzadder Warren, M. Duff John, Fundamentals of Engineering Drawing with an Introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice-Hall of India Pvt. Ltd., New Delhi.
6. NPTEL Online Engineering Drawing Courses: https://nptel.ac.in/courses/112103019/

Subject Code: 19FY1ES06L	Subject Name: Workshop	L-T-P: 0- 0-2	Credit: 1

Course Objectives:

1. Acquire knowledge of possible personal and general safety hazards in industrial settings and their mitigation techniques.
2. Learn about different mechanical tools used in engineering.
3. Learn about organization of machines and tools for a safe and effective workplace.
4. Machining and joining techniques of commonly used engineering materials.

Syllabus:

Experiments **(36 Hours)**

Fitting Practice:

Use of hand tools in fitting, preparing a male and female joint of M.S. or making a paper weight of M.S.

Welding Practice:

Gas welding & Electric Arc welding Practice. A joint such as a Lap joint, a T-joint or a Butt joint is to be prepared or to make furniture.

Machining:

(i) Stepped cylindrical Turning of a job and Thread-cutting in lathe.

(ii) Shaping (iii) Milling

Course Outcomes:

1. Identify safety signs and act accordingly, maintain personal as well as group and equipment safety.
2. Identify different tools and their applications.
3. Undertake minor fabrication and repair/maintenance work using commonly available tools and materials.

Books:

1. Hajrachoudhary, Elements of Workshop Technology, Vol. I and II, Khanna Publishers

2. WAJ Chapman, Workshop Technology, Viva Books
3. Kannaiah/ Narayana, Workshop Manual, Scitech

Subject Code:	Subject Name:	L-T-P: 0- 0-2	Credit: 1
19FY1HS01L	English Language Lab		

(This unit involves interactive practice sessions in Language Lab)

1. Listening Comprehension
2. Pronunciation, Intonation
3. Stress and Rhythm practice
4. Common Everyday Situations: Conversations and Dialogues
5. Formal Presentations
6. Reading Comprehension
7. Report writing
8. Writing letters, e-mails,
9. Writing essay, CV
10. Statement of Purpose
11. Grammar activities
12. Empathetic Listening

B. Tech. Programme Structure

Second Semester					
Theory					
Sl. No.	Category	Subject Code	Subject Name	L-T-P	Credit
1	BSC	19FY2BS01T/ 20FY2BS01T 19FY2BS02T	Physics (2019 Batch)/ Physics (2020 Batch)/ Chemistry	3-0-0	3
2	BSC	19FY2BS03T	Mathematics-II	3-0-0	3
3	ESC	19FY2ES01T/ 19FY2ES02T/ 20FY2ES02T	Basic Electrical Engineering/ Basic Electronics Engineering (2019 Batch)/ Basic Electronics Engineering (2020 Batch)	2-0-0	2
4	ESC	19FY2ES03T/ 19FY2ES04T	Basic Mechanical Engineering/ Basic Civil Engineering	2-0-0	2
5	ESC	19FY2ES05T	Problem Solving using C	3-0-0	3
Total Credit (Theory)					13
Practical					
1	BSC	19FY2BS01L/ 19FY2BS02L	Physics Lab/ Chemistry Lab	0-0-2	1
2	ESC	19FY2ES01L/ 19FY2ES02L	Basic Electrical Engineering Lab / Basic Electronics Engineering Lab	0-0-2	1
3	ESC	19FY2ES03L/ 19FY2ES04L	Basic Mechanical Engineering Lab/ Basic Civil Engineering Lab	0-0-2	1
4	ESC	19FY2ES05L	Programming Lab	0-0-2	1
5	ESC	19FY2ES06L/ 19FY2ES07L	Engineering Graphics & Design / Workshop or Manufacturing	0-0-2	1
6	MC	19FY2MC01L	NCC/NSS/Yoga/Professional	0-0-2	0

			Ethics		
Total Credit (Practical)					5
Total Semester Credit					18

Subject Code: 19FY2BS01T	Subject Name: Physics	L-T-P:3-0-0	Credit: 3

Course Objectives:

6. Understand and apply the knowledge to analyze the fundamental physics behind their courses in higher semester.
7. Do project works based on theoretical as well as experimental research.
8. Use the knowledge of Physics for Industrial development.
9. Generate fundamental knowledge needed for the future technological advances that will continue to drive the economic engines of the society.
10. Create an exciting intellectual adventure that inspires young mass and expands the frontiers of their knowledge about Nature.

Syllabus

Module-1 **(8 Hours)**

Oscillation & Waves:

Simple Harmonic Oscillation: velocity of motion, acceleration, time period, frequency, phase; damped harmonic oscillation: Wave equation of damped vibration, logarithmic decrement, quality factor, relaxation time; Forced oscillation, resonance, velocity resonance and amplitude resonance, coupled oscillation, Normal coordinates and normal frequencies, In-phase and out-of-Phase Oscillation, Concept of wave and wave equation, reflection and transmission of longitudinal waves at boundaries (Concepts).

Module - 2 **(10 Hours)**

Optics:

Concept of interference, two sources interference pattern, Bi-prism, Fringe width, uses of biprism, Newton's ring; measurement of wavelength and refractive index. Diffraction: Huygen's principle, Fresnel's Diffraction and Fraunhoffer's diffraction, Half period zone, Zone plate,

construction, principle, multiple foci, comparison of zone plate with convex lens, Fraunhofer's diffraction of Single slit, intensity distribution.

Module - 3 **(10 Hours)**

Laser and Fiber Optics:

Atomic excitation and energy states, Interaction of external energy with atomic energy states, Absorption, spontaneous emission and stimulated emission, Population inversion, Pumping mechanism, optical pumping, Electrical Pumping, Components of laser system, active medium, population inversion (All concepts only, not details), Ruby laser, Helium-Neon laser, Semiconductor laser (basic concepts, and Engineering application only, mechanism not required), Structure of optical fibre, Principle of propagation and numerical aperture (concept only, derivation not required), Acceptance angle, classification of optical fibre (Single mode and Multi mode, SIN and GRIN), FOCL (Fiber Optic Communication Link)

Solid State Physics:

Crystalline and Amorphous solid, unit cell, lattice parameter, Miller Indices, Reciprocal Lattice (Only concept), Bragg's law, Concept of fermions and Bosons and their distribution Functions, Band theory of Solids (Qualitative), Classification of materials: metals, semiconductor and insulator in terms of band theory.

Module - 4 **(8 Hours)**

Electromagnetism:

(Student will be familiarized with some basic used in vector calculus prior to Development of Maxwell's electromagnetic wave equations. No proof of theorems and laws included in this unit expected- statement and interpretation should sufficient.) Introduction; Scalar and vector fields, Gradient of Scalar Field, divergence and curl of Vector Field, Gauss divergence theorem, Stokes theorem (Only statements, no proof), Gauss's law of electrostatics in free space and in a medium (Only statements), Faraday's law of electromagnetic induction (Only statements), Displacement

current, Ampere's circuital law, Maxwell's equation in Differential and Integral form, Electromagnetic wave equation in E and B, Electromagnetic Energy, Poynting theorem and Poynting vector (no derivation).

Module - 5 **(10 Hours)**

Quantum Physics:

Elementary concepts of quantum physics formulation to deal with physical systems. Need for Quantum physics- historical overviews (For concept), Einstein equation, de- Broglie Hypothesis of matter waves, Compton Scattering, Pair production (no derivation), Uncertainty Principle, Application of Uncertainty Principle, Non-existence of electrons in the Nucleus, Ground state energy of a harmonic oscillator. Basic features of Quantum Mechanics: Transition from deterministic to Probabilistic, Wave function, probability density, Normalization of wave function (Simple problem), observables and operators, expectation values (Simple problem), Schrodinger equation- Time dependent and time independent equation.

Course Outcomes:

1. Memorize the Definitions, statements of physics.
2. Understand and explain different laws of physics governing our physical world.
3. Analyze the theoretical concepts mathematically as well as graphically.
4. Apply and interpret the knowledge to experimental application.

Text Books:

4. Malik and Singh, Engineering Physics, McGraw Hill.
5. Chattopadhay and Rakshit, Practical of physics
6. C. L. Arora, Practical Physics

Subject Code: 19FY2BS02T	Subject Name: Chemistry	L-T-P: 3- 0- 0	Credit: 3

Course Objectives:

5. To understand the basics of quantum mechanical concepts and spectroscopy.
6. To predict the bulk properties and processes using thermodynamic considerations.
7. To understand the fundamental concepts on fuels and corrosion chemistry.
8. To know the Basic concepts of electro-chemistry

Syllabus

Module-1 **(10 Hours)**

Quantum Chemistry and Spectroscopy:

Introductory concepts of wave-mechanical model for atom, Electromagnetic radiation, dual nature of matter, Uncertainty principle. Operators in quantum mechanics, Postulates of quantum mechanics, Schrodinger Wave Equation, Particle in a box model (1D), Energy levels.

Spectroscopy:

Introductory idea on rotational and vibrational spectroscopy: Principle and applications to diatomic molecules. Beer's-Lambert Law: Principles and applications of UV-Visible Molecular Absorption Spectroscopy; Chromophores, Auxochrome, applications on quantitative analysis. Effect of conjugation on chromophores, solvent effect, Absorption by aromatic systems.

Module-2 **(8 Hours)**

The phase rule:

Introduction to free energy and Claussius Clapeyron equation. Statement of Gibb's phase rule(derivation not required) and explanation of the terms involved, Phase diagram of one component system – water and sulfur system, Condensed phase rule, Eutectic system, Phase diagram of two component system –Bi-Cd, and Fe-C system.

Module-3 **(8 Hours)**

Fuels:

Classification of fuels, calorific value. (Determination by Dulong's formula), G.C.V. and N.C.V., Solid fuels: Analysis of coal. Liquid fuels: Classification of petroleum, Refining of petroleum, Cracking (Mechanism not required), Knocking in IC engines, Cetane and Octane numbers. Unleaded petrol, Synthetic petrol, Power alcohol. Gaseous Fuel: Producer gas, Water gas, LPG, CNG. Combustion Calculation.

Module-4 **(8 Hours)**

Electrochemistry:

Electrochemical cell, Electrode potential, Reference electrodes (Hydrogen, Calomel), EMF, Relation between EMF and Thermodynamic parameter, Nernst's Equation and it's applications: EMF, pH measurement (using Hydrogen and calomel electrode), Solubility product. Concentration cell, Lead storage cell, H2-O2 Fuel cell.

Module-5 **(6 Hours)**

Corrosion:

Chemical and Electrochemical corrosion, galvanic series, Types of corrosion: Galvanic corrosion, Differential aeration corrosion (Pitting, Crevice water line corrosion), Stress corrosion (caustic embrittlement in boilers), Factors affecting corrosion, Corrosion control: metal coatings (Galvanizing and Tinning) Corrosion inhibitors, cathodic protection.

Course Outcomes:

5. Understand the basics of quantum mechanical concepts and spectroscopy.
6. Understand and analyze phase transition and know the conditions of different stable and metastable phase equilibria for both single and binary system.
7. Analyze the quantitative aspects of different kinds of fuel and their combustion and know the properties of different natural and synthetic fuels.
8. To know the basic principles electrochemistry and mechanism of corrosion.

Text Books:

3. Wiley Engineering Chemistry, Second edition, Willey publication, 2013, New Delhi
4. P.C. Jain & M. Jain, Engineering Chemistry, 16th edition, Dhanpat Rai Publication, 2015, New Delhi.

Reference Books:

7. Colin N Banwell; Elaine M McCash, Fundamentals of Molecular Spectroscopy, 5th Edition, Tata McGraw Hill Education, 2013, New Delhi.
8. A.N. Acharya and B. Samantaray, Textbook on Applied Chemistry, 1st Edition, Pearson India, Education, 2017, Noida
9. A. K. Chandra, Introductory to Quantum Chemistry, 4th Edition, Tata McGraw Hill Education, 2013, New Delhi.
10. B. R. Puri, L. R. Sharma & M. S. Pathania, Principles of Physical Chemistry, 47th Edition, Vishal Publishing Co., 2017, New Delhi
11. B. L. Tembe, Kamaludddin and M. S. Krishan, Engineering Chemistry (NPTEL web-book).
12. Payal B. Joshi and Shashank Deep, Engineering Chemistry, 1st Edition, Oxford University Press, 2019, New Delhi.

Digital Learning Resources:

Course Name	Engineering Chemistry-1
Course Link	https://nptel.ac.in/courses/122/101/122101001/
Course Instructor	IIT, Bombay

Subject Code:	Subject Name:	L-T-P: 3-0-0	Credit: 3
19FY2BS03T	Mathematics-I		

Course Outcomes:

On completion of this course, students are able to:

6. Apply the knowledge of matrix algebra for solving system of linear equations and compute the inverse of matrices.
7. To develop the essential tool of matrices to compute Eigen values and Eigen vectors required for matrix Diagonalization process.
8. Apply the knowledge of calculus, Gamma & Beta functions for analyzing engineering problems.
9. Obtain a power series of convergent functions with basic knowledge of convergent sequence and series.
10. Apply the knowledge of periodic function, Fourier series, cosine & sine series analyzing engineering problems.

Syllabus

Module-1 **(8 Hours)**

LinearAlgebra:

Basic concepts of Matrix and its operation, Rank of a Matrix, Inverse of matrices (by Gauss-Jordan Method). Solution of system of linear equations (by Gauss Elimination and Gauss - Jordan). Examples of Vector Spaces.

Module-2 **(8 Hours)**

Linear Algebra:

Eigen values and Eigen vectors of a Matrix with their properties. Symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew Hermitian and Unitary matrices. Similar matrices, Diagonalization of Matrices.

Module-3 **(8 Hours)**

Beta&GammaFunction and VectorCalculus:

Beta & Gamma function. Scalar Field, Vector Field, Vector differential Operator, Gradient, divergent, Laplacian and Curl and properties, Directional derivatives.

Module-4 **(8 Hours)**

Application of Differential Calculus

Maximum, minimum and saddle points of one variable functions. Rolle's mean value, Lagrange mean value and Cauchy mean value theorems and its use Taylor's and Maclaurin's Theorem. Power series for exponential, trigonometric and logarithm functions, curvature.

Module-5 **(10 Hours)**

Fourier Series and transform

Fourier series, Fourier transform, Periodic function, Even and Odd function, Fourier series for arbitrary period. Half range series (Cosine series and sine series).

Course Outcomes:

On completion of this course, students are able to:

6. Apply the knowledge of matrix algebra for solving system of linear equations and compute the inverse of matrices.
7. To develop the essential tool of matrices to compute Eigen values and Eigen vectors required for matrix diagonalization process.
8. Apply the knowledge of calculus, Gamma & Beta functions for analyzing engineering problems. .
9. Obtain a power series of convergent functions with basic knowledge of convergent sequence and series.
10. Apply the knowledge of periodic function, Fourier series, cosine & sine series analyzing engineering problems.

Text Books:

3. Shanti Narayan and Mittal, Differential Calculus, 3rd Edition, S. Chand, 1989, New Delhi

4. E. Kreyszig, Advanced Engineering Mathematics, 10th Edition, Willey, 2010, Columbus, Ohio

Reference Books:

4. B. S. Grewal, Higher Engineering Mathematics, 42nd Edition, Khanna Publication, 2017, New Delhi
5. Debashis Datta, Text Books of Engineering Mathematics, NEW AGE International Publication, 2006
6. Kanti Bhushan Datta, Mathematical Methods of Science and Engineering, 1st edition, Cengage Learning India, 2012

Subject Code:	Subject Name:	L-T-P: 3-0-0	Credit: 3
19FY2ES01T	Basic Electrical Engineering		

Course Objectives:

4. Understand the basics of the Electrical Engineering
5. Able to Identify design and solve the engineering problems
6. Acquire the knowledge and use the concepts in the practical field of Electrical Engineering, Research as well as in project

Syllabus

Module- 1 **(8 Hours)**

DC Circuits:

Circuit laws: Methods of analyzing an electric circuit, Ohm's law, Kirchoff's laws, node voltage, mesh current, Superposition, Thevenin, Maximum power transfer theorem and Norton theorems, Star-Delta Conversion.

Module-2 **(8 Hours)**

Single Phase and Three Phase AC Circuits:

Single phase A.C circuit: Phasor representation, average, effective, peak and rms values, j operator, impedance and admittance calculation. Analysis of single-phase ac circuits consisting of R, L, C, series RL, RC, RLC and calculation of Real power, reactive power, apparent power, power factor.

Three phase circuit:

Three phase emf generation, phase sequence, delta-star and star-delta conversions, and voltage and current relations in star and delta connections. Three phase interconnections: Solution of the three phase circuits with balanced load conditions, measurement of power in three phase circuits.

Module- 3 **(6 Hours)**

Magnetic Circuits:

Magnetic Circuits: MMF, flux, reluctance, inductance, magnetic field, B-H characteristics and hysteresis loss, series and parallel magnetic circuits.

Module- 4 **(6 Hours)**

Electrical Machines:

Transformers (Single Phase): Construction, operation, impedance reflection, phasor diagram, transformer on no-load & on load and performance testing.

DC machines: EMF Equation, torque equation, types of D.C. machine, methods of Excitation, speed control.

Module- 5 **(6 Hours)**

Basic of Ammeter and Voltmeter:

Measuring instruments: Absolute and secondary instrument, indicating and recording instrument, Derivation for Deflecting Torque of PMMC, MI (attraction and repulsion types), Electro Dynamometer and Induction Type Ammeters and Voltmeters.

Course Outcomes:

After completion of this course the students will be able to:

7. Analysis of Resistive Circuits and Solution of resistive circuits with independent sources.
8. Two Terminal Element Relationships for inductors and capacitors and analysis of magnetic circuit.
9. Analysis of Single Phase & Three Phase AC Circuits, the representation of alternating quantities and determining the power in these circuits
10. Analysis of construction, connection and testing of single-phase transformer
11. Acquire knowledge about the constructional details and principle of operation of dc machines
12. Acquire knowledge about the working of dc machines as generators and motors

Text Books

1. Abhijit Chakrabarti, Sudipta Nath, Chandan Kumar Chanda, Basic Electrical Engineering, 2nd Edition, McGraw Hill Companies, 2009, New Delhi.
2. Rizzoni, Principles and Applications of Electrical Engineering, 5th Edition, McGraw Hill Education, 2017.

Reference Books

1. N. K. De and D. Sarkar, Basic Electrical Engineering, 1st Edition, University Press, 2015.

Digital Learning Resources:

Course Name	Basic Electrical Engineering
Course Link	https://nptel.ac.in/courses/108/106/108106172/
Course Instructor	Prof.Nagendra Krishnapura, Department of Electrical Engineering, IIT Madras

Subject Code:	Subject Name:	L-T-P: 2-0-0	Credit : 2
19FY2ES02T	Basic Electronics Engineering		

Course Objectives:

1. Develop an understanding of the characteristics and operation of modern semiconductor devices and their applications.
2. Understand the basics of operational amplifier and its applications.
3. Acquire the knowledge of basic logic gates and analyze its application to different combinational logic circuits.

Syllabus

Module - 1 **(10 Hours)**

Introduction to Semiconductors: Extrinsic and intrinsic semiconductor, doping, p-type and n-type semiconductor

Junction Diodes: Principle of operation, Diode Current Equation, V-I characteristics, AC and DC Resistance, Equivalent circuit of Diode, Breakdown Mechanism, Zener and Avalanche diode Applications: Clippers, clampers, rectifiers and voltage multiplier circuits. Zener diode as voltage regulator.

Module - 2 **(8 Hours)**

Bipolar Junction Transistors (BJTs): Types and Basic Principle of Operation, Modes of Operation, Configuration and characteristics: CB, CE and CC, Current amplification factors, Common Emitter configuration: Current Relationship IB, IC, IE, ICBO and ICEO, application as an amplifier, Limits of operation.

Module - 3 **(6 Hours)**

Field Effect Transistor: Construction and operation of N-Channel and P-Channel JFET, Shockley's Equation, Transfer characteristics, Output Characteristics, JFET as voltage control resistor, channel resistance (rd), trans-conductance (gm), Comparison of BJT and JFET.

Metal-Oxide Semiconductor FET: Construction and Operation of D-type and E-type MOSFET, Channel Current, Characteristics and its various region of operation.

Module - 4 **(6 Hours)**

Operational Amplifiers (OP-AMP): The Ideal OP-AMP, Equivalent circuit, different modes of operation: inverting, non-inverting and differential mode, virtual ground, general concept of feedback, Op-amps with feedback, different closed loop configuration and calculation of its gain.

Module - 5 **(10 Hours)**

Digital Electronic Principles: Digital Electronic Principles: Introduction, Binary digits, Logic levels and Digital waveforms, Introduction to basic Logic operation, Number system, Decimal numbers, Binary numbers, Decimal-to-Binary conversion, Simple binary arithmetic, Logic Gates, Boolean algebra and Combinational Logic Circuits: The inverter, The AND, OR, NAND NOR, Exclusive-OR and Exclusive-NOR gate, Boolean operations and expressions, Laws and Rules of Boolean algebra, De Morgan's theorem, Boolean analysis of logic circuits, Standard forms of Boolean expressions, Boolean expression and truth table. Basic combinational logic circuits, Implementation of combinational logic, the universal properties of NAND and NOR gates, Basic adders.

Course Outcomes:

5. Understand the basic characteristics of semiconductor materials, principle of operation of a p-n junction diode and its use in different circuit design.
6. Understand the construction, operation and characteristics of different types of transistors and their biasing details to be used in practical applications.

7. Analyze operational amplifier circuits by understanding its characteristics and configuration detail.
8. Gain the knowledge of logic gates and its application using Boolean algebra in the field of combinational circuit design.

Text Books:

3. Electronic Devices Circuit Theory - by Robert L. Boylestad 11th Edition, Pearson Publication, 2014.
4. Digital Design by M. Morris Mano, 5th Edition, Pearson Publication, 2016.

Subject Code:	Subject Name:	L-T-P: 2-0-0	Credit : 2
20FY2ES02T	Basic Electronics Engineering		

Course Objectives:

1. Develop an understanding of the characteristics and operation of modern semiconductor devices and their applications.
2. Understand the basics of operational amplifier and its applications.
3. Acquire the knowledge of basic logic gates and analyze its application to different combinational logic circuits.

Syllabus

Module-1 **(6 Hours)**

Introduction to Semiconductors, Principle of operation of Junction Diodes, V-I characteristics of Junction Diode, Diode Current Equation, AC and DC Resistance of Diode, Equivalent circuit of Diode, Applications of Diode-Clipper and Rectifier circuits.

Module-2 **(6 Hours)**

Bipolar Junction Transistors (BJTs):

Types and Basic Principle of Operation, Modes of Operation and Configurations, Common Emitter Characteristics, Requirement of Biasing, DC Biasing (Fixed bias and Voltage Divider), Load line Analysis, Basic characteristics of a voltage amplifier.

Module-3 **(6 Hours)**

Field Effect Transistors (FETs):

JFET-types, Operations and their Characteristics; MOSFET-types, Operations and their Characteristics; Concept of transconductance gm and channel resistance rd,Current Equations in FETs.

Module -4 **(4 Hours)**

Operational Amplifiers (OP-AMP):

The Ideal OP-AMP, Common Mode Rejection ratio (CMRR), Inverting and Non-Inverting configurations as amplifiers.

Module-5 **(5 Hours)**

Digital Electronic Principles:

Binary digits, Logic levels, Basic Logic Operations, Laws and Rules of Boolean algebra, Logic Gates - AND, OR, NOT, NAND, NOR, XOR and XNOR gate, De Morgan's theorem, Minterms and Maxterms, Standard forms of Boolean expressions, Universal properties of NAND and NOR gates, Function implementation using different Gates.

Course Outcomes:

5. Understand the basic characteristics of semiconductor materials, principle of operation of a p-n junction diode and its use in different circuit design.
6. Understand the construction, operation and characteristics of different types of transistors and learn to solve basic BJT DC circuits.
7. Analyze the basic operational amplifier circuits by understanding its characteristics and configuration details.
8. Gain the knowledge of basic logic gates and its application in functional implementation using Boolean algebra.

Text Books:

3. Robert L. Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, 11th Edition, Pearson Publication, 2014, New Delhi.
4. M. Morris Mano, Michael D. Ciletti, Digital Design, 5th Edition, Pearson Publication, 2016, New Delhi.

Reference Books:

4. Adel S. Sedra and Kenneth C. Smith, Microelectronic circuits, 7th Edition, Oxford University Press, 2006, New Delhi.

5. David A. Bell, Electronic Devices and Circuits, 5th Edition, Oxford University Press, 2010, New Delhi.
6. Thomas L. Floyd, Digital Fundamentals, 11th Edition, Pearson Publication, 2015, New Delhi.

Digital Learning Resources:

Course Name	Basic Electronics Engineering
Course Link	https://nptel.ac.in/courses/117/103/117103063/
Course Instructor	Prof. Chitralekha Mahanta, Department of Electronics and Communication Engineering, IIT Guwahati

Course Name	Basic Electronics Engineering
Course Link	https://nptel.ac.in/courses/108/101/108101091/
Course Instructor	Prof. Mahesh B. Patil, Department of Electrical Engineering, IIT Bombay

Subject Code:	Subject Name:	L-T-P: 2- 0- 0	Credit: 2
19FY2ES03T	Basic Mechanical Engineering		

Course Objectives:

7. Define System, Properties, Process, State, Cycle, various forms of energies, enthalpy
8. Explain the working principles of Air compressors, Steam Power Plant, Refrigerators, Heat pump and I.C. Engines Hydraulic Turbine and Pump.
9. Describe the working principles of Belt, Rope, Gear drives, coupling, clutch and brakes.
10. Describe about various machining process.
11. Discuss the working principle of Temperature, pressure, velocity, flow, strain, force, torque measurements.
12. Calculate the temperature and pressure at different states of a system.

Syllabus

Module-1 **(8 Hours)**

Basics of thermal and fluid science:

Systems, Properties, Process, State, Cycle, Internal energy, Enthalpy, Zeroth Law, basic modes of heat transfer, Properties of ideal gas, Fluid properties, Pascal's law, Buoyancy.

Module-2 **(8 Hours)**

Engineering materials:

Classification of engineering materials. Mechanical properties of Steel, Aluminium, Plastics and composites.

Module-3 **(8 Hours)**

Basic manufacturing process processes:

Casting and forming (Drawing, Forging, Extrusion) (working principles with Fastening Schematic diagram only), Joining process

Module-4 **(8 Hours)**

Power transmission devices:

Belt, Rope, Gear drives. Coupling, clutch, brakes, Cam. (Basics, applications, advantages and limitations only).

Module-5: **(8 Hours)**

Application of thermal and fluid science:

Air compressors, Steam Power Plant, Refrigerators, Heat pump, I.C. Engines and heat exchangers, Hydraulic turbine and Pump, (basics). (Brief description of different components of above mentioned systems and working principles with Schematic diagram only)

Course Outcomes:

6. Understand basics of thermodynamics and components of a thermal power plant.
7. Identify engineering materials, their properties, manufacturing methods encountered in engineering practice.
8. Understand basics of heat transfer, refrigeration and internal combustion engines.
9. Understand mechanism of power transfer through belt, rope, chain and gear drives.
10. Understand functions and operations of manufacturing process.

Text Books:

4. Pravin Kumar, Basic Mechanical Engineering, Second Edition, Pearson Education, 2018, New Delhi.
5. R. Israni, P. K. Shah, N. C. Nayak, Basic Mechanical Engineering, Second Edition, BS Publications, 2019, New Delhi.
6. S T Murthy, Text book of Elements of Mechanical Engineering, Third Edition, I. K. International Publishing House Pvt. Limited, 2010, New Delhi

Reference Books:

5. P. Chattopadhaya, Engineering Thermodynamics, 2nd Edition, Oxford University Press,

2015, New Delhi.

6. P. K. Nag, Engineering Thermodynamics, 4th Edition, Tata McGraw-Hill Publishing Company, 2008, New Delhi.
7. J K Kittur and G D Gokak, Elements of Mechanical Engineering, 1st Edition, Willey, 2015, New Delhi.
8. B. Agrawal, C M Agrawal, Basic Mechanical Engineering, 1st Edition, Willey-India, 2008, New Delhi.

Digital Learning Resources:

Course Name	Basic Thermodynamics
Course Link	https://nptel.ac.in/courses/112/105/112105123/
Course Instructor	Prof. S.K. Som, Department of Mechanical Engineering, IIT Kharagpur

Course Name	Introduction to Fluid Mechanics
Course Link	https://nptel.ac.in/courses/112/105/112105269/
Course Instructor	Prof. Suman Chakraborty, Department of Mechanical Engineering, IIT Kharagpur

Subject Code:	Subject Name:	L-T-P: 2- 0- 0	Credit: 2
19FY2ES04T	Basic Civil Engineering		

Course Objectives:

6. To understand the properties of common building materials.
7. To learn functional planning of building.
8. To understand the concepts of stress and strain of structural members.
9. To learn the various methods of surveying.
10. To understand public water supply system.

Syllabus

Module-1 **(8 Hours)**

Basics of Civil Engineering, Broad disciplines of Civil Engineering; Structural Engineering, Geotechnical Engineering, Water Resources Engineering, Transportation Engineering.Construction materials: Bricks: Qualities of a good brick, Classification of bricks. Types of cement and their uses, various field and laboratory tests on cement, Ingredients of cement concrete, Grades of concrete, workability of concrete.

Module-2 **(6 Hours)**

Functional planning of building:

General principles of site selection, site plan, principles of planning of buildings, open air spaces, floor area ratio, requirement of parts of buildings, lighting and ventilation, functional aspects various rooms, Building bye laws, Orientation of building, Components of building and their purpose.

Module--3 **(8 Hours)**

Structural mechanics:

Stress, Strain, Hooke's Law, Stress-Strain diagram, Young's modulus, Bulk modulus, Shear modulus of rigidity, Poisson's ratio. Parallel forces in a plane: General case of parallel forces, Center of parallel forces in a plane

Module-4 **(8 Hours)**

Surveying:

Linear measurement and chain survey: Use of chains and tapes for measurement of correct length of lines. Prismatic Compass: Bearing Systems and Conversions, Local Attraction.

Module-5 **(6 Hours)**

Water resources engineering:

Necessity and objectives of public water supply schemes; population growth and forecast – estimating the quantity of water required.

Course Outcomes:

After completion of the course the student will able to

1. Compare the properties of building materials.
2. Planning and design of building.
3. Understand the concepts of stress and strain of structural members.
4. Use of various surveying instruments and mapping.
5. Estimate the quantity of water required for a project.

Text Books:

1. S. Gopi "Basic Civil Engineering", Pearson Education India.
2. S. S. Bhavikatti, "Basic Civil Engineering", New age international.

Reference Books:

1. M. S. Palanichamy "Basic Civil Engineering", 3rd Edition, Tata McGraw-Hill, 2000, India.

Digital Learning Resources:

Course Name	Building Material and Construction
Course Link	https://nptel.ac.in/courses/105/102/105102088/
Course Instructor	Dr. B. Bhattacharjee, Department of Civil Engineering, IIT Delhi

Subject Code:	Subject Name:	L-T-P:	Credit:
19FY2HS01T	English	2- 0- 0	2

Course Objectives:

5. To learn communication technologies to communicate effectively by developing exceptional textual, visual and non-verbal communication abilities.
6. To draft effective formal written business messages in various formats and styles.
7. To learn the skills to effectively deliver formal oral presentations to a variety of audiences in multiple contexts.
8. To be acquainted with the soft skills and various selection procedures adopted by the recruiters.

Syllabus

Module-1 **(8 Hours)**

Basics of communication skills:

Significance of communication, The process and factors of communication (the communication loop), Difference between General and Technical Communication, Verbal communication and its principles, Non-verbal communication, Paralingustics, The importance of audience & purpose.

Module-2 **(10 Hours)**

Basics of English pronunciation & soft skills:

Introduction to English pronunciation with the IPA chart, Received Pronunciation, problems of Indian English, Professional presentations, Group Discussion, Interview etiquette, Leadership skills

Module-3 **(6 Hours)**

Brush up your grammar & vocabulary:

Parts of speech &Tense, Voice Change, Direct and Indirect Speech, Concord, Parallelism, Word formation- root words, synonyms, antonyms, homonyms & homophones, Common errors in English Grammar

(N.B. – Instead of teaching, this unit should be taught by assigning activities to the students in the class)

Module-4 **(6 Hours)**

Basics of reading and writing skills:

Reading Skill: Types of reading, Sub-skills of reading: Skimming, Scanning, Reading comprehension, Writing Skill: Steps to writing, Describing, Defining, Classifying and Providing examples or evidence, Empathetic and Result Oriented Writing.

Module-5 **(10 Hours)**

Professional writing:

Paragraph, Letter, Memos & Circulars, Reports, Proposals, e-mails & CV

Course Outcomes:

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

5. Become adept in their use of the spoken word in interpersonal communication, small group interaction and public speaking.
6. Use an appropriate style and format to write letters (formal and informal), prepare result oriented reports, prepare CVs and draft business documents.
7. Gather and prepare information and apply it to persuade or articulate one's own point of view clearly and efficiently.
8. Evaluate the employability market, identify the organizations to get good placements and broaden career plans by developing all-round personality.

Reference Books:

9. Sanjay Kumar and Pushp Lata, Communication Skills, Oxford University Press
10. Meenakshi Raman & Sangeeta Sharma, Technical Communication, Principle and Practice, Oxford University Press
11. M. Ashraf Rizvi, Effective Technical Communication, Tata McGraw – Hill.
12. Meenakshi Raman & Prakash Singh, Business Communication, Oxford
13. Urmila Rai and S M Rai, Communication for Management, HPH
14. Sengupta, Business and Managerial Communication, PHI
15. P. Mehra, Business Communication for Managers, Pearson
16. Soft Skills K Alex, S Chand

Suggested Readings:

6. Manual of English Grammar and Composition. J. C. Nesfield Forgotten Books
7. Practical English Usage. Michael Swan. OUP.
8. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press.
9. A Course in English phonetics by T. R. Kansakar , ORIENT LONGMEN Press.
10. A Communicative Grammar of English, Leech, Geoffrey & Jan Svartvik, , Longman.

Subject Code:	Subject Name:	L-T-P: 0- 0-2	Credit : 1
19FY2BS01L	Physics Lab		

Course Objectives:

Co-relate the theory with experiment.

Group project works based on as experimental physics knowledge

Create an exciting intellectual adventure with experimental skill.

List of Experiments

(A student is expected to perform ten experiments form the list given below.)

16. Determination of Young's modulus by Searle'smethod.
17. Determination of Rigidity modulus by staticmethod.
18. Determination of surface tension by capillary risemethod.
19. Determination of acceleration due to gravity by Barpendulum.
20. Determination of wave length of light by Newton's ringapparatus.
21. Determination of wavelength of laser source by diffraction gratingmethod.
22. Determination of grating element of a grating plate.
23. Plotting of characteristic curve of a PN junctiondiode.
24. Plotting of characteristic curves ofBJT.
25. Study of HallEffect.
26. Study of RCcircuit.
27. Determination of unknown resistance using MeterBridge.
28. Energy gap determination by Four-Probemethod.
29. Determination of Young's modulus by bending ofbeams.
30. Verification of laws of vibration of string using sonometer.

Course Outcomes:

3. Learn basics of measuring instruments and its expt. Applications.
4. Observe and evaluate hands on skill on experimental physics.

Books:

3. B. B. Swain, A Complete Course in Practical Physics, 1st Edition, Kalyani Publication.
4. C. L. Arora, Practical Physics, S. Chand Publication.

Subject Code:	Subject Name:	L-T-P: 0- 0-2	Credit: 1
19FY2BS02L	Chemistry lab		

Course Objectives:

4. To understand the water quality parameter
5. Quantitative analysis of some standard compound
6. Instrumental methods for quantitative analysis

List of Experiments

(A student is expected to perform ten experiments form the list given below.)

16. Determination of amount of sodium hydroxide and sodium carbonate in a mixture.
17. Determination of partition coefficients of iodine between toluene and water.
18. Determination of percentage of available chlorine in a sample of bleaching powder.
19. Determination of dissolved oxygen in a sample of water.
20. Determination of strength of acids in a mixture using pH meter.
21. Determination of total hardness of water by EDTA method.
22. Determination of strength of colored substance using colorimeter.
23. Determination of strength of acids in a mixture using Conductance Bridge.
24. Determination of surface tension of given sample using Stalagnometer
25. Determination of Viscosity of a supplied sample(s) by Ostwald's Viscometer.
26. Determination molecular weight of polymer by viscosity method.
27. Determination of rate constant of acid catalyzed ester hydrolysis.
28. Determination of Flash point of given oil by Pensky-Marten's flash point apparatus.
29. Determination of critical solution temperature of Phenol-Water system.
30. Determination of Calorific value of a fuel using Bomb calorimeter.

Course Outcomes:

4. Analyze the water quality parameter including dissolved oxygen, Hardness, and chlorine content.

5. Analyze qualitatively different compounds using analytical equipments like, pH meter, Conductivity meter, Colorimeter etc.
6. Qualitative analysis of liquid sample through viscosity and surface tension measurement.

Books:

3. S. K. Bhasin, Sudha Rani, Laboratory manual on Engineering Chemistry, 1st Edition, Dhanpat Rai Publication, 2012, New Delhi.
4. S. Ratan, Experiments in Applied Chemistry, 3rd Edition, S. K. Kataria and Sons, 2011, New Delhi

Subject Code:	Subject Name:	L-T-P: 0- 0-2	Credit: 1
19FY2ES01L	Basic Electrical Engineering Lab		

Course Objectives:

5. To enhance understanding of electrical engineering circuit analysis concepts including: Thevenin's theorem, Norton's theorem, Superposition Theorem
6. To get the knowledge of phasor representation, power and power factor measurement of electrical circuit
7. To know the concept of B-H Curve of the magnetic materials and to know the functionality of the transformer with their losses by conducting suitable tests on it.
8. To Apply knowledge of DC generators and motors in various applications and able to know the uses of starter

List of Experiments

10. V-I Characteristics of Incandescent (Filament) Lamp
11. Voltage and Power measurement of a Fluorescent Lamp
12. Verification of DC Network Theorems (Superposition, Thevenin's& Norton's Theorem)
13. Calculation of current, voltage and power in series R-L-C circuit excited by single phase AC supply and calculation of power factor
14. Measurement of power and power factor in a three phase AC circuit by using Two-Wattmeter method
15. Connection and testing of a Single-Phase Energy Meter
16. O.C & S.C Test on Single phase Transformer
17. Starting and Speed Control of a D.C. Shunt Motor
18. Study of B-H curve by using by using CRO

Course Outcomes:

After completion of this course the students will be able to:

5. Determine the DC network analysis with the use of theorems and their applicability for the practical application.
6. Know the fundamentals magnetic field theory, able to apply the laws of magnetic field for the transformer and also determination of its losses by conducting suitable tests
7. Understand the concept of Phasor representation and Power factor measurement of AC circuit
8. Analyze the performance of D.C machines and it various practical applications.

Subject Code:	Subject Name:	L-T-P: 0- 0-2	Credit: 1
19FY2ES02L	Basic Electronics Engineering Lab		

Course Objectives:

5. Understand the measurement techniques using basic measuring instruments.
6. Expose to characteristics and testing of various electronics components.
7. Assemble and test different circuits using diode and op-amps.
8. Verify the truth table of basic logic gates

List of Experiments

(Any ten Experiments out of 12 should be performed)

13. Study of digital multi-meters, CROs and function generators.
14. Familiarization and testing of different electronic components (Active & Passive).
15. Study of the V-I characteristics of P-N junction diode and calculation of DC & AC resistance.
16. Construction of half-wave rectifier with & without capacitive Filter and verify the output waveforms using CRO and calculation of efficiency and ripple factor.
17. Constructions of full wave rectifier circuits with & without capacitive Filter and verify the output waveforms using CRO and calculation of efficiency and ripple factor.
18. Design a Zener based voltage regulator to verify the load regulation.
19. Construction of positive and negative clipper circuits and study of their output waveforms by CRO.
20. Study of both input and output V-I characteristics of a Common Emitter configuration.
21. Study of output V-I characteristics of an n-channel JFET and define the pinch off voltage from it.
22. Design of inverting and non-inverting amplifiers using Op-Amp and compare the theoretical and practical gain values.

23. Truth table verification of logic gates.
24. Verification of universal properties of NAND and NOR gates.

Course Outcomes:

5. Identify and test basic electronics components using test and measuring instruments.
6. Design, assemble and test of diode characteristics and its application in circuits.
7. Design and testing of op-amp based configurations.
8. Familiarization and testing of basic logic gates.

Subject Code:	Subject Name:	L-T-P: 0- 0-2	Credit: 1
19FY2ES03L	Basic Mechanical Engineering Lab		

Course Objectives:

5. To understand basic working principle of power plant, IC engine and. refrigerator
6. To study various parts in Automobile
7. To give complete knowledge about power transmission.
8. To study the measurement of the fluid characteristics

List of Experiments:

12. Model study of Fire Tube Boilers and Water Tube Boilers.
13. Model study of Two stroke I.C. Engine.
14. Model study of Four stroke I.C. Engine.
15. Model study of Refrigerator
16. Model study of Water Turbines.
17. Model study of Water pumps.
18. Study of Gears and Gear trains.
19. Verification of Bernoulli's Theorem and its application to Venturimeter.
20. Calibration of Bourdon Tube Pressure gauge and measurement of pressure using manometers.
21. Model study of Automobile Parts.
22. Determination of velocity ratio of belt drive

Course Outcomes:

5. Understand basics of thermodynamics and components of a thermal power plant
6. Understand basics of refrigeration, air conditioners and internal combustion engines..
7. Understand mechanism of power transfer through belt, rope, chain and gear drives .
8. Understand the measurement of pressure and energy.

Subject Code:	Subject Name:	L-T-P: 0- 0-2	Credit: 1
19FY2ES04L	Basic Civil Engineering Lab		

Course Objectives:

1. To understand the shape, size and strength of properties
2. To understand the properties of cement and concrete.
3. To calculate the support reaction of different beams
4. To know the methods of surveying
5. To know the plan of a building

List of Experiments:

1. Shape, size and compressive strength test of brick
2. Consistency Test of Cement
3. Setting time of cement
4. Workability test of concrete: Slump test
5. Cube test of concrete (nominal mix)
6. Experiment on calculation of support Reactions of a simply supported beam.
7. Experiment on calculation of support Reactions of an overhanging beam.
8. Chain traversing through obstacles
9. Compass surveying to find out the Bearing of a Line.
10. Line plan of a two BHK building in a plot.

Course Outcomes:

After completion of the course the student will be able to

1. Have knowledge about the different test of brick.
2. Compare the properties of building materials.
3. Able to calculate the support reaction of any beam

4. Able to perform different method of surveying
5. Able to prepare the plan of any building.

Subject Code:	Subject Name:	L-T-P: 0-0-2	Credit: 2
19FY2ES05L	Engineering Graphics & Design		

Course Objectives:

6. The main objective of engineering graphics & design course is to develop the drawing communication skills, individual and team work, and usage of the modern tools. The main purpose of this course is to develop the visualization skills through understanding of the engineering components and their functions.
7. To learn use of different types of drawing instruments and drawing standards.
8. To learn orthographic projections of points, lines and diverse planes.
9. To learn orthographic projection of solids, section of solids, and development of lateral surfaces.
10. To learn isometric projection of solids for different regular solid shapes.

Syllabus:

Module-1 (6 Hrs.)

Importance of graphics in engineering applications – Use of drafting instruments. BIS conventions and specifications. Size, layout and folding of drawing sheets – Lettering and dimensioning; Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle. Drawing of tangents and normal to the above curves.

Module-2 **(8 Hrs.)**

Orthographic Projections:

Introduction, Definitions - Planes of projection, reference line and conventions employed, Projections of points in all the four quadrants, Projections of straight lines (located in First quadrant/first angle only),True and apparent lengths, True and apparent inclinations to reference planes 2 – Sheets

Module-3 **(8 Hrs.)**

Orthographic Projections of Plane Surfaces (First Angle Projection Only):

Introduction, Definitions–projections of plane surfaces–triangle, square, rectangle, rhombus, pentagon, hexagon and circle, planes in different positions by change of position method only 1-Sheet

Module-4 **(10 Hrs.)**

Projections of Solids (First Angle Projection Only):

Introduction, Definitions – Projections of right regular tetrahedron, hexahedron (cube), prisms, pyramids, cylinders and cones in different positions. 2-Sheets

Sections and Development of Lateral Surfaces of Solids:

Introduction, Section planes, Sections, Section views, Sectional views, Apparent shapes and True shapes of Sections of right regular prisms, pyramids, cylinders and cones resting with base on HP. 2 – Sheet

Module-5 **(8 Hrs.)**

Isometric Projection (Using Isometric Scale Only):

Introduction, Isometric scale, Isometric projection of simple plane figures, Isometric projection of tetrahedron, hexahedron(cube), right regular prisms, pyramids, cylinders, cones, spheres, cut spheres. 2-Sheets

Course Outcomes:

6. Familiar with drawing instruments, BIS codes, letter writing and dimensioning.
7. Understand the concepts of orthographic projections and draw the projection of points and lines.
8. Draw the orthographic projection of different planes using first angle projection.
9. Do orthographic projection of solids, sections of solids, and development of their lateral surfaces in first angle projection.
10. Understand and draw the isometric projection of solid entities.

Suggested Books:

7. N. D. Bhatt & V. M. Panchal, Engineering Drawing, Charotar Publishing House, Gujarat.
8. S. Trymbaka Murthy, Computer Aided Engineering Drawing, I. K. International Publishing House Pvt. Ltd., New Delhi.
9. N. S. Parthasarathy and Vela Murali, Engineering Drawing, Oxford University Press.
10. K. R. Gopalakrishna, Engineering Graphics, Subash Publishers, Bangalore.
11. J. Luzadder Warren, M. Duff John, Fundamentals of Engineering Drawing with an Introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice-Hall of India Pvt. Ltd., New Delhi.
12. NPTEL Online Engineering Drawing Courses: https://nptel.ac.in/courses/112103019/

Subject Code: 19FY2ES06L	Subject Name: Workshop	L-T-P: 0- 0-2	Credit: 1

Course Objectives:

5. Acquire knowledge of possible personal and general safety hazards in industrial settings and their mitigation techniques.
6. Learn about different mechanical tools used in engineering.
7. Learn about organization of machines and tools for a safe and effective workplace.
8. Machining and joining techniques of commonly used engineering materials.

Syllabus:

Experiments **(36 Hours)**

Fitting Practice:

Use of hand tools in fitting, preparing a male and female joint of M.S. or making a paper weight of M.S.

Welding Practice:

Gas welding & Electric Arc welding Practice. A joint such as a Lap joint, a T-joint or a Butt joint is to be prepared or to make furniture.

Machining:

(i) Stepped cylindrical Turning of a job and Thread-cutting in lathe.

(ii) Shaping (iii) Milling

Course Outcomes:

1. Identify safety signs and act accordingly, maintain personal as well as group and equipment safety.
2. Identify different tools and their applications.
3. Undertake minor fabrication and repair/maintenance work using commonly available tools and materials.

Books:

1. Hajrachoudhary, Elements of Workshop Technology, Vol. I and II, Khanna Publishers

2. WAJ Chapman, Workshop Technology, Viva Books
3. Kannaiah/ Narayana, Workshop Manual, Scitech

Subject Code:	Subject Name:	L-T-P: 0- 0-2	Credit: 1
19FY2HS01L	English Language Lab		

(This unit involves interactive practice sessions in Language Lab)

1. Listening Comprehension
2. Pronunciation, Intonation
3. Stress and Rhythm practice
4. Common Everyday Situations: Conversations and Dialogues
5. Formal Presentations
6. Reading Comprehension
7. Report writing
8. Writing letters, e-mails,
9. Writing essay, CV
10. Statement of Purpose
11. Grammar activities
12. Empathetic Listening

Third Semester					
Theory					
Sl. No.	**Category**	**Course Code**	**Course Title**	**L-T-P**	**Credit**
1	BSC	19CM3BS01T	Math-III (Probability, Statistics & Numerical Methods)	3-0-0	3
2	HSMC	19CM3HS01T/ 19CM3HS02T	Engineering Economics/Organizational Behavior	3-0-0	3
3	ESC	19CM3ES01T	Data Structure using C	3-0-0	3
3	ESC	19ME3ES02T	Engg. Mechanics	3-0-0	3
4	PCC	19ME3PC01T	PCC-1: Engineering Thermodynamics	3-0-0	3
5	PCC	19ME3PC02T	PCC-2: Introduction to Physical Metallurgy & Engg Materials	3-0-0	3
6	MC	19CM3MC01T	Environmental Science		0
Total Credit (Theory)					18
Practical					
1	PCC	19ME3PC01L	Engineering Thermodynamics Lab	0-0-2	1
2	PCC	19ME3PC02L	Introduction to Physical Metallurgy & Engg. Materials lab	0-0-2	1
3	ESC	19CM3ES01L	Data Structure using C Lab	0-0-2	1
4	ESC	19ME3ES02L	Engineering Mechanics Lab	0-0-2	1

4	**PSI**	**19ME3PS01L**	**Summer Internship**	**0-0-2**	**1**
Total Credit (Practical)					**5**
Total Semester Credit					**23**

Course Code: 19FY3BS01T	**Course Name: Mathematics-III**	**L-T-P 3- 0- 0**	**Credit 3**

Course Objectives:

The course should enable the students to:

1. Enrich the knowledge of probability on single random variables and probability distributions.
2. Apply the concept of correlation and regression to find covariance. Analyse the given data for appropriate test of hypothesis Understand the foundations for classical inference involving confidence intervals and hypothesis testing. Knowledge of Numerical method for solving mathematical problems.

Syllabus:

Module-1 **(8 Hrs)**

Random variables: discrete and continuous random variables, probability distribution of a random variable. Some characteristic of probability distribution. Probability mass function and probability density functions; Mathematical expectation: Mean, Variance and standard deviation of a probability distribution.

Module-2 **(8 Hrs)**

Binomial distribution; Mean and variances of Binomial distribution, Recurrence formula for the Binomial distribution; Poisson distribution: Poisson distribution as a limiting case of Binomial distribution, mean and variance of Poisson distribution, Recurrence formula for the Poisson distribution; Normal distribution; Mean, Variance, Characteristics of normal distribution.

Module-3 **(10 Hrs)**

Methods of Sampling. Estimation, point and interval estimation, Basic data analysis, setting of hypothesis, null hypothesis and alternate hypothesis, testing of hypothesis, type I and type II errors, critical region, confidence interval, level of significance. One sided test, two sided test. Chi-square test: Goodness of fit and test of association. Correlation: Coefficient of correlation, Computation of correlation coefficient, Regression: Lines of regression and their properties.

Module-4 **(8 hrs)**

Root Finding: Introduction, Numerical solution by Bisection Method, Newton Raphson method, Secant method, Fixed point method. Interpolation: Lagrange, Newton forward, Backward, Divided Difference Method.

Module-5 **(10 hrs)**

Numerical Integration; Trapezoidal Method, Simpson's 1/3 rule, Gauss-quadrature 2 & 3 points method, Solution of First Order Differential equation by Euler's method, Modified Euler's method, Runge-Kutta 4th order and Predicator & Corrector methods(Adams-Bash forth Method).

Course Outcomes:

On completion of this course, students are able to:

1. Use the basic probability rules, discrete and continuous probability distributions, including requirements of mean and variance and making decisions.
2. Identify the characteristics of different discrete and continuous distributions. Identify the type of statistical situation to which different distributions can be applied.
3. Use of continuous distribution various hypothesis of testing, Employee the principles of linear regression and correlation and significance of the correlation coefficient.
4. Use of the Numerical method for finding roots, fitting the data into a polynomial equation, integrating any integration and solve any first order ode with initial condition.

Text Books:

1. E. Kreyszig, *Advanced Engineering Mathematics*, Tenth Edition, Willey.
2. Richards A Johnson, Irvin Miller and Johnson E Freund,*Probability and Statistics for Engineering*, 9th Edition, PHI.
3. M. K. Jain, S.R.K. Iyenger and R.K. Jain, *Numerical Methods for Scientific and engineering Computations*, New age International Publication (P) Ltd.

Reference Books:

1. Fundamentals Of Mathematical Statistics is written by SC Gupta and VK Kapoor and published by SULTAN CHAND & SONS, Delhi.
2. Rohit Khurana, Kanti B. Datta, Engineering Mathematics, Cengage Publications.
3. Jay l. Devore, Probability and Statistics for Engineering and the Sciences. 8th edition, Cengage.
4. S Arora, Sumeet Arora, P N Arora. Comprehensive Statistical Methods, Schaum Series, S. Chand Publication.

5. B.V. Raman, Higher Engineering Mathematics, Mc-Graw Hills Education.

1. B. S. Grewal, Higher Engineering Mathematics, Khanna Publisher

Digital Learning Resources:

Course Name	Mathematics-III
Course Link	http://www.nptelvideos.in/2012/11/mathematics-iii.html
Course Instructor	Prof.P.N.Agarwal, Department of Mathematics, IIT Roorkee.

Course Code:	Course Name:	L-T-P 3- 0- 0	Credit 3
19CM3HS01T	Engineering Economics		

Module-I: **(8 Hrs.)**

Introduction to Economics: Definition, scope and nature of economics, consumption laws, demand & supply analysis, elasticity of demand& supply, indifference curve analysis.

Module-II: **(10 Hrs.)**

Production: factors of production, production function, law of variable proportion, laws of return to scale, elasticity of factor-substitution, optimal combination of factor-inputs, production efficiency, economies of scales, Cost of Production: types of costs, economic costs: fixed cost and variable costs, short-run and long-run cost functions.

Module-III: **(10 Hrs.)**

Market Structure: pure competition, perfect competition, imperfect market, monopoly and oligopoly. Indian Banking System, Functions and Roles of Commercial Banks and Reserve Bank of India.

Module-IV: **(12 Hrs.)**

Time value of money and interest formulae, Nominal and effective rate of interest, Present, Annual and Future worth analysis, Rate of Return Analysis, Cost-Benefit analysis in Public sector projects.

Module- V: (as per choice of faculty) **(8 Hrs.)**

Portion covered can be tested through Internal evaluation only not to be included in University examination.

Reference Books:

1. Koutsoyiannis, A., 'Modern Microeconomics', English Language Book Society, Macmillan.
2. Pindyck, R S, Rubinfeld, D L &Mehta , 'Microeconomics', 6 th Edition, Pearson Education India.
3. Varian, H R, 'Intermediate Microeconomics', 7th edition, East West Press India.
4. Samuelson, Paul A, 'Economics', 5th edition, McGraw Hill New York.
5. Basics of Engineering Economy; Leland Blank and Anthony Tarquin, TMH
6. Contemporary Engineering Economics, Chan. S Park, Pearson
7. Engineering Economics, Paneerselvam, PHI
8. Engineering Economics; Sasmita Mishra.

Digital Learning Resources:

Course Name	Engineering Economics
Course Link	https://www.classcentral.com/course/swayam-engineering-economic-analysis-9919
Course Instructor	Pradeep K. Jha ,IIT Roorkee.

Course Code:	Course Name:	L-T-P 3- 0- 0	Credit: 3
19CM3HS02T	Organizational Behavior		

Course Objectives:

Developing an understanding of the behavior of individuals and groups inside organizations by enhancing the skills in appreciating individuals, interpersonal, and group process for increased effectiveness both within and outside of organizations is the goal of any organization. Through this course students will develop theoretical and practical insights and problem-solving capabilities for effectively managing the organizational processes.

Syllabus:

Module-I: Fundamentals of OB: (6 Hours)

Definition, scope and importance of OB, Relationship between OB and the individual, Evolution of OB, Models of OB. Learning; Theories and their applications

Module II: Foundations of Individual Behavior: (12 Hours)

Personality and values: Definition and importance of Personality for performance, The Myers-Briggs Type Indicator and The Big Five personality model, Significant personality traits suitable to the workplace (personality and job – fit theory), Personality Tests and their practical applications. Attitude; ABC Model. Perception: Meaning and concept of perception, Factors influencing perception, Selective perception, Perceptual errors.

Motivation: Definition & Concept of Motive & Motivation, The Content Theories of Motivation (Maslow's Need Hierarchy & Herzberg's Two Factor model Theory), The Process Theories (Vroom's expectancy Theory & Porter Lawler model), Contemporary Theories – Equity Theory of Work Motivation.

Module- III: Foundations of Group Behavior: (8 Hours)

Group Dynamics, Types of Groups, The Five – Stage Model of Group Development.

Developing Work Teams, Team Effectiveness & Team Building.

Leadership: Concept, Types & Styles of Leadership, Traditional & Contemporary theories of leadership Success stories of today's Global and Indian leaders.

Module- IV: Foundations of Organizational Behavior: (10 Hours)

Organizational Culture; creating and maintenance. Organizational Change; concept and technique and theories of change. Organizational Development; concept and methods of doing development.

Text Books:

Organizational Behavior, Robbins, Judge, Sanghi, Pearson.

Reference Books:

1. Organizational Behaviour, K. Awathappa, HPH.
2. Organizational Behaviour, VSP Rao, Excel
3. Introduction to Organizational Behaviour, Moorhead, Griffin, Cengage.
4. Organizational Behaviour,Hitt, Miller, Colella, Wiley
5. Organizational Behaviour, Suba Rao,Mishra, Himalaya
6. Organizational Behaviour – Uma Sekharan
7. Understanding Organizational Behaviour, Parek, Oxford

Digital Learning Resources:

Course Name	Organizational Behavior
Course Link	https://onlinecourses.nptel.ac.in/noc20_mg51/preview
Course Instructor	By Prof. M. P. Ganesh ,IIT Hyderabad .

Course Code:	Course Name:	L-T-P 3- 0- 0	Credit 3
19CM3ES01T	Data Structure using C		

Course Objectives:

1. To introduce the concepts of ADT, Time and Space complexity and asymptotic performance of algorithms and apply the important algorithmic design paradigms and methods of analysis.
2. Analyse and Design of the Algorithms and how the different data structures [Linear and non-linear] are used for efficient accessing of the data and Manipulation of the data.
3. Implementation of the linear and non-linear data structures, searching and sorting techniques and analyzing their time complexities.

MODULE - I **14 hours**

Abstract data types –adt's, stack, queue, sparse matrices Review on structures, array of structures, pointer to structures, passing structure to a function, dynamic memory allocation, Function pointer, pointer to pointer, menu driven programs

Abstract data types – definition and representation, adt of rational number, adt of stack, data structure and adt. stack and its usages: reversing string, matching parentheses, in fix to postfix, decimal to binary number. queue: linear & circular queue, deque & applications. matrix – sparse and dense. representation of sparse matrix, transpose & addition of sparse matrices.

Module -II : **8 hours**

Linked list and its representation: using array, using self-referential structure. Singly, circular and double linked lists. operations on linked list – insertion, deletion, traversals. usages of linked

list, insertion sort, addition/multiplication of polynomials. addition/multiplication of large numbers.

Module -III : **12 hours**

Tree: definition and terminologies, child and parent nodes, sub tree, root, leaf node, internal node, height of a tree, binary, ternary, quad tree. binary tree traversals. reconstruction of binary tree from traversals. binary search tree – inserting a new key, deleting a key, searching a key. avl tree – inserting a new key into an avl tree using rotations. b- tree : insertion and deletion using node splitting and merging.

Module -IV : **6 hours**

Sorting and searching: bubble sort, selection sort quick sort and merge sort. Linear and binary search, Fibonacci search.

Module -V : **6 hours**

Basic graph algorithm: graph representation – adjacency matrix and list – pros and cons. Graph, traversals – depth first search and breadth first search.

Course Outcomes:

On Completion of this Course, the students should be able to:

1. To understand the concept of ADT, Time and Space complexity, asymptotic performance of algorithms and understand how different data structures are used for data storage and retrieval.
2. Implement the linear data structures and non-linear data structures ,various searching and sorting techniques, BST, AVL trees and graph traversal algorithms

3. Analyzing the time complexities of algorithms used in learning the subject. Analyze the situation in hand and the type of data structure to be used and implement using a programming language.

Text Books:

1. Data Structures: A Pseudocode Approach with C – Gilberg & Forouzan, 2nd Edition, Cengage, Indian Reprint 2016
2. Data Structures and Program Design in C – Kruse, Leung, 2nd Edition, Pearson,2008
3. Data Structures Using C - Yedidyah Langsam & Moshe J. Augenstein Aaron M. Tanenbaum, 3rd Edition, Pearson, 2009
4. Algorithms and Data Structures: The basic toolbox, Kurt Mehlhorn and Peter Sanders, Springer, 2010
5. Programming and Data Structures (NPTEL) – (Video lectures by Dr. Naveen Garg, IIT Delhi, new course available from July 2019)

Reference books:

1. Schaums Outlines Data Structures with C by Seymour Lipschutz" , Publisher: Mcgraw Hill, 2011. [SIE]
2. Data Structures Using C, Oxford University Press, 2014.
3. Data Structures, Algorithms, and Applications in C++ , McGraw-Hill international editions: Computer science series.

Digital Learning Resources:

Course Name	Data Structure using C
Course Link	https://nptel.ac.in/noc/courses/noc18/SEM1/noc18-cs25/
Course Instructor	By Prof. Sudarshan Iyengar IIT Ropar

Course Code: **19ME3ES02T**	**Course Name:** **Engineering Mechanics**	**L-T-P 3- 0- 0**	**Credit 3**

Course Objectives:

1. The overall objective of this course is to learn how to draw the free body diagram and analyze the system of forces of structure. This includes the understanding of concurrent forces on plane.
2. The objective of this topic is to learn how to draw the free body diagram and analyze the Parallel forces, center of gravity forces, moment of inertia, and plane trusses.
3. The objective of this topic is to analyze the rectilinear motion of particle with the aid of D'Alembert's principle.
4. The objective of this topic is to analyze dynamics of particle with the help of momentum and impulse, work and energy and impact.
5. The objective of this topic is to analyze the curvilinear motion of particle with the aid of D'Alembert's principle.

Syllabus:

MODULE – I **(8 Hours)**

Concurrent forces on a plane – Composition and resolution of forces and equilibrium of concurrent coplanar forces, Method of projections, Methods of moment, Friction, Parallel forces in a plane- Two parallel forces, General case of parallel forces.

MODULE – II **(12 Hours)**

Center of parallel forces in a plane and center of gravity- centroids of composite plane figure and curves, Distributed parallel forces in a plane. General case of forces in a plane- composition of forces in a plane and equilibrium of forces in a plane. Moments of Inertia- Plane figure with respect to an axis in its plane and perpendicular to the plane- parallel axis theorem, Moment of Inertia of material bodies.

MODULE – III **(6 Hours)**

Plane trusses- method of joints and method of sections, Principle of virtual work –equilibrium of ideal systems.

MODULE – IV **(4 Hours)**

Rectilinear Translation- Kinematics- Principles of Dynamics- Concept of Inertial and Non-inertial frame of reference, D'Alembert's Principles.

MODULE – V **(6 Hours)**

Momentum and impulse, Work and Energy- impact; Curvilinear translation- Kinematics- equation of motion- projectile- D'Alembert's Principle in curvilinear motion, Moment of momentum, Work- Energy in curvilinear motion.; Introduction to kinetics of rotation of rigid body.

Course Outcomes:

On successful completion of these modules the student will be able to:

1. Apply the basic knowledge of mathematics, physics, and engineering mechanics to solve the engineering problems.
2. Identify the forces, draw the free body diagrams and determine the resultant forces and moments.
3. Determine the center of gravity for distributed forces and moments of inertia for plane and mass bodies.
4. Analyze the statistical determinate structure problems.
5. Formulate and determine the rectilinear motion of a rigid body by using the kinematics principle.
6. Application of Newton's law and D'Alembert's Principle for solving problems.
7. Apply fundamental concepts of kinematics and kinetics of particles and rigid bodies to the analysis of simple, practical problems.
8. Apply Conservation Laws to different type of collision and motion of rigid bodies.

Text Books:

1. S Timoshenko, D.H Young and J.V.Rao ,Engineering Mechanics, Fifth Edition, McGraw Hill Publishing Company,2017,New Delhi .
2. K.L. Kumar ,Engineering Mechanics , Fourth Edition, Tata McGraw Hill Publishing Company, 2010,New Delhi.

Reference books:

1. A. K. Tayal ,Engineering Mechanics Statics and Dynamics, , Fourteenth Edition, Umesh Publications, 2008, New Delhi.
2. S. Rajasekhara & G. Sankaran Subramaniam ,Fundamental of Engineering Mechanics, Vikash Publishing House Pvt. Ltd.

Digital Learning Resources:

Course Name	Engineering Mechanics
Course Link	https://nptel.ac.in/courses/112/106/112106286/
Course Instructor	IIT Madras

Course Code:	Course Name:	L-T-P 3- 0-0	Credit 3
19ME3PC01T	Engineering Thermodynamics		

Course Objectives:

1. This course is designed to introduce a basic application of thermodynamic laws and application of thermodynamics concept to various practical engineering problems.
2. Evaluate availability and energy for a system with concept of entropy
3. States of pure substance and performance parameters for vapor power cycles based on the Rankine and Brayton cycle with superheat, reheat, and regeneration.
4. Demonstrate the ability to analyze the performance of refrigeration cycles.
5. Thermodynamics relation between the various thermodynamic property can be describe and evaluate.
6. Evaluate the performance of reciprocating air compressor in ideal and actual case

Syllabus:

Module-1: **8Hrs**

Introduction, ideal gas, work , heat transfer, first law of thermodynamics for closed and open system (steady flow), second law of thermodynamics, PMM1, PMM2, reversible and irreversible processes, heat engine, reverse heat engine, Carnot cycle,

Properties of pure substances, Steam formation, Types of Steam, Enthalpy, Specific volume, Internal energy and dryness fraction of steam, use of Steam tables. Related numerical.

Module-II **8 Hrs**

Basic Concept of Entropy, Clausius theorem, Clausius inequality, Principle of increase of entropy, Entropy change of pure substances, isentropic processes, property diagrams involving entropy, entropy change of liquids and solids, the entropy change of ideal gases, Third law of thermodynamics, Absolute entropy. Entropy generation ,Entropy balance for closed systems and steady flow systems, Available energy, Quality of energy, Availability for non-flow and flow process, Irreversibility, Energy balance, Second law efficiency.

Module-III **8Hrs**

Vapour Power Cycles: The Carnot vapor cycle and its limitations, The Rankine cycle, Means of increasing the Rankine cycle efficiency, The reheat cycle, The regenerative feed heating cycle, Cogeneration, Combined cycle power generation systems, Binary vapour cycles.

Module-IV **8Hrs**

Gas Power Cycles: Air standard cycles- Otto, Diesel, Dual Combustion and Brayton cycles, The Brayton cycle with non-isentropic flow in compressors and turbines, The Brayton cycle with regeneration, reheating and intercooling, Ideal jet propulsion.

Module-V **8 Hrs**

Refrigeration cycles: Reversed Carnot cycle, Reversed Brayton cycle (Gas refrigeration system), The vapor compression cycle, The vapor absorption cycle.

Course Outcomes:

1. Understand the basics concepts, work and heat and first law of thermodynamics
2. Apply the 2nd law of thermodynamics to analyze boilers, heat pumps, refrigerators, heat engines, compressors and nozzles.

3. Evaluate the pure substances and performance of steam power cycles
4. Apply the knowledge of gas power cycle in analysis of engines
5. To analyse the refrigeration cycle to have better energy saving features

Text Books:

1. P. K. Nag, Engineering Thermodynamics, Sixth Edition, Tata McGraw Hill Publishing Company, 2017, New Delhi

Reference books:

1. P. Chattopadhyay, Engineering Thermodynamics, Second Edition, OXFORD University Press, 2011, New Delhi.
2. Sonntag, Borgnakke, Van Wylen, Fundamentals of Thermodynamics, Sixth Edition, John Wiley & Sons, New Delhi.
3. E. Radhakrishnan, Fundamentals of Engineering Thermodynamics, Second Edition, PHI Publication, 2005, New Delhi.

Digital Learning Resources:

Course Name	Engineering Thermodynamics
Course Link	https://nptel.ac.in/courses/101/104/101104063/
Course Instructor	IIT Kanpur

Course Code: 19ME3PC02T	Course Name: Introduction to Physical Metallurgy & Engineering Materials	L-T-P: 3- 0- 0	Credit: 3

Course Objectives:

1. Give basic knowledge of science behind materials & physical metallurgy.
2. Introduce the concept of mechanical behavior of materials, phase & phase diagram, heat treatment, failure of materials, applications of advanced materials.
3. Develop intuitive understanding of the subject to present a wealth of real world engineering examples to give students a feel of how material science is useful in engineering practices.

Syllabus:

Module-I **8 Hrs**

Classification of Engineering Materials, Engineering properties of materials. Characteristic property of metals, bonding in solids, primary bonds like ionic, covalent and metallic bond, crystal systems, common crystal structure of metals, representations of planes and directions in crystals, atomic packing in crystals, calculation of packing density, voids in common crystal structures and imperfections crystals.

Module-II **8 Hrs**

Concept of plastic deformation of metals, critical resolve shear stress, dislocation theory, deformation by slip and twin, plastic deformation in polycrystalline metals, yield point phenomenon and related effects, concept of cold working preferred orientation. Annealing; recovery; recrystallization and grain growth;

Hot working. Concept of alloy formation, types of alloys, solid solutions, factors governing solids solubility viz. size factor, valency factor, crystal structure factor and chemical affinity factor; order-disorder transformation.

Module-III **10 Hrs**

Binary phase diagrams (a) Isomorphism system, (b) Eutectic system, (c) Peritectic system, (d) Eutectoid system and (e) Peritectoid system. Allotropic transformation. Lever rule and its application, Interpretation of solidification behaviors and microstructure of different alloys belonging to those systems, Effect of non-equilibrium cooling, coring and homogenization.

Iron-cementite and iron-graphite phase diagrams, microstructure and properties of different alloys (alloy steels; stainless steel, tool steel, HSS, high strength low alloy steel) types of cast iron, their microstructures and typical uses. Specification of steel.

T.T.T. diagram: concept of heat treatment of steels i.e. annealing, normalizing, hardening and tempering; microstructural effects brought about by these processes and their influences on mechanical properties; factor affecting hardenability.

Module-IV **5 Hrs**

Optical properties of Materials: Scattering, Refraction, Theory of Refraction and absorption, Atomic Theory of optical properties. Lasers, Optical fibres- Principle, structure, application of optical fibres; Plastic-: Thermosetting and thermoplastics; Ceramics: Types, structure, Mechanical properties, application.

Module-V **5 Hrs**

Composite Materials: Agglomerated Materials: Cermet's.

Reinforced Materials: Reinforced Concrete. Fibre reinforced plastics, Properties of composites, Metal matrix composites, manufacturing procedure for fiber reinforced composite.

Course Outcomes:

1. Analyze & Distinguish between SC, BCC, FCC & HCP structures & to understand the types of crystal structures and relate it to the final properties
2. Understand the different types of crystal imperfections i.e. point defects, line defects, surface defects
3. Explain the phase rule, term involved in it and its application & the different types of binary phase diagrams, and their construction. Apply the principles of Tie-line rule and Lever rule to find the composition of the phases present and their weight percentages
4. Understand & suggest the purpose & objectives of Heat Treatment i.e. annealing,
5. tempering, normalizing ,etc and the concept of hardenability test (Jominy test).
6. To acquire knowledge about composite, plastics, ceramics materials, types, manufacturing methods & its applications & suggest suitable materials for the required application.

Text Books:

1. W.D.Callister ,Materials Science and Engineering, Eighth Edition, Wiley and Sons Inc, 2017, New Delhi.

Reference Books:

1. Avner, Introduction to Physical Metallurgy, Second Edition, Tata McGraw Hill Publishing Company, 2017, New Delhi.
2. Raghavan ,Physical Metallurgy: Principles and Practice, Third Edition, PHI Publication, 2015, New Delhi.

Digital Learning Resources:

Course Name	**Introduction to Physical Metallurgy &Engineering Materials**
Course Link	https://nptel.ac.in/courses/113/102/113102080/
Course Instructor	IIT Delhi

Course Code:	Course Name:	L-T-P 0- 0- 2	Credit
19CM3ES01L	Data Structure using C Lab		1

Course Objectives:

1. To choose the appropriate data structure and algorithm design method for a specified application and finding the performance of the programs.
2. To understanding about writing algorithms and step by step approach in solving problems with the help of fundamental data structures.
3. To solve problems using data structures such as linear lists, stacks, queues, hash tables, binary trees, heaps, binary search trees, and graphs and writing programs for these solutions.
4. Students should acquire skills in using generic principles for data representation & manipulation with a view for efficiency, maintainability, and code-reuse.

Syllabus:

1. Revisiting structure, union, dynamic memory allocation and pointers, pointers to structures and function pointers, menu driven programs.
2. Infix to postfix conversion and evaluation of postfix expressions using STACK.
3. Insert and delete operations on a Linear Queue.
4. Sparse matrix representation and addition of two sparse matrices.
5. Implementing a singly linked list – operations include insert [beg, mid, end], delete [beg, mid, end], traverse [fwd, backward], Reversing it, count nodes.
6. Polynomial representation and addition of 2 polynomials using linked list.
7. Performing various operations on a Binary Search tree – Create, traverse, find min, find max, mirror, delete, count internal and external nodes Related programs using BST.
8. Implementing various searching and sorting algorithms

Course Outcomes:

On Completion of this Course, the students should be able to:

1. Able to identify the appropriate data structure for given problem.
2. Determine and analyze the time and space complexity of given Linear and Non-Linear data structures Algorithms.
3. Implement operations like searching, insertion, and deletion, traversing mechanism etc. on various data structures [linear and non-linear] and analyzing the complexity of each operation.
4. Have practical knowledge on the applications of data structures.

Suggested Books:

1. Data Structures: A Pseudocode Approach with C – Gilberg & Forouzan, 2nd Edition, Cengage, Indian Reprint, 2016

2. Data Structures and Program Design in C – Kruse, Leung, 2nd Edition, Pearson,2008

3. Data Structures Using C - Yedidyah Langsam & Moshe J. Augenstein Aaron M. Tanenbaum, 3rd Edition, Pearson, 2009

4. Algorithms and Data Structures: The basic toolbox, Kurt Mehlhorn and Peter Sanders, Springer, 2010

5. Programming and Data Structures (NPTEL) – (Vodeo lectures by Dr. Naveen Garg, IIT Delhi, new course available from July 2019)

Reference books:

1. Schaums Outlines Data Structures with C by Seymour Lipschutz” , Publisher: Mcgraw Hill, 2011. [SIE]

2. Data Structures Using C, Oxford University Press, 2014.

Course Code:	Course Name: Engg. Mechanics Lab	L-T-P: 0- 0- 2	Credit :1

Course Objectives:

1. To supplement the theoretical knowledge gained in Engineering Mechanics with practical testing for determining resultant of forces. This would enable the student to have a clear understanding the concept of equilibrium and its application to solve different type of real life problems.
2. To understand the concept of friction and its application.
3. To develop knowledge in dynamics of particle.

Syllabus:

List of Experiments:

(At least 10 out of 13 experiments should be done)

1. To verify the law of Force Polygon (or Parallelogram Law of Vector Addition)
2. To verify the law of Moments using Parallel Force apparatus.
3. To determine the co-efficient of friction between wood and various surface (like Leather, Wood, Aluminum) on an inclined plane.
4. Determination of Belt friction using belt friction apparatus.
5. Experiment on trusses to calculate the force in the member of simple trusses.
6. To find CG of an irregular body using Computation method.
7. Moment of Inertia of Flywheel.

8. Newton's Second Law of Motion
9. Ballistic Pendulum
10. Elastic and Inelastic Collision.
11. Projectile Motion
12. Simple & compound gear-train experiment.

Course Outcomes:

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

1. Verify the Parallelogram law of vector addition and law of Moments using Parallel Force apparatus (Different type of support).
2. Evaluate co-efficient of friction between the different surfaces in contact.
3. Analyze planar systems to determine the forces in members of trusses.
4. Determine the centroid and moment of inertia of plane lamina.
5. Demonstrate the types of collision/impact and determine corresponding coefficient of restitution.
6. Differentiate the kinematics and kinetics of a particle.

Course Code: 19ME3PC01L	Course Name: Engineering Thermodynamics Lab	L-T-P: 0- 0- 2	Credit: 1

Course Objectives:

1. Apply the laws of thermodynamics to the working of I.C engines like petrol and diesel engine.
2. To understand the working principle of 2-stroke,4-stroke I.C. engine
3. Design and working of thermal power plant
4. Analyze performance of reciprocating and centrifugal compressors.
5. Analyze various refrigeration systems with its components.
6. To determine the efficiency of gear pump.

Syllabus:

List pf Experiments:

Select any 10 experiments from the list of 11 experiments

1. Model study of Fire Tube Boilers and Water Tube Boilers.
2. Model study of Two stroke I.C. Engine.
3. Model study of Four stroke I.C. Engine.
4. Model study of Refrigerator
5. Model study of Water Turbines.
6. Model study of Water pumps.
7. Study of Gears and Gear trains.
8. Verification of Bernoulli's Theorem and its application to Venturi meter.
9. Calibration of Bourdon Tube Pressure gauge and measurement of pressure using manometers.
10. Model study of Automobile Parts.

11. Determination of velocity ratio of belt drive.

Course Outcomes:

On Completion of this Course, the students should be able to:

1. Classify the IC engines along with the working principle and combustion process.
2. Explain the working of air compressor (reciprocating and centrifugal) along with factors influencing its performance
3. Compute the cooling load for COP of refrigeration systems.
4. Students can describe about working principle of steam power plant.
5. Students can able to explain performance of gear pump.

Course Code: 19ME3PC02L	Course Name: Introduction to Physical Metallurgy & Engg Materials Laboratory	L-T-P: 0- 0- 2	Credit: 1

Course Objectives:

1. To introduce the physical origin of and demonstrate the correlation between crystal structure and properties of materials.
2. Learning the metallurgical sample preparation techniques: cutting, mounting, grinding and polishing & characterization of microstructure using optical microscope.
3. To understand how the mechanical behavior may be affected by using various heat treatment processes.
4. To measure and compare the hardness & impact toughness of several different materials.

Syllabus:

List of Experiments:

Select any 8 experiments from the list of 9 experiments

1. Study of Crystal Structures through Ball Models
2. Metallurgical Microscope: Principles and Operations
3. Specimen Preparation techniques for Metallographic Analysis
4. Microstructural Analysis of Carbon Steels & Cast Iron
5. Microstructural Analysis of Non-Ferrous Metals: Brass & Copper
6. Heat treatment of Steels

7. Jominy end quench test.
8. Hardness testing of ferrous material
9. Impact testing (Charpy/Izod)

Course Outcomes:

On Completion of this Course, the students should be able to:

1. Analyze & prepare SC, BCC, FCC & HCP structures using balls and sticks
2. Prepare the specimens for metallographic examination with best practice and operate the optical microscope and understand, interpret, analyze the microstructure of materials
3. Understand & suggest the purpose & objectives of Heat Treatment i.e annealing, tempering, normalizing ,etc and the concept of hardenability test (Jominy test).
4. Classify the different mechanical testing methods with their inherent merits and limitations.

Fourth Semester					
Theory					
Sl. No.	Category	Course Code	Course Title	L-T-P	Credit
1	HSMC	19CM3HS01T	Humanities-1/Management-1(OB/EEC)	3-0-0	3
2	ESC	19ME4ES01T	Fluid Mechanics and Hydraulics Machines	3-0-0	3
3	PCC	19ME4PC01T	Mechanics of Solids	3-0-0	3
4	PCC	19ME4PC02T	Kinematics of Machines	3-0-0	3
5	PCC	19ME4PC03T	Manufacturing Science - I	3-0-0	3
6	PEC	19ME4PE01T / 19ME4PE02T	CIM & FMS; IC Engines & Gas Turbines	3-0-0	3
7	MC	19CM4MC01T	Mandatory(Constitution of India/ Essence of Indian Tradition Knowledge)		0
Total Credit (Theory)					18
Practical					
1	ESC	19ME4ES01L	Fluid Mechanics and Hydraulics Machines Laboratory	0-0-2	1
2	PCC	19ME4PC01L	Mechanics of Solids Laboratory	0-0-2	1
3	PCC	19ME4PC02L	Kinematics of Machines Laboratory	0-0-2	1

4	PCC	19ME4PC03L	Manufacturing Science - I Laboratory	0-0-2	1
Total Credit (Practical)					4
Total Semester Credit					22

Course Code: 19CM4HS01T	Course Name: Engineering Economics	L-T-P 3- 0- 0	Credit 3

Syllabus

Module-I: **(8 Hrs.)**

Introduction to Economics: Definition, scope and nature of economics, consumption laws, demand & supply analysis, elasticity of demand& supply, indifference curve analysis.

Module-II: **(10 Hrs.)**

Production : factors of production, production function, law of variable proportion, laws of return to scale, elasticity of factor-substitution, optimal combination of factor-inputs, production efficiency, economies of scales,Cost of Production: types of costs, economic costs: fixed cost and variable costs, short-run and long-run cost functions.

Module-III: **(10 Hrs.)**

Market Structure: pure competition, perfect competition, imperfect market, monopoly andoligopoly. Indian Banking System, Functions and Roles of Commercial Banks and Reserve Bank of India.

Module-IV: **(12 Hrs.)**

Time value of money and interest formulae,Nominal and effective rate of interest, Present, Annual and Future worth analysis, Rate of Return Analysis, Cost-Benefit analysis in Public sector projects.

Module- V: (as per choice of faculty) **(8 Hrs.)**

Portion covered can be tested through Internal evaluation only not to be included in University examination.

Reference Books:

1. Koutsoyiannis, A., 'Modern Microeconomics', English Language Book Society, Macmillan.
2. Pindyck, R S, Rubinfeld, D L &Mehta , 'Microeconomics', 6 th Edition, Pearson Education India.
3. Varian, H R, 'Intermediate Microeconomics', 7th edition, East West Press India.
4. Samuelson, Paul A, 'Economics', 5th edition, McGraw Hill New York.
5. Basics of Engineering Economy; Leland Blank and Anthony Tarquin, TMH.
6. Contemporary Engineering Economics, Chan. S Park, Pearson.
7. Engineering Economics, Paneerselvam, PHI.
8. Engineering Economics; Sasmita Mishra.

Course Code: 19CM4HS02T	Course Name: Organizational Behavior	L-T-P 3- 0- 0	Credit 3

Course Objectives:

Developing an understanding of the behavior of individuals and groups inside organizations by enhancing the skills in appreciating individuals, interpersonal, and group process for increased effectiveness both within and outside of organizations is the goal of any organization. Through this course students will develop theoretical and practical insights and problem-solving capabilities for effectively managing the organizational processes.

Syllabus:

Module-I: Fundamentals of OB: (6 Hours)

Definition, scope and importance of OB, Relationship between OB and the individual, Evolution of OB, Models of OB. Learning; Theories and their applications

Module II: Foundations of Individual Behavior: (12 Hours)

Personality and values: Definition and importance of Personality for performance, The Myers-Briggs Type Indicator and The Big Five personality model, Significant personality traits suitable to the workplace (personality and job – fit theory), Personality Tests and their practical applications. Attitude; ABC Model. Perception: Meaning and concept of perception, Factors influencing perception, Selective perception, Perceptual errors.

Motivation: Definition & Concept of Motive & Motivation, The Content Theories of Motivation (Maslow's Need Hierarchy & Herzberg's Two Factor model Theory), The Process Theories (Vroom's expectancy Theory & Porter Lawler model), Contemporary Theories – Equity Theory of Work Motivation.

Module- III: Foundations of Group Behavior: (8 Hours)

Group Dynamics, Types of Groups, The Five – Stage Model of Group Development.

Developing Work Teams, Team Effectiveness & Team Building.

Leadership: Concept, Types & Styles of Leadership, Traditional & Contemporary theories of leadership Success stories of today's Global and Indian leaders.

Module- IV: Foundations of Organizational Behavior: (10 Hours)

Organizational Culture; creating and maintenance. Organizational Change; concept and technique and theories of change. Organizational Development; concept and methods of doing development.

Course Outcomes:

1. Students will understand the essential of maintaining the inter-personal relationships in organizations.
2. Personality factors will be effectively used to understand the communication among groups.
3. The reasons for conflict will be known and prescriptive methods can be devised to enhance higher productivity in organizations.
4. Being an employee in an organization the importance of organizational change and culture can be known to all.

Text Books:

Organizational Behaviour, Robbins, Judge, Sanghi, Pearson.

Reference Books:

1. Organizational Behaviour, K. Awathappa, HPH.
2. Organizational Behaviour, VSP Rao, Excel.
3. Introduction to Organizational Behaviour, Moorhead, Griffin, Cengage.
4. Organizational Behaviour,Hitt, Miller, Colella, Wiley.
5. Organizational Behaviour, Suba Rao,Mishra, Himalaya.
6. Organisational Behaviour – Uma Sekharan.
7. Understanding Organizational Behaviour, Parek, Oxford.

Course Code: 19ME4ES01T	Course Name: Fluid Mechanics and Hydraulic Machines	L-T-P: 3-0-0	Credit: 3
Note: Each and every module must practice with computer program like C, C++, Matlab, etc.			

Course Objectives:

1. Analyse fluid and its usage in flow measurement, hydraulic Machines, etc.
2. Compute pressure through manometer and design and develop marine systems with the usage of hydrostatic forces and buoyancy.
3. Differentiate velocity, acceleration, rotation and deformation etc. of fluid particles
4. Establish Euler's theorem and deduce Bernoulli's equation or a ideal fluid and real fluids and examine and evaluate energy losses in fluid transmission trough pipes
5. Do the performance analysis of different turbines and pumps

Syllabus:

Module-I: **8 Hrs**

Introduction: Scope of fluid mechanics and its development as a science Physical property of Fluid: Density, specific gravity, specific weight, specific volume, surface tension and capillarity, viscosity, compressibility and bulk modulus, Fluid classification.

Fluid statics: Pressure, Pascal's Law, Pressure variation for incompressible fluid, atmospheric pressure, absolute pressure, gauge pressure and vacuum pressure, manometer. Hydrostatic process on submerged surface, force on a horizontal submerged plane surface, force on a vertical submerged plane surface. Buoyancy and floatation, Archimedes' principle, stability of immersed and floating bodies, determination of metacentric height.

Module-II: **8 Hrs**

Fluid kinematics: Introduction, description of fluid flow, classification of fluid flow. Reynold's number, Acceleration of fluid particles, flow rate and continuity equation, differential equation

of continuity, Mathematical definitions of irrotational and rotational motion. Circulation, potential function and stream function. Flow net

Module-III: **8 Hrs**

Fluid dynamics : Introduction, Introduction to N-S equation, Euler's equation along a streamline, energy equation, Bernoulli's equation and its application to siphon, venturimeter, orificemeter, pitot tube. Flow in pipes and ducts: Loss due to friction, Minor energy losses in pipes Hydraulic Gradient Line (HGL), Total Energy Line (TEL), Power transmission in the fluid flow in pipes, fluid flow in pipes in series and parallel. Flow through nozzles.

Module-IV: **8 Hrs**

Hydraulic turbines: Classification, Impulse and Reaction turbine; Tangential, Radial and axial turbine. Impulse turbine, Pelton wheel, bucket dimensions, number of buckets in pelton wheel, efficiency and performance curves.

Reaction Turbines: Francis turbine and Kaplan turbine, velocity triangle and efficiencies, performance curve. Function of draft tube and casing cavitation.

Module-V: **8 Hrs**

Centrifugal Pump: constructional features, vane shape, velocity triangles, Efficiencies, Multi stage centrifugal pumps, Pump Characteristic, NPSH and Cavitation.

Positive displacement pumps: Reciprocating Pump, Working principle, Discharge, work done and power requirement, Slip, Indicator diagram.

Course Outcomes:

1. Apply conservation laws to fluid flow problems in engineering applications.
2. Design experimental procedure for physical model studies.
3. Design the working proportions of hydraulic machines.
4. Compute drag and lift coefficients using the theory of boundary layer flows.
5. Analyze and design free surface and pipe flows
6. Formulate and solve one dimensional compressible fluid flow problems

Suggested Books:

1. Y. A. Cengel and J. M. Cimbala, Fluid Mechanics , Tata McGraw-Hill, 3rd edition,2017, New Delhi
2. CSP Ojha and P.N. Chandramouli, Fluid Mechanics and Machinery, Oxford University Press, 4th edition, 2010, New Delhi
3. S. K. Som and G. Biswas, Introduction to Fluid Mechanics and Fluid Machines, McGraw Hill Education, 6th edition, 2017, New Delhi
4. R. W. Fox, A. T. McDonald and P. J. Pritchard, Introduction to Fluid Mechanics, John Wiley, 8th edition, 2011, New Delhi
5. Piyush Kundu, Ira Cohen & David Dowling, Fluid Mechanics, Elsevier, 6th Edition, 2016, Cambridge

Digital Learning Resources:

Course Name	Fluid Mechanics and Hydraulic Machines
Course Link	https://swayam.gov.in/nd1_noc19_me55/
Course Instructor	Dr. Sankar Kumar Som

Course Code: 19ME4PC01T	Course Name: Mechanics of Solids	L-T-P: 3-0-0	Credit: 03
Note: Each and every module must practice with computer program like C, C++, Matlab, etc.			

Course Objectives:

1. Understand mechanics of deformable bodies and apply them in analysis and design problems
2. Analyze bodies subjected to two dimensional stress systems
3. Understand behaviour of structural members in flexure and Torsion
4. Evaluate slope and deflection in beams subjected to loading
5. Understand stability of columns and struts
6. Predict the stress distribution in beams, pressure vessels and shafts

Syllabus:

Module-I: **8 Hrs**

Concept of Stress: Load, Stress, Principle of St.Venant, Principle of Superposition, Strain, Hooke's law, Modulus of Elasticity, Stress-Strain Diagrams, Working Stress, Factor of safety, Strain energy in tension and compression, Resilience, Impact loads, Analysis of Axially Loaded Members: Composite bars in tension and compression - temperature stresses in composite rods, Concept of Statically indeterminate problems. Shear stress, Complimentary shear stress, Shear strain, Modulus of rigidity, Poisson's ratio, Bulk Modulus, Relationship between elastic constants

Module-II: **8 Hrs**

Biaxial State of Stress: Analysis of Biaxial Stress. Plane stress, Principal plane, Principal stress, Mohr's Circle for Biaxial Stress. Stresses in thin cylinders and thin spherical shells under internal pressure, wire winding of thin cylinders; Biaxial State of Strain: Two dimensional state

of strain, Principal strains, Mohr's circle for strain, Calculation of principal stresses from principal strains, Strain Rossette.

Module-III: **8 Hrs**

Shear Force and Bending Moment Diagrams: Shear force and bending moment. Types of load and Types of support. Support reactions, Relationship between bending moment and shear force, Point of inflection. Shear Force and Bending Moment diagrams.

Bending of Beams: Theory of simple bending of initially straight beams, Bending stresses, Shear stresses in bending, Distribution of normal and shear stress, Composite beams

Module-IV: **8 Hrs**

Deflection of Beams: Differential equation of the elastic line, Slope and deflection of beams by integration method and area - moment method; Theory of Columns: Long columns, Euler's column formula, Lateral buckling, Critical Load, Slenderness ratio, Eccentric loading of short column

Module-V: **8 Hrs**

Torsion: Torsion in solid and hollow circular shafts, Twisting moment, Strain energy in shear and torsion, strength of solid and hollow circular shafts. Strength of shafts in combined bending and twisting, Close - Coiled helical springs.

Course Outcomes:

After completing the course, the students will be able to

1. Identify the different engineering materials, describe their properties and predict their behaviour under different types of loading.
2. Compute the stresses, strains, moments, deflections, etc. and derive the expressions used from the fundamentals.
3. Select materials, sizes and sections for various applications such as beams, shafts, pressure vessels, columns, etc. and justify the selection.

4. Determine mechanical properties by destructive and non-destructive methods.

Suggested Books:

1. S.P.Timoshenko and D.H.Young, Elements of Strength of Materials, Affiliated East West Press, 5th edition, 2003, New Delhi
2. G. H. Ryder, Strength of Materials by Macmillan Publishers India Limited, 3rd edition, 2002, Chennai
3. S.S.Rattan, Strength of Materials by Tata Mc Graw Hill, 3rd edition, 2017, New Delhi
4. R.Subramaniam, Strength of Materials, Oxford University Press, 3rd edition, 2016, New Delhi

Digital Learning Resources:

Course Name	Mechanics of Solids
Course Link	https://nptel.ac.in/courses/112/102/112102284/
Course Instructor	Prof. Ajeet Kumar

Course Code:19ME4PC02T	Course Name: Kinematics of Machines	L-T-P:3-0-0	Credit: 03
Note: Each and every module must practice with computer program like C, C++, Matlab, etc.			

Course Objectives:

1. Describe the concept of machines, mechanisms and inversion
2. Analyze planar mechanism for displacement, velocity and acceleration both by graphical and analytic method
3. Analyze planar mechanism for displacement, velocity and acceleration both by graphical and analytic method
4. analyze the function of different types of drive
5. Understand techniques for studying motion of machines and their components.

Syllabus:

Module-I: **8 Hrs**

Kinematic fundamental: Basic Kinematic concepts and definitions, Degrees of freedom, Elementary Mechanism : Link, joint, Kinematic Pair, Classification of kinematic pairs, Kinematic chain and mechanism, Gruebler's criterion, Inversion of mechanism, Grashof criteria, Four bar linkage and their inversions, Single slider crank mechanism, Double slider crank mechanism and their inversion. Transmission angle and toggle position, Mechanical advantage.

Kinematic Analysis: Graphical analysis of position, velocity and acceleration of four bar and Slider crank mechanisms. Instantaneous centre method, Aronhold-Kennedy Theorem, Rubbing velocity at a Pin-joint. Coriolis component of acceleration.

Module-II: **8 Hrs**

Mechanism Synthesis: Graphical methods of synthesis, Chebychev spacing for precision positions, Freudenstein's equation applicable to four bar linkages.

Mechanism Trains: Gear Terminology and definitions, Analysis of mechanism Trains: Simple Train, Compound train, Reverted train, Epicyclic train and their applications.

Module-III: **8 Hrs**

Combined Static and Inertia Force Analysis: Inertia forces analysis, velocity and acceleration of slider crank mechanism by analytical method, engine force analysis - piston effort, force acting along the connecting rod, crank effort. Dynamically equivalent system, compound pendulum, correction couple.

Module-IV: **8 Hrs**

Friction Effects: Screw jack, friction between pivot and collars, single, multi-plate and cone clutches, anti friction bearing, film friction, friction circle, friction axis.

Flexible Mechanical Elements: Belt, rope and chain drives, initial tension, effect of centrifugal tension on power transmission, maximum power transmission capacity, belt creep and slip.

Module-V: **8 Hrs**

Brakes &Dynamometers: Classification of brakes, Analysis of simple block, Band and internal expanding shoe brake, Braking of a vehicle. Absorption and transmission dynamometers, Prony brake, Rope brake dynamometer, belt transmission, epicyclic train, torsion dynamometer.

Course Outcomes

Suggested Books:

1. Thomas Bevan, Theory of Machines, CBS Publications, 3rd edition, 2005, New Delhi
2. Charles E. Wilson and J. Peter Saddler, Kinematics and Dynamics of Machinery, Pearson Education, 3rd edition, 2008, Chennai
3. J.S.Rao and R.V.Dukipatti, Mechanism and Machine Theory, New Age International, New Delhi, 1992

4. A. Ghosh & A. K. Mallick, Theory of Mechanisms and Machines, East West Press, 3rd edition, 2008, New Delhi

Digital Learning Resources:

Course Name	Kinematics of Machines
Course Link	https://nptel.ac.in/courses/112/105/112105268/
Course Instructor	Prof. Anirvan Dasgupta

Course Code:	Course Name:	L-T-P: 3-0-0	Credit: 03
19ME4PC03T	Manufacturing Science - I		

Course Objectives:

1. To understand basic manufacturing processes like casting, welding and metal forming.
2. To learn various aspects of different manufacturing techniques such as various casting methods, welding methods and metal forming methods
3. To decide which manufacturing technology can be implemented for a specific product

Syllabus:

Module-1: **10 Hrs**

Foundry : Types of patterns, pattern materials and pattern allowances: Molding Materials: sand molding, metal molding, investment molding, shell molding, Composition of molding sand, Silica sand, Zircon sand, binders, additives, Binders - clay, binders for CO_2 sand, binder for shell molding, binders for core sand, Properties of molding sand and sand testing; Melting furnaces: cupola, resistance furnace, induction and arc furnace;

Solidification of castings, design of risers and runners, feeding distance, centre line freezing resistance chills and chaplets; Degasification and inoculation of metals; Casting methods like continuous casting, centrifugal casting, disc; casting; Casting defects.

Module-2: **8 Hrs**

Welding and cutting: Introduction to gas welding, cutting, Arc welding and equipment's. TIG (GTAW) and MIG (GMAW) welding, resistance welding and Thermit welding;

Modern Welding methods like plasma Arc, Laser Beam, Electron Beam, Ultrasonic, Explosive and friction welding; Edge preparation in butt welding. Brazing and soldering, welding defects; Destructive and non-destructive testing of castings and welding.

Module-3: **8 Hrs**

Brief introduction to powder metallurgy process; Plastic deformation of metals: Variables in metal forming and their optimization. Dependence of stress strain diagram on Strain rate and temperature. Hot and cold working of metals, classification of metal forming processes; Forging: Smith Forging, Drop and Press forging, M/c forging, Forging defects;

Module-4: **6 Hrs**

Extrusions: Direct, Indirect, Impact and Hydrostatic extrusion and their applications, Extrusion of tubes; Brief introduction to sheet metal working: Bending, Forming and deep drawing, shearing;

Brief introduction to explosive forming, coating and deposition methods;

Module-5: **8 Hrs**

Wire drawing methods and variables in wire-drawing, Optimum dies shape for extrusion and drawing; Rolling: Pressure and Forces in rolling, types of rolling mills, rolling defects;

Course Outcomes:

On completion of the course, students will be able to

1. Recognize the different types of casting process.
2. Select suitable manufacturing process for typical components.
3. Describe the various welding process.
4. Explain the concept of forging, rolling process and drawing.

Suggested Books:

1. P. N. Rao, Manufacturing technology, Volume 1, Tata McGraw Hill publication, 4th edition, 2013, New Delhi
2. R. A. Little, Welding Technology , Tata McGraw Hill publication, 2017, New Delhi
3. A. Ghosh and A. K. Malick, Manufacturing Science, EWP, 2nd edition, 2010, New Delhi

4. P. C. Sharma, A Text Books of Production Engineering, S. Chand Publishing, 11th edition, 2019, New Delhi

Digital Learning Resources:

Course Name	Manufacturing Science - I
Course Link	https://nptel.ac.in/courses/112/107/112107219/
Course Instructor	Prof. D.K. Dwivedi

Course Code: 19ME4PE01T	Course Name: Computer Integrated Manufacturing and Flexible Manufacturing System (CIM & FMS)	L-T-P: 3-0-0	Credit: 03

Course Objectives:

1. To learn the application of computers in manufacturing sectors.
2. To learn about NC part programming and robot programming
3. To learn application of computer in quality inspection, process planning, design.

Syllabus:

Module-1: **(8 Hrs.)**

Fundamentals of Manufacturing and Automation: Production systems, automation principles and its strategies; Manufacturing industries; Types of production function in manufacturing; Automation principles and strategies, elements of automated system, automation functions and level of automation.

Module-2: **(8 Hrs.)**

Product/production relationship, Production concept and mathematical models for production rate, capacity, utilization and availability; Cost-benefit analysis. Computer Integrated Manufacturing: Basics of product design, CAD/CAM, Concurrent engineering, CAPP and CIM.

Module-3: **(14 Hrs.)**

Industrial Robotics: Robot anatomy, control systems, end effectors, sensors and actuators; fundamentals of NC technology, CNC, DNC, NC part programming; Robotic programming, Robotic languages, work cell control, Robot cleft design, types of robot application, Processing operations, Programmable Logic controllers: Parts of PLC, Operation and application of PLC,

Fundamentals of Net workings; Material Handling and automated storage and retrieval systems, automatic data capture, identification methods, bar code and other technologies.

Module-4: **(6 Hrs)**

Introduction to manufacturing systems: Group Technology and cellular manufacturing, Part families, Part classification and coding, Production flow analysis, Machine cell design, Applications and Benefits of Group Technology.

Module-5: **(8 Hrs.)**

Flexible Manufacturing system: Basics of FMS, components of FMS, FMS planning and implementation, flexibility, quantitative analysis of flexibility, application and benefits of FMS. Computer Aided Quality Control: objectives of CAQC, QC and CIM, CMM and Flexible Inspection systems.

Course Outcomes:

1. Will be able to apply computer to manufacture industrial components.
2. Will understand the elements of an automated manufacturing environment.
3. Will able to make NC part programming and robot programming.

Suggested Books:

1. M.P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, Pearson Publication, 4th edition, 2016, Chennai
2. P. Radhakrishnan, S. Subramanyam and V. Raju, CAD/CAM/CIM, New Age International, 4th edition, 2018, New Delhi
3. J. Talavage and R. G. Hannam, Flexible Manufacturing Systems in Practice, Marcell Decker, US, 1987

Digital Learning Resources:

Course Name	Computer Integrated Manufacturing and Flexible Manufacturing System (CIM & FMS)
Course Link	https://nptel.ac.in/courses/112/104/112104289/
Course Instructor	Prof. Janakarajan Ramkumar, Prof. Amandeep Singh

Course Code: 19ME4PE02T	Course Name: Internal Combustion Engines & Gas Turbines; (ICE & GT)	L-T-P: 3-0-0	Credit: 03
Note: Each and every module must practice with computer program like C, C++, Matlab, etc.			

Course Objectives:

1. To make students familiar with operating characteristics and terms used in internal combustion engines.
2. To study the thermodynamics, combustion, heat transfer, friction and other factors affecting engine power, efficiency and emissions.
3. To introduce students to the environmental effect and fuel economy challenges facing the inter combustion engine.
4. To apply analytical techniques to the engineering problems and performance analysis of Gas turbines.
5. To make students familiar with operating characteristics and terms used in internal combustion engines.

Syllabus:

Module-I: **(8 Hrs.)**

Introduction : Classification, Engine nomenclature, engine operating and performance parameters, Valve timing diagram of SI & CI Engines, Comparison of SI and CI engine.

Thermodynamic Analysis of cycles : Significance of Fuel-Air & Actual cycles of I.C. engines. Comparison with Air Standard Cycles. Analysis of Fuel-Air & Actual cycles (Effect of chemical equilibrium and variable specific heats. Effect of air fuel ratio and exhaust gas dilution. Time Loss Factor, Heat Loss Factor, Exhaust Blow down, Loss Due to Gas Exchange Processes, Volumetric Efficiency, Loss due to Rubbing Friction).

Fuels :Fuels of SI and CI engine, Fuel additives, Properties, potential and advantages of alternative liquid and gaseous fuels for SI and CI engines (biofuels, LPG and CNG), Fuel Induction Techniques in IC engines : Fuel induction techniques in SI and CI engines, Mixture Requirements at Different Loads and Speeds.

Module-II: **(10 Hrs.)**

Carburetion: Factors Affecting Carburetion, Principle of Carburetion, Simple Carburetor and its drawbacks, Calculation of the Air–Fuel Ratio, Modern Carburetors;

Fuel Injection: Functional Requirements of an Injection System, Classification of Injection Systems, Fuel Feed Pump, Injection Pump, Injection Pump Governor, Mechanical Governor, Pneumatic Governor, Fuel Injector, Nozzle, Injection in SI Engine, Electronic Injection Systems, Multi-Point Fuel Injection (MPFI) System, Functional Divisions of MPFI System, Injection Timing, Group Gasoline Injection System, Electronic Diesel Injection System; Ignition :Energy requirement for ignition, requirements of an ignition system, conventional ignition systems, modern ignition systems (TCI and CDI), firing order, Ignition timing, Spark advance mechanism;

Module-III: **(10 Hrs.)**

Combustion : Stages of combustion in SI and CI engines, effects of engine variables on flame propagation and ignition delay, Abnormal combustion, Preignition & Detonation, Theory of Detonation. Effect of engine variables on Detonation, control of Detonation. Diesel Knock & methods to control diesel knock, Requirements of combustion chambers. Features of different types of combustion chambers system for S.I. engine. (I-head, F-head combustion chambers), C.I. engine combustion chambers -Open and divided type, Air swirl turbulence-M. type combustion chamber. Comparison of various types of combustion chambers.

Super Charging &Scavenging : Thermodynamics Cycles of supercharging. Effect of supercharging, Efficiency of supercharged engines. Methods of super charging, supercharging and scavenging of 2- stroke engines.

Module-IV: **(6 Hrs.)**

Testing and Performances :Power, fuel & air measurement methods, Performance characteristic curves of SI & CI engines, variables affecting performance and methods to improve engine performance;

Cooling & Lubricating Systems, Engine Emission &Controls :Air cooling & water cooling systems, Effect of cooling on power output & efficiency, Properties of lubricants and different types of lubricating system;

Modern developments in IC Engines, EGR, MPFI, CRDI, GDI, HCCI, dual fuel engine, Lean burn engine, Stratified engine (basic principles);

Engine Emission and control : Mechanism of pollutant formation and its harmful effects. Methods of measuring pollutants and control of engine emission.

Module-V: **(6 Hrs.)**

Axial Flow & Centrifugal Compressor : Basic construction of centrifugal and axial flow compressor, Velocity diagram, performance characteristics of centrifugal and axial flow compressor, effects of slip, surging and stalling on compressor.

Course Outcomes:

1. Understand working and performance of IC Engines through thermodynamic cycles.
2. Understand combustion phenomena in SI and CI engines and factors influencing combustion chamber design.
3. Outline emission formation mechanism of IC engines, its effects and the legislation standards.
4. Understand working principles of instrumentation used for engine performance and emission parameters.
5. Evaluate methods for improving the IC engine performance.
6. Understand the latest developments in IC Engines and alternate fuels.

Suggested Books:

1. M. L. Mathur & R. P. Sharma, A Course on Internal Combustion Engines, Dhanpat Rai Publication, 8th edition, 1996, New Delhi
2. V. Ganesan, Internal Combustion Engines, Tata McGraw Hill publication, 4th edition, 2017, New Delhi
3. V. Ganesan, Gas Turbines, Tata McGraw Hill publication, 3rd edition, 2017, New Delhi
4. V. M. Domkundwar, A course in Internal Combustion Engines, Dhanpat Rai & Co publication, 1st edition 1999, New Delhi

Digital Learning Resources:

Course Name

Internal Combustion Engines & Gas Turbines

Course Link

https://nptel.ac.in/courses/112/103/112103262/

Course Instructor

Prof. Pranab K. Mondal, Prof. Vinayak N. Kulkarni

Course Code: 9ME4ES01L	Course Name: Fluid Mechanics and Hydraulics Machines	L-T-P: 0-0-2	Credit: 1

Course Objectives:

The students able to

1. known about basic concept of buoyancy force with the flow device.
2. impart training on flow measuring devices such as orifice.
3. provide practice in estimating friction losses.
4. get basic information about fluid flow and its mechanism
5. gain basic knowledge about fluid machine such as pump and turbine with basic concept of impact jet.

Syllabus:

List of the Experiments:

1. Determination of Metacentric Height and application to stability of floating bodies.
2. Determination of Cv and Cd of Orifices.
3. Experiments on impact of Jets
4. Experiments on performance of Pelton Turbine.
5. Experiments on performance of Francis Turbine
6. Experiments on performance of Kaplan Turbine
7. Experiments on performance of centrifugal pump

8. Experiments on performance of reciprocating pump
9. Experiments on Reynold's Apparatus
10. Experiments on Flow through pipes
11. Experiments on performance of Gear pump
12. Verification of momentum equation

Course Outcomes:

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

1. Compute coefficients of orifice.
2. Calibrate flow discharge measuring device used in pipes channels and tanks.
3. Determine fluid and flow properties of buoyancy.
4. Characterize laminar and turbulent flows.
5. Test the performance of pumps and turbines

Course Code:19ME4PC01L	Course Name: Mechanics of Solids Laboratory	L-T-P: 0-0-2	Credit: 01

Course Objectives:

The students able to

1. Determine material properties.
2. Understand fatigue phenomena.
3. Determine Surface material properties.
4. Understand spring properties
5. Determine strain and load relationship

Syllabus:

List of the Experiments:

1. Determination of tensile strength of materials by Universal Testing Machine
2. Determination of compressive strength of materials by Universal testing Machine
3. Determination of bending strength of materials by Universal Testing Machine
4. Double shear test in Universal Testing Machine
5. Determination of Impact strength of material (Charpy and Izod)
6. Determination of Hardness strength of materials (Brinnel, Rockwell and Vickers)
7. Determination of Rigidity modulus of material

8. Determination of Fatigue strength of material
9. Estimation of Spring Constant under Tension and Compression.
10. Load measurement using Load indicator, Load Cells.
11. Strain measurement using Strain Gauge.
12. Stress measurement using strain rosette.

Course Outcomes:

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

7. Evaluate fatigue strength of materials under different loading conditions
8. Evaluate material properties under different loading conditions
9. Determine surface hardness of materials
10. Determine spring constant under different loading condition
11. Evaluate strain vs load relationship under different loading condition

Course Code:19ME4PC02L	Course Name: Kinematics of Machines Laboratory	L-T-P: 0-0-2	Credit: 01

Course Objectives:

The students will able to

1. Understand the motion resulting from a specified set of linkages and to synthesize the mechanism.
2. Understand the effect of screw jacks, bearings and clutch.
3. Understand the basic concepts of toothed gearing and kinematics of gear trains.
4. Determine friction in brakes and dynamometer.

Syllabus:

List of Experiments:

1. Radius of gyration of compound pendulum
2. Radius of gyration of connecting rod
3. TRI –FILAR / BI-FILAR System
4. Experiment on Screw Jack
5. Experiment on Journal Bearing Apparatus
6. Experiment/Study on clutches
7. Experiment on Epicyclic Gear Train
8. Experiments on Simple/Compound/Reverted Gear trains
9. Experiment on Dynamometer

10. Experiment on Brake

11. Experiment on Coriolis component of acceleration

Course Outcomes:

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

1. Analyze the velocity and acceleration of links of different mechanisms.
2. Evaluate the effect of friction in screw jacks, bearings and clutch.
3. Design and develop a gear train as per power transmission & gear terminologies and can calculate velocity of gears.

Course Code: 19ME4PC03L	Course Name: Manufacturing Science - I Laboratory	L-T-P: 0-0-2	Credit: 01

Course Objectives:

1. To determine the grain size of the sand, clay content in the sand sample, permeability of the test sample and to find out tensile, compressive and shear strength of the moulding sand
2. To familiar with foundry practices.
3. To determine the strength of brazed and soldered joint
4. To familiar with different types rolling mills and extrusion processes
5. To make job using sheet metals.
6. To learn how to make wood pattern for making mould.

Syllabus:

List of Experiments:

1. Determination of grain size, clay content, permeability and green compressive strength of molding sand. (2 to 3 experiments)
2. Foundry Practices
3. Preparation of a wood pattern.
4. Determination of strength of brazed and solders joints
5. Practice and preparation of job in sheet metal using processes like forming and deep drawing.
6. Demonstration of different rolling mills

7. Demonstration of Extrusion processes

Course Outcomes:

Students are able to

1. determine the grain size of the sand, clay content in the sand sample, permeability of the test sample and are able to determine the tensile, compressive and shear strength of the moulding sand.
2. know the foundry practices and are able to make patterns
3. determine strength of brazed and soldered joint
4. get familiar with different types of rolling mills and extrusion process.
5. are able to make job with sheet metals

Fifth Semester					
Theory					
Sl. No.	Category	Course Code	Course Title	L-T-P	Credit
1	PCC	19ME5PC01T	Dynamics of Machines	3-0-0	3
2	PCC	19ME5PC02T	Applied Thermodynamics	3-0-0	3
3	PCC	19ME5PC03T	Manufacturing Science-II	3-0-0	3
4	PEC	19ME5PE01T/ 19ME5PE02T/ 19ME5PE03T/ 19ME5PE04T	Mechanics of Composite materials; Advanced Mechanics of Solid; Automobile Engineering; Production and Operation Management	3-0-0	3
5	OEC	Open Elective – 1 (for Non-ME Students)			
		19ME5OE01T	Engineering Management	3-0-0	3
		19ME5OE02T	Micro Electro-Mechanical Systems (MEMS)	3-0-0	3
		Open Elective – 1 (for ME Students)			
		19IT5OE01T	Java Programming	3-0-0	3
		19EC5OE01T	VLSI Design	3-0-0	3
		19CE5OE01T	Building Services and Maintenance	3-0-0	3
		19EE5OE01T	Renewable Energy Systems	3-0-0	3
6	OEC	Open Elective – 2 (for Non-ME Students)			
		19ME5OE03T	Smart and Intelligent Materials	3-0-0	3
		19ME5OE04T	Nanoscience and Technology	3-0-0	3
		Open Elective – 2 (for ME Students)			
		19IT5OE02T	Computer Networks	3-0-0	3
		19EE5OE03T	Smart Grids	3-0-0	3
		19CE5OE03T	Geo-Environmental Engineering	3-0-0	3

		19EC5OE04T	Radar System Engineering	3-0-0	3
7	MC	19CM5MC01T	Essence of Indian Tradition Knowledge	3-0-0	0
		19CM5MC02T	Constitution of India	3-0-0	0
Total Credit (Theory)					18
Practical					
1	PCC	19ME5PC01L	Dynamics of Machines Lab	0-0-2	1
2	PCC	19ME5PC02L	Applied Thermodynamics Lab	0-0-2	1
3	PCC	19ME5PC03L	Manufacturing Science-II Lab	0-0-2	1
4	PSI	19CM5MC01L	Summer Internship/Training Lab	0-0-2	1
Total Credit (Practical)					4
Total Semester Credit					22

Course Code: 19ME5PC01T	Course Name: Dynamics of Machines	L-T-P 3- 0- 0	Credit 3

Course Objectives:

To make the student to:

1. Recognize the engineering features of flywheel and governors.
2. Develop knowledge on balancing of rotary and reciprocating masses.
3. To study the gyroscope effect and its application.
4. Understand theory involved in the analysis cam.
5. Understanding of vibrations and its significance on engineering design

Syllabus

Module- I **[8 hours]**

Cams: Types of cams, Types of followers, Types of follower motions - Simple Harmonic, Uniform Velocity and Constant Acceleration & Retardation Types, Analysis for Displacement, velocity and Acceleration of Follower, Generation of Cam Profiles by Graphical Method, Introduction on Cams with specified contours.

Module-II **[8 hours]**

Flywheels: Engine force analysis, turning moment of crankshaft, dynamically equivalent system, inertia of connecting rod. Turning moment diagrams, fluctuation of energy, flywheels, dimensions of flywheel rim, applications.

Governors: Watt, Porter, Proell, Hartung. Wilson-Hartnell, spring-controlled gravity governor, inertia governor. Sensitiveness, hunting, isochronism, stability, power, effort, controlling force of a governor.

Module-III **[8 hours]**

Balancing: Static and dynamic balancing of rotating masses, force balancing of four bar linkage, Primary and Secondary balancing of reciprocating engine, balancing inline engine (2,4,6,

cylinders), V-engines, W-engines and radial engines, direct and reverse crank method, balancing machines – static, dynamic theory of field balancing.

Module-IV **[8 hours]**

Gyroscopes: Angular velocity, angular acceleration, gyroscopic couple, gyroscopic effect on airplanes, ships. Static and dynamic force analysis of planar mechanisms, Stability of four-wheel and two- wheel automobiles, rigid disc at an angle fixed to a rotating shaft.

Module-V **[8 hours]**

Vibrations: Definitions, types, basic features, degrees of freedom, free longitudinal vibration – equilibrium method, energy method, displacement, velocity, acceleration, effect of mass of spring, damped vibration, logarithmic decrement.

Forced longitudinal vibrations: Harmonic excitation, magnification factor, vibration isolation and transmissibility. Transverse vibrations, Single concentrated load, uniformly distributed load, several loads, Dunkerley‘s method, whirling of shafts.

Text Books:

1. Theory of Machine, S.S Rattan, Tata McGraw Hill, 3rd Edition, 2017
2. Kinematics and Dynamics of Machinery, R L Norton, Tata MacGraw Hill, Special Indian Edition, 2017

Reference Books:

1. The Theory of Machines: A textbook for engineering students, Thomas Bevan, Pearson, 3rd Edition, 2009
2. Theory of Machines, Sadhu Singh, Pearson Education, 3rd Edition, 2011
3. Theory of Mechanisms and Machines, A. Ghosh & A. K. Mallick, East West Press, 3rd Edition, 2008
4. Theory of Machines and Mechanisms, John J. Uicker Jr., Gordon R. Pennock and Joseph E. Shigley, Oxford University Press, Fourth Edition, 2014

Course Outcome:

The student will be able to:

1. Evaluate the performance of Flywheels, governors and their application.
2. Analyze the theory involved in balancing of rotating and reciprocating members.
3. Examine the effect of a gyroscope on ships, airplanes and automobile.
4. Design the basic cam systems and its application.
5. Analyze mechanical systems subjected to vibrations under different boundary conditions.

Course Code: 19ME5PC01L	Course Name: Dynamics of Machines Lab	L-T-P 0- 0- 2	Credit 1

Course Objectives:

1. Learn the principles involved gyroscope.
2. Educate about the fundamental principles involved in governors.
3. Examine mode shapes of rotating shaft and vibration.
4. Understand the concepts of balancing of mass and cam profile.
5. Analyze the behavioral characteristics of damping in vibration.

List of Experiments:

1. To study gyroscopic effects through models.
2. Determination of gyroscopic couple using gyroscopic test rig.
3. Performance characteristics of a spring loaded governor
4. Performance characteristics of a dead weight load governor
5. Determination of critical speed of rotating shaft
6. Experiment on static and dynamic balancing apparatus
7. Experiment on Cam Analysis Apparatus.
8. Damping force vibration of an equivalent spring mass system.

9. Undamped free vibration of an equivalent spring mass system
10. To study dynamic equivalent system.

Course Outcome:

1. Understanding of the effect of gyroscopic couple..
2. Analyze the performance of governor.
3. Perform the balancing of rotating system and rotating shaft.
4. Evaluate the concept of Cam and draw the Cam profile.
5. Inspect the critical speed of shaft and determine natural frequency of damped and un-damped vibrating system.

Course Code: 19ME5PC02T	Course Name: Applied Thermodynamics	L-T-P 3- 0- 0	Credit 3

Course Objectives:

The student will be able to

1. Understand thermodynamics relations and its usage in deriving properties of substances
2. Understand the behavior of ideal gas and real gas.
3. Estimate the properties of real gases.
4. Utilize the knowledge of thermodynamic cycles in design of air compressor.
5. Understand the air craft propulsion using the knowledge of gas turbine cycles.

Syllabus

Module-I **[9 hours]**

Ideal Gas and Real Gas: Ideal gas, relation among the specific heats, internal energy, enthalpy. Analysis of isochoric, isobaric, isothermal, isentropic, isenthalpic processes, representation of the above processes on P-v, T-s planes. Determination of work, heat, entropy and enthalpy changes during the above processes, problems. Characteristic gas equations of a real gas, virial coefficients, law of corresponding states, compressibility factor, generalized compressibility chart, problems

Module-II **[9 hours]**

Properties of Gases and Gas Mixtures: Equations of State, changes in internal energy, enthalpy and entropy for an ideal gas, Equations of state for a real gas, Virial Expansions, Law of Corresponding States, Generalized Compressibility Chart, Reduced coordinates, Other Equations of state, Dalton's Law of Partial Pressures, Internal Energy, Enthalpy and Entropy and Specific Heats of Gas Mixtures, Gibbs Function of a Mixture.

Module-III **[9 hours]**

Thermodynamic Relations:

Some Mathematical Theorems, Maxwell's Relations, T-ds Equations, Difference in Heat Capacities, Ratio of Heat Capacities, Energy Equation, Claussius-Clapeyron Equation, Joule-

Thomson Coefficient, Evaluation of Thermodynamic Properties from Equation of State, Mixtures of Variable Composition, Conditions of Equilibrium for a Heterogeneous System, Gibbs Phase Rule, Types of Equilibrium, Conditions of Stability, Third Law of Thermodynamics

Module-IV **[8 hours]**

Reciprocating Air Compressors: Introduction (Uses of compressed air), The reciprocating cycle neglecting and considering clearance volume, Volumetric efficiency and its effect on compressor performance, Limitations of single stage compression, Multistage compression and intercooling, Optimum intercooler pressure, Performance and design calculations of reciprocating compressors, Air motors.

Module-V **[9 hours]**

Gas Turbines: Introduction, Open and closed cycle gas turbines, Analysis of practical gas turbine cycle.

Air Craft Propulsion: Analysis of Turbo Jet, Turbo Prop, Turbo fan & Ram jet engines.

Course Outcome:

Students will able to

1. Derive different properties using the thermodynamic relations.
2. Use the ideal gas and real gas effects in solving real life problems
3. Compute the thermodynamic properties of gas mixture..
4. Design the air compressor based on the thermodynamics analysis of compressor
5. Use the knowledge of gas turbine cycles in analyzing the air-craft propulsion.

Text Books:

1. Basic and Applied Thermodynamics, P.K.Nag, 2nd Ed, TMH.
2. Fundamentals of Thermodynamics, Sonntag, Borgnakke, Van Wylen, John Wiley & Sons
3. Fundamentals of Engineering Thermodynamics, E. Rathakrishnan, PHI

Reference Books

1. Thermodynamics and Thermal Engineering, Kothandaraman & Domkundwar, Dhanpat Rai.
2. Applied Thermodynamics, P.L.Ballaney, Khanna Publishers
3. Thermodynamics-An Engineering Approach, Y.A. Cengel, M.A. Boles, 8th Ed, TMH.
4. Molecular Thermodynamics, Mcquarrie, D.A., and Simon, J.D Viva Books, 2010.
5. Gas Turbines, Cohen and Roser

Course Code: 19ME5PC02L	**Course Name:** Applied Thermodynamics Lab	**L-T-P** 0- 0-2	**Credit** 1

Course Objectives:

1. Able to get brief knowledge about Compressor
2. Understand the basic concept of expansion of a gas through Joule experiment.
3. Basic knowledge of gas turbine and jet propulsion system.
4. Gaining knowledge about load carrying system of petrol and diesel engine.
5. Understand about various performance analysis of load test, heat balance and Morse test of various engine.

List of Experiments:

1. Performance analysis of reciprocating air-compressor.
2. Performance analysis of Centrifugal / Axial Flow compressor.
3. Verification of Joule-Thomson coefficient.
4. Performance analysis of gas turbine.
5. Model study of Jet propulsion system
6. Abel's apparatus: Determination of flash and fire points of a given oil sample
7. Redwood Viscometer: Determination of kinematic and absolute viscosities of an oil sample given
8. Load test on 4-stroke single cylinder C.I. engine.
9. Load test on 4-stroke single cylinder S.I. engine.

10. Morse Test on multi-cylinder S.I. or C.I. engine
11. Load test on variable compression ratio S.I. engine
12. Load test and Heat balance on 2 stroke S.I. Engine

Course Outcomes

1. Brief description about various types of compressor and its components with characteristics analysis.
2. Describe about aircraft system and its working principle.
3. Determine the properties of gases, mixture.
4. Evaluate the performance of petrol and diesel engine.
5. Evaluate the various accept of load test, heat balance of variable 2-stroke and 4-stroke engine.

Course Code: 19ME5PC03T	Course Name: Manufacturing Science-II	L-T-P 3- 0- 0	Credit 3

Course Objectives:

The students will able to

1. learn basic metal removal processes and different tools used in them
2. learn mechanics and mechanism of machining, tool life, tool materials, heating effect in machining, machining time and economy of machining process
3. Learn about different machine tools.
4. Learn about Jigs and fixtures and their application in different machine tools.
5. learn about non- traditional machining processes and their application in machining specific material

Syllabus

Module-I **[12 hours]**

Machine Tools: Geometry of cutting tools in ASA and ORS, Mechanics of chip formation, Merchant's theory, Force relationship and velocity relationship, Cutting tool materials.

Flank wear, Crater wear, Wear measurement, Cutting fluid and its effect; Machinability Criteria, Tool life and Taylor's equation, Effect of variables on tool life and surface finish, Measurement of cutting force, Lathe tool dynamometer, Drill tool dynamometer.

Module-II **[9 hours]**

Conventional machining process and machine tools: Turning, Drilling, Shaping, Planning, Milling, Grinding. Machine tools used for these processes, their specifications and various techniques used. Principles of machine tools: Kinematics of machine tools, speed transmission from motor to spindle, speed reversal mechanism, mechanism for feed motion, Tool holding and job holding methods in different Machine tools.

Module-III **[9 hours]**

Mechanism in machining: Indexing mechanism and thread cutting mechanism, Quick return mechanism.

Module-IV **[8 hours]**

Production Machine tools: Engine lathe, Speed lathe**,** Capstan and turret lathes, single spindle and multi spindle semiautomatics, Gear shaper and Gear hobbing machines, Copying lathe and transfer machine

Module-V **[8 hours]**

Non-traditional Machining processes: Ultrasonic Machining, Laser Beam Machining, Plasma Arc Machining, Electro Chemical Machining, Electro Discharge Machining, Wire EDM , Abrasive Jet Machining

Course Outcomes:

1. Explain the features and applications of lathe, milling, drilling and broaching machines.
2. Discuss features and applications of reciprocating machine tools like shaper, planer and slotting machine.
3. Explain economics of machining.
4. Explain Jigs and fixtures and their application.
5. Explain different types of non- traditional machining processes.

Text Books:

1. Fundamentals of Machining and Machine Tools, G.Boothroyd and W.A.Knight, CRC Press
2. Metal Cutting Principles, M.C.Shaw, Oxford University Press
3. Metal Cutting Theory and Practice, A.Bhattacharya, Central Book Publishers

Reference Books:

1. Manufacturing Technology , P.N.Rao, Tata McGraw Hill publication.
2. Fundamentals of Machining and Machine Tools, G.Boothroyd and W.A.Knight, CRC Press
3. Manufacturing Science, Ghosh and Mallik, East West Press.

4. Metal Cutting and Machne Tools, G.T.Reddy, Scitech
5. Modern Manufacturing Processes, P.C.Pandey, H.S.Shan, Tata McGraw Hill
6. Metal Cutting Theory and Practice, D.A.Stephenson and J.S.Agapiou, CRC Press
7. Machining Technology; Machine Tools and Operation, H.A.Youssef and H. El-Hofy, CRC Press
8. Machine Tools and Manufacturing Technology, Krar, Rapisarda and Check, Cengage
9. Introduction to Machining and Machining Fluids: NPTEL-noc19-me32

Course Code: 19ME5PE01L	**Course Name:** Manufacturing Science-II Lab	**L-T-P** 0- 0- 2	**Credit** 1

Course Objectives:

1. Learn about the different types of cutting tools & its geometry
2. Get the knowledge about various types of conventional machining operation, principle of machine tools
3. Learn to calculate cutting forces during machining.
4. Learn about the CNC lathe and milling machines.
5. Learn about the various non-traditional machining processes and their importance.

List of Experiments:

1. Job on lathe with tapper turning, thread cutting, knurling and groove cutting (3 experiments).
2. Gear cutting (with index head) on milling machine
3. Working with shaper, Planner and slotting machine.
4. Working with surface and cylindrical grinding.
5. Determination of cutting force using Lathe tool dynamometer.
6. Determination of cutting force in drilling using drill tool dynamometer.
7. Study of Non-traditional machining processes.(USM, AJM, EDM, ECM)
8. Study of CNC Lathe and demonstration of making job in CNC lathe.
9. Study of CNC Milling machine and demonstration of making job in CNC Milling machine

Course Outcomes:

1. Students have learned about the use of cutting tools for various operations
2. Students have learned to conduct various machining operations on conventional machining
3. Students were able to calculate cutting forces during machining using dynamometer
4. Students were able to operate and conduct the machining on CNC machines
5. Students have learned the importance of the non-conventional machining processes.

Course Code: 19ME5PE01T	Course Name: Mechanics of Composite materials	L-T-P 3- 0- 0	Credit 3

Course Objectives:

The objective of the course is to

1. understand the concept of composite material
2. know the processes involved in the manufacturing of composite materials
3. understand the various types of composite materials and their compositions
4. know the micro and macro mechanical properties of composite materials
5. Know the concept of lamination theory.

Syllabus

Module-I **[7 hours]**

Introduction to Composite Material: Classification and characteristics of composite materials, mechanical behavior of composites, constituents, Reinforcements, Matrices, Fillers, Additives, Applications and advantages of composites.

Module-II **[7 hours]**

Manufacturing Procedures of composites: Constituent Materials, Initial form of constituent materials,. Testing of Composites, Evaluation of Engineering Constants and Strengths.

Module-III **[7 hours]**

Macro-mechanical behavior of composites: Stress strain relations of anisotropic materials - Engineering constants for orthotropic materials, Stress strain relations for specially orthotropic lamina. Transformation relationships for a lamina of arbitrary fibre orientation.

Module-IV **[7 hours]**

Micromechanical Analyses of orthotropic lamina: Evaluation of Engineering Constants using Micromechanical principles, Rules of Mixtures, Kelly Davis Model for Minimum and Critical Volume Fractions.

Module-V **[7 hours]**

FRP Composite: Laminate designation and codes, Macro-mechanical Behaviour of FRP Composite Laminates, Classical Lamination Theory. General Design Consideration and Suitable laminating Scheme.

Course Outcomes:

The student will be able to

1. Understand and describe the basic concept and classification of the composite.
2. Acquire the knowledge in polymer matrix composites and its processing methods.
3. Understand the micromechanical properties of composites.
4. Understand the macro mechanical of composites.
5. Use of Mathematical techniques to predict the macroscopic properties of different Laminates

Text Books:

1. Mechanics of Composite Materials, R.M. Jones, Mc. Graw Hill Book Co.
2. Composite Materials: Engineering and Science, Matthews and Rawlings, CRC Press.
3. Mechanics of composite materials and structures, M Mukhopadhay, Universities Press.

Reference Books:

1. Fibre - Reinforced composites: - Materials, manufacturing and Design, P.K. Mallick, CRC Press.
2. Engineering Mechanics of Composite Materials, I.M.Danel, O.Issai, Oxord University Press
3. Composite materials, Broutman & Crock,
4. Principles of Composite Material Mechanics, R.F.Gibson, CRC Press
5. An Introduction to composite material, D.Hull and T.W. Clyne, Cambridge University press
6. Fundamentals of Metal Matrix Composites, S.Suresh, A.Martensen, and A.Needleman, Butterworth, Heinemann
7. Metal Matrix Composites, Thermo mechanical Behavior, M.Taya, and R.J.Arsenault, Pergamon Press, Oxford.

Course Code: 19ME5PE02T	Course Name: Advanced Mechanics of Solid	L-T-P 3- 0- 0	Credit 3

Course Objectives:

11. To solve solid mechanics problems using theory of Elasticity.
12. Understand the advanced concept of stress-strain behavior of materials.
13. To solve solid mechanics problems using energy methods.
14. To estimate the stress and strain in thick cylinders.
15. Recognize the basics mode of failure criteria and fracture analysis.

Syllabus

Module-I **[9 hours]**

Concept of elasticity: stresses in three dimensions, Principal Stresses, Stress Invariants, Mohr's Circle for 3-D state of stress, Octahedral Stresses, State of pure shear. Differential equations of equilibrium, compatibility conditions, plane stress.

Module-II **[8 hours]**

Analysis of strain: State of strain at a point, Strain Invariant, Principal Strains, Plane state of strain, Strain measurements. Theories of Failure, Various yield criteria

Module-III **[10 hours]**

Energy Methods: Work done by forces and elastic strain energy stored. Reciprocal relations, Theorem of virtual work, Castigliano's theorems, Bending of beams: Asymmetrical bending, Shear centre, Bending of curved beams, Stress distribution in beam with rectangular, circular and trapezoidal cross section, stresses in crane hooks, ring and chain links. Deflection of thick curved bars.

Module-IV **[8 hours]**

Thick cylinder: Thick walled cylinder subjected to internal and external pressures, Compound cylinders, Shrink fit.

Module-V **[9 hours]**

Fatigue and Fracture Analysis: Repeated stresses and fatigue in metals, Fatigue tests and fatigue design theory, Goodman, Gerber and Soderberg criteria, Concept of stress concentration, Notch sensitivity.

Introduction to Fracture Mechanics: Basic modes of fracture, Fracture toughness evaluation.

Course Outcomes:

1. To understand the elastic and plastic behavior of material and evaluate stress invariants, principal stresses and their directions.
2. Develop constitutive relationships between stress and strain for linearly elastic solid.
3. Analyze solid mechanics problems using energy methods
4. Examine the properties of ideally plastic solid and apply the concepts of energy methods in solving structural problems.
5. Analyze theories of failure and design components for safe operation.

Text Books:

1. Elements of Strength of Materials, S P Timoshenko and D H Young, Affiliated East West Press
2. Strength of Materials, G. H. Ryder, Macmillan Press
3. Strength of Materials, S S Rattan, Tata Mc Graw Hill

Reference Books:

1. Mechanics of Materials, James M Gere, Thomson Learning
2. Engineering Mechanics of Solids, Egor P Popov, Prentice Hall of India
3. Advanced Mechanics of Solids, L.S. Srinath, Tata McGraw Hill
4. Advanced Mechanics of Materials : Boresi and Schmdt, Willey
5. Advanced Mechanics of Materials : Siley and Smith
6. Mechanics of Materials, Beer and Johnston, Tata McGraw Hill
7. Mechanics of Materials, R.C.Hibbeler, Pearson Education

8. Mechanics of Materials, William F.Riley, Leroy D.Sturges & Don H.Morris, Wiley Student.
9. Engineering Machanics of Solids, Egor P. Popov, Prentice Hall of India

Course Code: 19ME5PE03T	Course Name: Automobile Engineering	L-T-P 3- 0- 0	Credit 3

Course Objectives:

1. Identify the different parts of engine & know the construction of chassis & amp body.
2. Calculate different resistances act upon the vehicle & amp; power related to it.
3. Know the steering geometry & amp; related mechanism.
4. Know about electrical vehicle & amp; electrical circuit diagram of electrical system of vehicle.
5. Apply their ideas on Automobile project work & amp; related industrial sector for future development of Automobile.

Syllabus

Module-I **[8 hours]**

Introduction

Main Modules of automobile chassis and body, different systems of the automobile, description of the main parts of the engine, motor vehicle act.

Alternative Energy Sources-Use of Natural Gas, LPG, Biodiesel, Gasohol and Hydrogen in Automobiles, Electric and Hybrid Vehicles, Fuel Cells.

Module-II **[8 hours]**

Types of Resistance

Resistance to motion, rolling resistance, air resistance, gradient resistance, power required for propulsion, tractive effort and traction, road performance curves.

Hydraulic braking system, braking of vehicles when applied to rear, front and all four wheel, theory of internal shoe brake, design of brake lining and brake drum, different arrangement of brake shoes, servo and power brakes.

Module-III **[8 hours]**

Transmission Systems, Layout of the transmission system, main function of the different

components of the transmission system, transmission system for two wheels and four wheel drives. Hotchkiss and torque tube drives.

Module-IV **[8 hours]**

Gear box: Sliding mesh, constant mesh and synchromesh gearbox, design of 3 speed and 4 speed gear box, over drive, torque converter, semi and fully automatic transmission.

Hookes joint, propeller shaft, differential, rear axles, types of rear axles, semi floating, there quarter floating and full floating types.

Front wheel Geometry and steering systems : Camber, castor, kingpin inclination, toe-in and toeout, centre point steering condition for true rolling, components of steering mechanism, power steering.

Module-V **[8 hours]**

Electrical system of an automobile: Starting system, charging system, ignition system, other electrical system.

Electrical vehicles: History, electrical vehicles and the environment pollution, description of electric vehicle, operational advantages, present EV performance and applications, battery for EV, Battery types and fuel cells, Solar powered vehicles, hybrid vehicles.

Course Outcomes:

1. Understand the basic lay-out of an automobile.
2. Understand the operation of engine cooling, lubrication, ignition, electrical and air conditioning systems.
3. Understand the principles of transmission, suspension, steering and braking systems.
4. Understand automotive electronics.
5. Study latest developments in automobiles.

Text Books:

1. Automobile Mechanics, N.K.Giri, Khanna publishers
2. Automobile Engineering, K.M. Gupta, VolI & II, Umesh Publication

3. Automobile Engineering, Vol. I & II, Kirpal Singh, Standard Publications

Reference Books:

1. Automotive mechanics: William h. Crouse and Donald L. Anglin, TMH
2. The motor vehicle, Newton and Steeds
3. Automobile Mechanics, J. Heitner, East West Press
4. Automobile Engineering, Jain and Asthana, Tata McGraw Hill
5. Automobile Engineering, K.K.Ramalingam, Scitech
6. A Text Book of Automobile Engineering, R.K.Rajput, Laxmi Publishers

Course Code: 19ME5PE04T	Course Name: Production and Operation Management	L-T-P 3- 0- 0	Credit 3

Course Objectives:

1. Acquire a working understanding of the roles/functions of production management in the context of business enterprise.
2. Develop skills in solving production management problems.
3. Recognize, appreciate, and perform the job of a competent production or operation manager

Syllabus

Module-I **[8 hours]**

Introduction: Operations Function in an Organization, Manufacturing Vs. Service Operations, System view of Operations, Strategic Role of Operations, Operations Strategies for Competitive Advantage, Operations Quality and Productivity Focus, Meeting Global Challenges of Production and Operations Imperatives.

Designing Products, Services and Processes: New Product Design- Product Life Cycle, Product Development Process, Process Technology: Project, Job shop, Batch, Assembly Line, Continuous Manufacturing; Process Technology Life Cycle, Process Technology Trends, FMS, CIM, CAD, CAM; Design for Services, Services Process Technology.

Module-II **[8 hours]**

Work Study: Methods Study- Techniques of Analysis, recording, improvement and standardization; Work Measurement: Work Measurement Principles using Stopwatch.

Time Study: Predetermined Motion Time Standards and Work Sampling, Standard Time Estimation.

Module-III **[8 hours]**

Location and Layout Planning: Factor Influencing Plant and Warehouse Locations, Impact of Location on cost and revenues.

Facility Location Procedure and Models: Qualitative Models, Breakeven Analysis, location Model, centroid method.

Layout Planning: Layout Types : Process Layout, Product Layout, Fixed Position Layout Planning, block diagramming, line balancing, computerized layout planning- overview.
Forecasting: Principles and Method, Moving Average, weighted Moving Average, Exponential, Smoothing, Winter's Method for Seasonal Demand, Forecasting Error.

Module-IV **[8 hours]**

Manufacturing Planning and Control: The Framework and Components: Aggregate Planning, Master Production Scheduling, Rough-cut-Capacity Planning, Material Requirements Planning, Capacity Requirements Planning.
Sequencing and Scheduling: Single Machine Sequencing: Basics and Performance Evaluation Criteria, Methods for Minimizing Mean Flow Time, Parallel Machines: Minimization of Makespan, Flowshop sequencing: 2 and 3 machines cases: Johnson's Rule and Jobshop Scheduling: Priority dispatching Rules.

Module-V **[8 hours]**

Inventory Control: Relevant Costs, Economic Batch Quantity, Basic EOQ Model, Model with Quantity discount, Periodic and Continuous Review Systems, Safety Stock, Reorder Point and Order Quantity Calculations. ABC Analysis.
Modern Trends in Manufacturing: Just in Time (JIT) System: Shop Floor Control By Kanbans, Total Quality Management, Total Productive Maintenance, ISO 9000, Quality Circle, Kaizen, Poka Yoke, and Supply Chain Management, Group Technology.

Course Outcomes:

1. Identify the elements of operations management and various transformation processes to enhance productivity and competitiveness.

1. Analyze and evaluate various facility alternatives and their capacity decisions, develop a balanced line of production & scheduling and sequencing techniques in operation environments
2. Develop aggregate capacity plans and MPS in operation environments.
3. Plan and implement suitable materials handling principles and practices in the operations.
4. Plan and implement suitable quality control measures in Quality Circles to TQM.

Text Books:

1. Production and Operations Management, R. Paneerselvam, Prentice Hall of India.
2. Production & Operations Management, Aswathappa & Bhatt, HPH.
3. Production and Operations Management, S.N.Chary, Tata McGraw Hill.

Reference Books:

1. Operations Management, Gaither & Frazier, Cengage Publication
2. Operations Management, Russell & Taylor , PHI Publication
3. Operations Management, Chase, Aquilanno, Jacob & Agarwal, TMH Publication.
4. Production and Operations Management, E.E. Adam and R.J. Ebert, Prentice Hall of India

Other Elective Subject

Course Code: 19ME5OE01T	Course Name: Engineering Management	L-T-P 3- 0- 0	Credit 3

Course Objectives:

1. To provide an introduction to Engineering Management and exposure to forecasting methods, namely qualitative & quantitative methods .
2. Impart knowledge on the Aggregate Planning and Materials Requirement Planning?
3. Understand the principles/methods of Scheduling and Sequencing.
4. Understand the Maintenance Planning and Control and the methods for reliability improvement?
5. Impart knowledge on the Modern concepts/ techniques in operations management and Supply Chain management.

Syllabus

Module – I **[8 hours]**

Management and Organizations, Management process: Definition, planning organizing, directing, controlling, coordinating, types of management. Organization Definition, planning, design and development, types of organizations. Management planning and control: Classical, new classical and modern principles. General Management, scientific management, engineering, management, systems management. Planning: Procedures, resources and constraints, objectives, goals, policies and procedures. Control: Setting of reference or standards, appraisal or evaluation, monitoring and controlling, types of control.

Module – II **[7 hours]**

Human resource planning and management: selection, recruitment, training, retraining, skill development, competence development, promotion and career development, participative management, trade unions, and collective bargaining, Management of Physical Resources Plant: site selection procedures, factors affecting selection. Layout-types and relative merits and demerits, Maintenance-Objectives, different types of associated decisions, strategies for effective

maintenance, computer applications. Material : Functions, objectives, planning and control including inventory models with or without storage costs, price break(excluding dynamic and probabilistic considerations). Different classes of inventory. Material Requirement Planning (MRP).

Module – III **[8 hours]**

Financial management: Introduction to standard forms of financial statements, i.e., balance-sheet, profit and loss, and income statement. Fixed and current asset items. Fixed and current liability items. Linkage of two successive balance-sheets through income or profit and loss statement. Funds flow statement. Financial ratios and their implications. Managerial economics: Concepts, theory of production, marginal productivity and cost. Introduction to theory of firm.

Module – IV **[7 hours]**

Quality management: Quality definition, quality planning, quality control and quality management, Total quality management, ISO 9000 systems, simple quality control techniques like control charts and acceptance sampling. Marketing management consumer behavior, market research, product design and development pricing and promotion.

Module – V **[10 hours]**

Project management: Introduction. Concept of a project, project management concepts, project simulation, cost or project and means of financing, economic evaluation criteria of the project, project implementation, project planning, scheduling and monitoring, project control (PERT, CPM techniques including crashing). Project evaluation.

Information technology and management. Role of information, management information system and decision support system, Information technology-introduction to e-business, e-commerce and integration tools like enterprise resource planning (ERP).

Course Outcomes:

1. Acquire a sound knowledge on the principles of Operations Management .

2. Use forecasting methods, principles/methods of scheduling and Sequencing, methods of maintenance planning and control, concepts/ technique supply chain management for Engineering Management.
3. Select and use an appropriate principles/methods/ techniques/ modern concepts with reference to given application/situation in the mechanical systems/ project management and finance
4. Develop and implement new ideas/ modern concepts with reference to given application/situation for best manufacturing practices.
5. Preparation and ability to engage in independent and lifelong learning in the context of technological change in Engineering Management

Text Books:

1. Engineering Management, A K Gupta, S. Chand Publishing
2. Engineering Management: Meeting the Global Challenges, C. M. Chang, Second Edition, CRC Press, Taylors & Francis Group

Reference Books:

1. Engineering Management, A. S. Chauhan, R. S. Vaishwanar, Neetu Jain, Jain Brothers Publications
2. Engineering Management, Fraidoon Mazda, Pearson Edition
3. The Practice of Engineering Management, Patrick D. T. O'Connor, Wiley–Blackwell

Course Code: 19ME5OE02T	Course Name: Micro Electro-Mechanical Systems (MEMS)	L-T-P 3- 0- 0	Credit 3

Course Objectives:

1. Learning fundamental concepts for design of micro-electromechanical devices (MEMS), including mechanical and thermal behavior of materials and structures, transduction principles, transducer design, and modeling.
2. Learn about the current and future trends of MEMS in the industry. Types of MEMS devices, their application areas.
3. Acquire comprehensive knowledge of microfluidic devices.
4. Learn different techniques for fabrication of MEMS devices, materials used and their properties.
5. Learn analytical/mathematical modeling of a MEMS device. Gain knowledge on capabilities of different tools used in the industry.

Syllabus

Module-I **[7 hours]**

Introduction to MEMS

History of micro system technology, overview of commercial MEMS products, future trends, Case study, Micro-fabrication basics and materials used. Miniaturization : Moore's law, Effects of scaling: on mechanical strength, heat transfer, vibrational and magnetic characteristics. Benefits and limitations of the materials and miniaturization.

Module-II **[8 hours]**

MEMS types, application areas

Mechanical Transducer: Inertial Sensors (Accelerometer, Gyroscope), Pressure Sensors, Flow Sensors, Force Sensors (SPM), Magnetic Transducers: Magnetic Field Sensors, Magnetic Actuators, Proximity sensor;

Chemical/Biological Transducers : Gas sensor, Thermal Transducers: Thermometers, IR Sensors; Applications of MEMS: smart homes, electrical systems, material transport, condition monitoring, biomedical prosthesis.

Packaging of MEMS devices : Standard Packages, Packaging Concepts, Packaging Examples

Module-III **[7 hours]**

Microfluidics:

Fundamentals of fluid mechanics, Basic components of a micro-fluidic system, Micro flows, Micro pumps, Capillarity and Surface Tension, Micro pumping methods, Micro dispensers, Micro nozzles

Module-IV **[7 hours]**

Materials and Fabrication techniques of MEMS

Properties of materials used in MEMS fabrication : silicon, polymers, metals, ceramics. Their structure and properties. Structure of silicon and other materials (polymers), Silicon wafer processing, Bulk micro machining and Surface micro machining, Wafer-bonding. Thin-film deposition, Lithography, wet etching and dry etching.

Module-V **[9 hours]**

Modeling of MEMS structures

System modeling of MEMS : Analytical vs Numerical Modeling, Lumped Element modeling, Finite element modeling; MEMS simulation packages : MEMS pro, MEMS+, SUGAR, Coventor, SoftMEMS, COMSOL etc. Demonstration of MEMS pro-Ansys integration

Course Outcomes:

1. Understand the operation of micro devices, micro systems and their applications.
2. Select whether the particular situation requires the use of a MEMS device. If required, select an appropriate device.
3. Analyze a chemical/biological system to select the right microfluidic device.

4. Apply knowledge of physical, chemical and biological principles to engineer MEMS devices using different materials and techniques. Select appropriate MEMS fabrication techniques for a particular design and application.
5. Apply knowledge of MEMS analysis to evaluate suitability of MEMS designs for particular applications. Select a suitable tool for a

Text Books:

1. Smart Material Systems and MEMS:Design and Development Methodologies, Vijay K. Varadan, K. J. Vinoy, S. Gopalakrishnan, Wiley, 2006
2. MEMS & Micro systems Design and Manufacture, Tai Ran Hsu, Tata McGraw Hill, New Delhi, 2002

Reference Books:

1. MEMS Sensors, Design and Application, Siva Yellampalli, IntechOpen, 2018
2. MEMS : Design and Fabrication, Mohamed Gad-el-Hak, CRC Press, 2005
3. Microsystem Design, Stephen D. Senturia, Springer US, 2001

SubjectCode: 19IT5OE01T	Subject Name: JAVA Programming	L-T-P 3- 0- 0	Credit 3

Course Objectives:

1. Learn the syntax, semantics and idioms of the Java Programming language
2. Gain confidence in object oriented programming principles through lots of practical examples that provides full exposer to the core Java class libraries

Syllabus

Module-I **[8 hours]**

Introduction to Java and Java Programming Environment, Object Oriented Programming Concepts, Encapsulation, Abstraction, Inheritance, Polymorphism

Fundamental Programming Structure: Data Types variables, key words, type casting, Arrays, operators, and their precedence.

Control Flow: Java's control Statements (if, switch, iteration, statement, while, do-while, for, Nested loop) . Concept of Object and Classes, Using existing Classes building your own classes, constructor over loading, static, final, this keyword.

Module-II **[8 hours]**

Inheritance: Introduction, types of inheritance, use of super keyword, Method overriding, Dynamic method Dispatch, Using Abstract Classes, Using final with inheritance. The Object Class.

Packages & Interfaces: Packages, Access Protection, Importing Package, Interface, Implementing Interfaces, variable interfaces, Interfaces can be extended.

Module-III **[7 hours]**

Exception Handling: Fundamentals, Types Checked, Unchecked exceptions, Using try and catch, Multiple catch, throw, throws, finally Java's Bulletin exceptions, user defined exception.

String Handling: String constructors, String length, Character Extraction, String Comparison, Modifying a String,

Module-IV **[7 hours]**

Java I/O: Classes & Interfaces, Stream classes, Byte streams, Character Streams, Serialization

Multi Threading: Java Thread Life Cycle, Thread Priorities, Synchronization, Creating a thread, runnable interfaces, creating multiple threads, Using is Alive() and join(), wait() & notices().

Module-V **[9 hours]**

Wrapper Classes and Collection Framework: Wrapper classes and its methods, Introduction, Interfaces, List, Set, Map etc.

Event Handling: Event Delegation Model, Event Classes, Event listener Interfaces, Adapter classes

AWT: AWT Classes window fundamentals, component, container, panel, Window, Frame working, with Graphics, Control Fundamentals, Layout Managers, Handling Events by Extending AWT Components.

Course Outcomes:

1. Implement and apply various Object Oriented Programming concepts
2. Applying Collection Classes and Files, Multiple Threads, & handle Exceptions in developing a java applications
3. Developing a Java standalone application having front end design and back end.

Text Books:

1. Java; One step Ahead, Anita Seth, B. L. Juneja, Oxford University Press.
2. Head First Java, Kathy Sierra and Bert Bates, 2nd edition
3. JAVA Complete Reference, Herbert Schildt, 9th Edition

Reference Books:

1. https://www.udemy.com/java-the-complete-java-developer-course/
2. Java Programming Masterclass for Software Developers Creared by Tim Buchalka, Tim Buchalka's Learn Programming Academy, Goran Lochert

Digital Learning Resources:

Course Name	Foundation Engineering
Course Link	http://nptel.ac.in/courses/105/105/105105176/
Course Instructor	Prof. Koushik Deb, Department of Civil Engineering, IIT Kharagpur

Course Code: 19EC5OE01T	Course Name: VLSI Design	L-T-P 3- 0- 0	Credit 3

Course Objectives:

1. To understand the concept of VLSI Design Methodology, Design Flow, fabrication steps of NMOS as well as CMOS process and MOSFET the static and switching behavior of MOS Inverter.
2. To understand the design and working of combinational and sequential MOS circuits.
3. To understand the concept of semiconductor memories.
4. To understand the concept of Layout of CMOS Digital Circuits, DRC, LVS and RCX

Syllabus

Module-I **[8 Hours]**

Introduction, Historical perspective, VLSI Design methodologies, VLSI Design Flow, Design Hierarchy, Design Styles, CAD Technology .

Fabrication of MOSFETS, Fabrication processes, NMOS Fabrication, CMOS n-well process, Layout Design rules, Stick Diagrams, Full Custom Mask Layout Design.

MOS Transistor, Review of structure and operation of MOSFET (n-MOS enhancement type), CMOS, MOSFET V-I characteristics, MOSFET scaling and small geometry effects, MOSFET capacitances.

Module-II **[10 Hours]**

MOS Inverters:

Basic NMOS inverters, characteristics, inverters with resistive load and with n-type MOSFET load, CMOS inverter and characteristics.

MOS inverters: Switching characteristics and interconnect effects: Delay time definitions and calculation, inverter design with delay constraints, estimation of parasitic switching power dissipation of CMOS inverters.

Module- III **[8 Hours]**

Combinational MOS logic circuits: CMOS logic circuits, state style, complex logic circuits, pass transistor logic.

Sequential logic circuit – Introduction, SR latch, clocked latch & flip-flop circuits, CMOS D latch and edge triggered flip-flop**.**

Module-IV **[6 Hours]**

Semiconductor Memories: Introduction, Read Only Memory Circuits, Static Read-Write Memory (SRAM) Circuits, Dynamic Read-Write Memory (DRAM) Circuits.

Module-V **[8 Hours]**

Layout concepts and examples of CMOS Inverter, 2-Input NAND Logic Gate, 2-Input NOR Logic Gate, 2:1 Multiplexer using Transmission Gate, D-Latch using Transmission Gate, Concept of DRC, LVS and RCX.

Course Outcomes:

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

1. Analyze the characteristic of MOSFET, understand the fabrication steps, design CMOS inverters, calculate the dimension of MOSFETs for delay and inverter threshold voltage.
2. Design combinational and sequential circuits using CMOS technology and verify their functionalities.
3. Analyze the memory cells and verify its functionality
4. Analyze the layout and verification of CMOS integrated circuits.

Text Books:

1. CMOS Digital Integrated Circuits: Analysis and Design, Sung-Mo Kang, Yusuf Leblebici and Chul Woo Kim, 4th Edition, Tata McGraw-Hill Publishing Company Limited, 2015.
2. VLSI Design, Debaprasad Das, 2nd Edition, Oxford University Press, 2015, New Delhi.

REFERENCE BOOKS:

1. CMOS VLSI design a circuits and systems perspective, Neil H. E. weste, David Harris and Ayan Banerjee, 4th Edition, Pearson Education, 2015.
2. Digital Integrated Circuits– A Design Perspective, Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, 2nd Edition, PHI Learning, 2016, New Delhi
3. Basic VLSI Design, Douglas A. Pucknell and K. Eshraghian, 3rd Edition, PHI Learning, 2009, New Delhi

Digital Learning Resources:

Course Name	CMOS Digital VLSI Design
Course Link	https://nptel.ac.in/courses/108/107/108107129/
Course Instructor	Prof. Sudeb Dasgupta | IIT Roorkee

Course Name	Digital VLSI Design
Course Link	https://nptel.ac.in/courses/108/103/108103108/
Course Instructor	Prof. Chandan Karfa | IIT Guwahati

Course Code: 19CE5OE01T	Course Name: Building Services and Maintenance	L-T-P 3- 0- 0	Credit 3

Course Objectives:

1. To explain the activities involved in maintenance of a building
2. To know services of an anti-termite treatment and repair of pipes , sanitary works and joints.
3. To analyses the strengthening technique of foundations
4. To understand the strengthening technique of beams, columns, slabs and masonry walls
5. To understand water supply systems in a building and its maintenance

Syllabus

Module-I **[8 hrs]**

Maintenance of Building: White washing, color washing and dis-tempering, painting, replacement of glass panels, re-polishing of terrazzo and mosaic, replacement of decayed timber, easing of doors and windows, repairs to damaged part of the flooring.

Module-II **[8 hrs]**

Removal of stains from concrete and terrazzo floor, anti termite treatment in building, foundations, floors and wood work, repairing of plumbing, drain and sanitary works. Repair of water storage sumps and tanks

Module-III **[8 hrs]**

Special Repairs: Strengthening of foundation and foundation soils, rectification of leaking roof and concrete covers palled roof, repairs to crack in masonry wall, repairs to leakage at window sill, special repairs to joinery work at roof level, providing D.P.C. to the exciting buildings, repairs to expansion and contraction joints, repair storamped floors.

Module-IV **[6 hrs]**

Strengthening of beams, Strengthening of columns, Strengthening of slab Strengthening of masonry wall

Module-V **[10 hrs]**

Water quality, Purification and treatment- water supply systems-distribution systems in small towns-types of pipes used, laying jointing, testing- testing for water tightness plumbing system for building-internal supply in buildings- municipal bye laws and regulations - Rain Water Harvesting - Sanitation in buildings-arrangement of sewerage systems in housing -pipe systems storm water drainage from buildings-septic and sewage treatment plant – collection, conveyance and disposal of town refuse systems.

Course Outcome:

After completion of the course the student is able to

1. Analyses the activities involved in maintenance of a building
2. Evaluate various anti-termite treatments and repair of pipes, sanitary works and joints
3. Design the strengthening technique of foundations
4. Analyses the strengthening technique of beams, column slab and masonry walls
5. Design water supply systems in a building and its maintenance

Text Books:

1. Building Constrution, V. N. Vazirani and S. P. Chandola, Khanna Publishers, NewDelhi, India.

Reference Books:

1. Building Maintenance Management, B. Chanter and P. Swallow, Second Edition, Wiley-Blackwell, 2017, New Jersey, United States.
2. General Specification for Building Maintenance Works in Residential Buildings, prepared by Building Surveying Division, HKIS

Digital Learning Resources

CourseName	Fire Protection, Services and Maintenance Management of Building
CourseLink	https://nptel.ac.in/courses/105/102/105102176/
CourseInstructor	Dr. B. Bhattacharjee, Department of Civil Engineering, IIT Delhi

Course Code: 19EE5OE01T	Course Name: Renewable Energy Systems	L-T-P 3- 0- 0	Credit 3

Course Objectives:

The program is expected to enable the students to

1. Design and develop innovative products and services in the field of Renewable Energy.
2. Keeps abreast with the latest technology and tool set.
3. Communicate effectively to propagate ideas and promote team work
4. Attain intellectual leadership skills to cater to the changing needs of power industry, academia, society and environment

Syllabus

Module-I **[4 Hours]**

Introduction: Causes of Energy Scarcity, Solution to Energy Scarcity, Factors Affecting Energy Resource Development, Energy Resources and Classification, Renewable Energy – Worldwide Renewable Energy Availability, Renewable Energy in India.

Quality of Energy: Measure of Quality of energy, Identification of potential energy resources in terms of their quality. Dependency of Efficiency of energy conversion on Quality of energy. Cogeneration, Dispersed or Distributed generation.

Module-II **[8 Hours]**

Energy from Sun: Sun- earth Geometric Relationship, Solar radiation geometry, Layer of the Sun, Earth – Sun Angles and their Relationships, Solar Energy Reaching the Earth's Surface, Sunpath diagram and evaluation of insolation quality at a location using Sunpath, Solar Thermal Energy Applications.

Solar Thermal Energy Collectors: Types of Solar Collectors, Configurations of Certain Practical Solar Thermal Collectors, Material Aspects of Solar Collectors, Concentrating Collectors, Parabolic Dish – Stirling Engine System, Working of Stirling or Brayton Heat Engine, Solar Collector Systems into Building Services, Solar Water Heating Systems, Passive Solar Water Heating Systems, Applications of Solar Water Heating Systems, Active Solar

Space Cooling, Solar Air Heating, Solar Dryers, Crop Drying, Space Cooing, Solar Cookers, Solar pond.

Module-III **[7 Hours]**

Solar Photovoltaic Cells: Components of Solar Cell System, Elements of Silicon Solar Cell, Equivalent Circuit of a PV Cell, Impact of parameters of PV cell performance, Solar Cell materials, Practical Solar Cells, I – V Characteristics of Solar Cells, Maximum Power Point Tracking (MPPT), MPPT algorithms: P&O, Incremental Conductance, Efficiency of Solar Cells, Photovoltaic Panels, Shading & Mitigation techniques, Applications of Solar Cell Systems.

Module-IV **[10 Hours]**

Wind Energy Conversion System (WECs): Energy content in wind, extractible content of energy through WECs. Types of wind turbines with respect to axis of rotation (Horizontal & vertical axis wind turbine), working principle (lift and drag type) etc.

Airfoil terminology - Blade element theory - Blade design - Rotor performance and dynamics- Balancing technique (Rotor &Blade), significant parameters determining efficiency of WECs, Pitch angle, No of blades, solidity, Tip Speed ratio.

Constant speed Constant frequency - Variable speed variable frequency - Up wind-Down wind - Stall control-Pitch control - Gear coupled generator type - Direct generator drive/PMG/Rotor excited sync generator.

Module-V **[10Hours]**

Integrated Energy Systems: Systems aspects of Integration: voltage effect, thermal effects, fault level, islanding. Stand alone systems: Network voltage and system efficiency, Case studies of standalone system. Hybrid energy systems ans its economic evaluation. Technological aspects of power electronic systems connection to the grid. Hybrid and integrated energy systems, total energy concepts and waste heat utilization, Energy modeling to optimize different systems

Course Outcomes:

1. Appraise the need and possibility of extracting solar energy and converting into electrical energy using PV cell.
2. Design and analyze stand-alone and grid connected PV system.
3. Describe the dynamics of wind turbine and electrical generator.
4. Select and design suitable configuration of the wind energy conversion system based on application.
5. Suggest, design and analyze hybrid energy systems.

Text Books:

1. Non-conventional Energy Sources by G. D. Rai, Khanna Publishers.
2. Renewable Energy by Boyle, Godfrey Oxford University Press.
3. Renewable Energy Systems Design and Analysis with Induction Generators, by M. Godoy Simoes, Felix A. Farret, CRC press.
4. Micro-grid: A Conceptual Solution, Robert Lasseter, Paolo Piagi, PESC2004, June 2004.

Reference Books:

1. Renewable Energy Resources byJ ohn Twidell and Tony Weir, Taylor Francis Group.
2. Renewable Energy Sources for fuels and Electricity by Laurie Barrtom, Island Press.

Digital Learning Resources:

Course Name	Solar, Wind and Biomass Energy Systems
Course Link	https://nptel.ac.in/courses/103/103/103103206/
Course Instructor	Prof. R. Anandalakshmi Prof. Vaibhav Vasant Goud, Department of Chemical Engineering, IIT Guwahati
CourseName	Solar & WindEnergy
CourseLink	https://nptel.ac.in/courses/103/107/103107157/

CourseInstructor	Prof. P. Mondal, Department of Chemical Engineering, IIT Roorkee
CourseName	Energy Resources
CourseLink	https://www.youtube.com/watch?v=cZSYukWvpsE
CourseInstructor	Prof. Rangan Benarjee, Department of Energy Science & Technology, IIT Bombay
CourseName	Design of Photo voltaic system
CourseLink	https://www.youtube.com/watch?v=hr2sId412zU&list=PLuv3GM6-gsE2KyXoBTQ6lbrwn22Z3SiVm&index=2
CourseInstructor	Prof. L. Umanand, Department of Electronic System Engineering, IISc, Bangalore

Course Code: 19ME5OE03T	Course Name: Smart and Intelligent Materials	L-T-P 3- 0- 0	Credit 3

Course Objectives:

1. To study different type of smart material and its application.
2. Understand in details on the shape memory material and Chromogenic materials.
3. Understand the details of smart polymer and its application.
4. To study about smart hydrogels and its properties.
5. Understanding of smart material and its application in aerospace engineering.

Syllabus

Module-I **[7 hours]**

Smart materials and structures: System intelligence- components and classification of smart structures, common smart materials and associated stimulus-response, Application areas of smart systems **Ferroelectric materials:** Piezoelectric materials- piezoelectric effect, Direct and converse, parameter definitions, Piezoceramics, Piezopolymers, Piezoelectric materials as sensors, Actuators and bimorphs

Module-II **[7 hours]**

Shape memory materials: Shape memory alloys (SMAs), Shape memory effect, Martensitic transformation, One way and two-way SME, training of SMAs, binary and ternary alloy systems, Functional properties of SMAs

Chromogenic materials: Thermochromism, Photochromism, Electrochromism, Halochromism, Solvatochromism- principle and design strategies

Module-III **[7 hours]**

Smart polymers: Thermally responsive polymers, Electroactive polymers microgels, Synthesis, Properties and Applications, Protein-based smart polymers, pH-responsive and photo-responsive polymers, Self-assembly, Molecular imprinting using smart polymers, Approaches to molecular imprinting, Drug delivery using smart polymers

Module-IV **[7 hours]**

Smart hydrogels: Synthesis, Fast responsive hydrogels, Molecular recognition, Smart hydrogels as actuators, Controlled drug release, Artificial muscles, Hydrogels in microfluidics

Module-V **[7 hours]**

Smart systems for space applications: Elastic memory composites, Smart corrosion protection coatings, Self-healing materials, Sensors, Actuators, Transducers, MEMS, Deployment devices, Molecular machines

Course Outcomes:

1. On successful completion of this course students will be able:
2. Characterize and evaluate smart materials for specific applications.
3. Inspect the theory of shape memory alloy material and chromogenic materials.
4. Understand the structure of smart polymer and its application to engineering problems.
5. Examine the properties of smart hydrogels.
6. Design advanced materials for aerospace, biological, nuclear and high temperature applications.

Text Books:

1. Engineering Analysis of Smart Material Systems, D.J. Leo, Wiley 2007.
2. Smart Materials and New Technologies in Architecture, M. Addington, D.L. Schodek, Elsevier 2005.
3. Shape Memory Materials, K. Otsuka, C.M. Wayman (Eds.), Cambridge University Press, 1998.
4. Smart Materials and Structures, M.V. Gandhi, B. S. Thompson, Chapman & Hall, 1992.

Reference Books:

1. Processes, and Methods Technology, M. Schwartz, New Materials, CRC Press, 2006.
2. Made to Measure: Materials for the 21stCentury, P. Ball, Princeton University Press, 1997.

3. Smart Polymers: Applications in Biotechnology and Biomedicine, Galaev, B. Mattiasson (Eds.), 2nd ed., CRC Press, 2008.
4. Reflexive Polymers and Hydrogels: Understanding and Designing Fast Responsive Polymeric Systems , N. Yui, R. J. Mrsny, K. Park (Eds.), CRC Press, 2004.

Course Code: 19ME5OE04T	Course Name: Nanoscience and Technology	L-T-P 3- 0- 0	Credit 3

Course Objectives:

1. Learn about the background on Nanoscience and nanomaterials.
2. Understand the synthesis of nanomaterials and their application and the impact of nanomaterials on environment
3. Recognize the different functionalities of nonamaterials.
4. Understand the fundamentals of Biomimetic nanomaterials and its application.
5. Understand the different applications of nanomaterials.

Syllabus

Module-I **[10 hours]**

General introduction and theory of nanomaterials- History of nanomaterials; Size and shape dependent properties and their uniqueness; Energy at nanoscale - surface characteristics and electrostatic and steric stabilization - Quantum confinement - zero dimensional, one dimensional and two dimensional nanostructures

Module-II **[8 hours]**

Synthesis of nanomaterials- Introduction to nanoparticle synthesis – top-down and bottom up approaches - physical nanofabrication techniques (PVD, MBE, CVD, self-assembly, lithographic techniques etc.) and wet chemical methods for the synthesis of zero dimensional one dimensional and two dimensional nanostructures-metal nanoparticles, quantum dots, nanoclusters, nanowires and rods, thin films

Module-III **[12 hours]**

Functional nanomaterials- Synthesis, properties and applications of organic, inorganic, hybrid nanomaterials – core-shells, nanoshells, self-assembled nanostructures, superlattices, nanoceramics metallic, polymeric and ceramic nanocomposites, nanoporous materials, nanofluids, nanolayers and carbon based nano materials - Occurrence, production, purification,

properties and applications of fullerene, carbon nanotube, graphene, carbon onion, nanodiamond and films

Module-IV **[8 hours]**

Biomimetic nanomaterials - Introduction to biomimetics, mimicking mechanisms found in nature, synthesis and applications of bioinspired nanomaterials and self-assemblies

Module- V **[8 hours]**

Applications of nanomaterials- Application of nanomaterials in healthcare, biosenors, coatings environment, catalysis, agriculture, automotives, sensors, electronics, photonics, information technology, quantum computing, energy and aerospace sectors.

Course Outcomes:

1. To develop a foundational knowledge of the Nanoscience and related fields.
2. Apply their learned knowledge to develop Nanomaterial's.
3. Evaluate the different functional properties of nanomaterials.
4. Understand the details about Biomimetic nanomaterials and its application.
5. Utilize the knowledge of nanomaterial in solving engineering problems.

Text Books:

1. Nanoscale Materials in Chemistry, K. J. Klabunde and R.M. Richards (Eds.), 2nd Edn., John Wiley & Sons, 2009.
2. Nano: The Essentials, T. Pradeep, McGraw-Hill (India) Pvt Limited, 2008.
3. Handbook of Nanotechnology, Bharat Bhushan, Springer, 2007.

Reference Books:

1. Nanostructured Materials: Processing Propertiesand Applications, Carl C. Koch (Ed.), William Andrew Inc., 2007.
2. Carbon Materials and Nanotechnology, Anke Krueger, Wiley-VCH Verlag GmbH & Co. KGaA, 2010.

3. Nanostructures and Nanomaterials Synthesis, Cao, G., Properties, and Applications, Imperial College Press, 2004.
4. Characterization of nanophase materials, Wang, Z. L., (Ed.), Wiley-VCH Verlag GmbH, 2000.
5. Nanotechnology for the Energy Challenge. Garcia-Martinez, J., (Ed.), Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, 2009.
6. Handbook of Nanoscience, Engineering, and Technology, Goddard III W.A., et. al.,(Ed.), Taylor & Francis Group, 2007.
7. Hybrid Nanomaterials: Synthesis, Characterization, and Applications, B.P.S. Chauhan (Ed), Wiley-VCH Verlag GmbH, 2011.
8. Bioinspired Intelligent Nanostructured Interfacial Materials, J. Lei andF.Lin, World Scientific Publishing Company, 2010.
9. Biomimetic and Bioinspired Nanomaterials, Challa S. S. R. Kumar (Ed.) Wiley-VCH Verlag GmbH, 2010.

Course Code: 19IT5OE02T	Course Name: Computer Networks	L-T-P 3- 0- 0	Credit 3

Course Objectives:

1. Understand the concepts of data communication, layered model, wireless devices in computer networks.
2. Explain the various techniques used to access a shared channel in the network and IEEE specifications for LANs.
3. List types of networking devices, back bone networks and Internet Protocol (IP) addressing.
4. Explain the responsibilities of network, transport and application layers.

Syllabus

Module-I **[12 hours]**

Overview of Data Communication Networks, Protocols and standards, OSI Reference model, TCP/IP Protocol.

Physical Layer: Analog Signals, Digital Signals, Data Rate Limits, Transmission Impairment, Data rate limit, Digital Transmission: Digital to Digital conversion, Analog to Digital conversion, Transmission modes, Analog Transmission: Digital-to-Analog conversion, Analog-to-Analog conversion, Multiplexing: Frequency Division Multiplexing (FDM), Wave Division Multiplexing (TDM), Transmission Media: Guided Media (Twisted-Pair Cable, Coaxial Cable and Fiber-Optic Cable) and unguided media (wireless), Switching: Circuit Switched network, Datagram Network,Virtual-Curcuit Network.

Module-II **[12 hours]**

Error Detection and Correction

Types of Error, Error Detection mechanism (Linear codes, CRC, Checksum), Error Correction mechanism: Hamming Encoding. Data Link Control and Protocols,: Flow and Error Control, Stop-and-Wait ARP. Go-Back-N ARO, Selective Repeat ARO, HDLC and Point-to-Point

Protocol Multiple Access: Random access (ALOHA, CSMA, CSMA/CD, CSMA/ CA), Controlled Access (Polling, Reservation, Tpken Passing)

Module-III **[6 hours]**

Wireless LANS

IEEE 802.11 and Bluetooth Connecting Devices: Passive Hub, Repeater, Active Hub, Bridge, Two layers Switch, Router, Three layers Switch, Gateway. Virtual Circuit Networks: Frame Relay, Architecture and layers, ATM: Design goals,Architecture and layers.

Module-IV **[8 hours]**

Network Layer: IPV4 addresses, IPV6 addresses, Internet Protocol: Internetworking. IPV4 datagram, IPV6 packet format and advantages, network Layer Protocols: ARP, RARP, IGMP and ICMP, Routing: Unicast Routing Protocols and Multicast Protocols.

Transport Layer: Process to Process Delivery, User Datagram Protocol (UDP) and Transmission Control Protocol (TCP).

Module- V **[8 hours]**

Domain Name System (DNS)

Name Space, Domain Name Space, DNS in Internet, Resolution and Dynamic Domain name System (DDNS), Remote loggong, Electronic mail (SMTP) and file transfer (FTP), WWW: Architecture and Web document.

Course Outcomes:

1. Explain computer network reference models, networking devices and different transmission techniques.
2. Reason the need for flow and error control at the data link layer and explain the associated protocols; enumerate the shared channel access methods, associated protocols and Wired LAN standards and implementations.
3. Explain how network layer, transport layer and application layer facilitates the transfer of message from one node to another in a global network.

Text Books:

1. Data Communication and Networking , Behrouz A. Forouzan, Tata McGraw-Hill, 5th Edition (2013).
2. Computer Networks, A. S. Tannenbum, D. Wetherall, Pearson Education, 5th Edition (2014).
3. Data and Computer Communications, William Stallings, pearson Education, 10th Edition (2018).

Reference Books:

1. Computer Networking, A Top-Down Approach, James F. Kurose, Keith W. Ross, Pearson publication, 6th Edition (2017).
2. http://www.nptelvideos.in/2012/11/computer-networks.html, Prof. Sujoy Ghosh, IIT, Kharagpur.
3. https://nptel.ac.in/courses/106105183/, Prof. Soumya Kanti Ghosh, IIT, Kharagpur.
4. https://www.classcentral.com/course/stanford-openedx-introduction-to-computer- networking-1578, Prof. Philip Levis and Professor Nick McKeown, Stanford University.

Course Code: 19EE5OE03T	Course Name: Smart Grids	L-T-P 3- 0- 0	Credit 3

Course Objectives:

The objectives of the course are to make the students,

1. To understand the basic concepts, components and architecture of smart grid
2. To understand the various measurement technologies in smart grid
3. To educate the importance of renewable energy in smart
4. To know about battery technology and energy storage
5. To brief about role of Electric Vehicles in smart grids

Syllabus

Module-I **[12 hours]**

Introduction to Smart Grid:

Basics of power systems, definition of smart grid, need for smart grid, smart grid domain, enablers of smart grid, smart grid priority areas, regulatory challenges, smart-grid activities in India, differences between traditional grid and smart grid.

Module-II **[7 hours]**

Concept of Microgrids:

Introduction to the concept of microgrid, the overview of the structure and architecture of microgrid with brief control, operational aspects. Recent pilot microgrid projects and their outcomes.

Module-III **[8 hours]**

Control of Smart Power Grid System:

Load Frequency Control (LFC) in Micro Grid System – Voltage Control in Micro Grid System – Reactive Power Control in Smart Grid

Module-IV **[7 hours]**

Energy Storage Systems:

Batteries, Super Conducting Magnetic Energy Storage System, Pumped Hydro, Compressed Air Energy Storage, Flywheel, Ultra capacitors.

Module- V **[8 hours]**

Domain Name System (DNS)

Phasor Measurement Units Importance of PMUs, Phasor Measurement Units and Phasor Data Concentrators Wide Area Monitoring: WAMS concept, data collection, WAMS architecture, Advanced data processing, optimal placement of PMUs.

Course Outcomes:

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

1. Understand the features of Smart Grid.
2. Understand the basic concepts of micro grid and characteristics of energy storage devices.
3. Understand the concepts of Phasor measurements in power system.
4. Analyze the power system behavior using synchronized phasor measurements.

Text Books:

1. Smart Grids, Infrastructure, Technology and Solutions, S. Borlase, CRC Press, 1st Edition, 2013.
2. Microgrids Architecture and control, N. D. Hatziargytiou, IEEE Press Series, John Wiley & Sons Inc, 1st Edition, 2013.
3. Wide Area Monitoring of Interconnected Power Systems, A. R. Messina, IET publisher, 1st Edition, 2015.

Reference Books:

1. Synchronized Phasor Measurements and Their Applications, Arun G. Phadke, James S. Thorp, Springer International Publishing AG 2008, 2nd Edition, 2017.
2. Design of Smart power grid renewable energy systems, Ali Keyhani, Wiley IEEE,2011.
3. The Smart Grid: Enabling Energy Efficiency and Demand Response, Clark W. Gellings, CRCPress, 2009.
4. Smart Grid: Infrastructure, Technology and solutions, Stuart Borlase, CRC Press.
5. Smart Grid: Technology and Applications, Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, Wiley.
6. The Advanced Smart Grid: edge Power Driving, Andres Carvallo, John Cooper, Artech House Publishers July 2011.

Digital Learning Resources:

Course Name	Introduction to Smart Grid
Course Link	https://nptel.ac.in/courses/108/107/108107113/
Course Instructor	Prof. N P Padhy & Prof. Premalata Jena, Department of Electrical Engineering, IIT Roorkee

Course Code: 19CE5OE03T	Course Name: Geo-Environmental Engineering	L-T-P 3- 0- 0	Credit 3

Course Objectives:

1. To know the sub-surface contamination, geo- synthetics types and its application.
2. To gain comprehensive knowledge solid and hazardous waste management.
3. To provide knowledge on contaminant transport.
4. To understand about the remediation techniques.
5. To know the basic concept of Landfill design.

Syllabus

Module-I **[8 hours]**

Introduction: Scope, importance, waste generation, subsurface, contamination, Geo-synthetics: Types of manufacturing functions, applications and economics.

Module-II **[8 hours]**

Solid and Hazardous Waste Management: Classification of waste, Characterization solid wastes, Environmental Concerns with waste, waste management strategies.

Module-III **[8 hours]**

Contaminant Transport: Transport process, Mass-transfer process, Bioremediation, Phytoremediation.

Module-IV **[8 hours]**

Remediation Techniques: Objectives of site remediation, various active and passive methods, Soil washing, Emerging Remediation Technologies.

Module- V **[8 hours]**

Landfills: Types of landfills, Site Selection, Waste Containment Liners, Leachate collection system, Cover system, Gas collection system

Course Outcomes:

After completion of the course the student can

1. Understand surface contamination, geo-synthetic types and its function.
2. Analyze the classification of waste and waste management strategies.
3. Identify contaminant transport mechanisms in soils.
4. Understand the principles of soil treatment techniques
5. Get idea about different landfill concepts.

Text Books:

1. K. R. Reddy and H D Sharma, "*Geoenvironmental Engineering: Site Remediation, waste containment, and emerging waste management technologies*", John Willey , New Jersey, USA
2. R N. Yong, "*Geo Environmental Engineering: Contaminated Ground: Fate of Pollutions and Remediation*"., Thomson Telford , London, UK

Reference Books:

1. L N Reddy and H.I. Inyang, "*Geoenvironmental Engineering: Principles and Applications*", Marcel Dek , New York, USA
2. R. W. Sarsby, "*Environmental Geotechnics*", Thomson Telford , London, UK

Digital Learning Resources:

Course Name	Geo-Environmental Engineering
Course Link	https://nptel.ac.in/courses/105/102/105102160/
Course Instructor	Prof. Manoj Datta, Department of Civil Engineering, IIT Delhi

Course Code: 19EC5OE04T	Course Name: Radar System engineering	L-T-P 3- 0- 0	Credit 3

Course Objectives:

1. To learn the basics of the RADAR fundamentals and familiarization with various components of Transmitter and receiver.
2. To understand the concept of radar signal and its processing techniques under ambiguity conditions.
3. To learn about different types of RADARs and their operational principles.
4. To understand basic detection theory and tracking principles of a Radar systems.

Syllabus

Module-I **[10 hours]**

Introduction to Radar:

Basic radar, maximum unambiguous range, building blocks of radar, simple form of radar equation, Block diagram of Radar transmitter, Radar frequencies, Applications to radar and related Problems.

Radar Equation : Prediction of Range Performance, Minimum Detectable Signal, Receiver Noise and SNR, Integration of Radar Pulses, Radar Cross Section of Targets (simple targets - sphere, cone-sphere), Transmitter Power, PRF and Range Ambiguities, System Losses (qualitative treatment). Related Problems.

Module-II **[8 hours]**

CW and Frequency Modulated Radar:

Range and Doppler Measurement, Block Diagram and Characteristics (Approaching/ Receding Targets), FM-CW altimeter, Measurement Errors, Multiple Frequency CW Radar.

Module-III **[10 hours]**

MTI and Pulse Doppler Radar:

Introduction, Principle, MTI Radar with - Power Amplifier Transmitter and Power Oscillator Transmitter, Delay Line Cancellers – Filter Characteristics, Blind Speeds, Double Cancellation, Staggered PRFs. Range Gated Doppler Filters. MTI Radar Parameters, Limitations to MTI Performance. Non-coherent MTI, MTI versus Pulse Doppler Radar.

Module-IV **[7 hours]**

Tracking Radar:

Tracking with Radar- Types of Tracking Radar Systems, Monopulse Tracking- Amitude Comparison Monopulse (one-and two-coordinates), Phase Comparison Monopulse. Sequential Lobing, Conical Scan Tracking, Block Diagram of Conical Scan Tracking Radar, Tracking in Range, Comparison of Trackers**.**

Module- V **[8 hours]**

Radar Receiver:`

Block Diagram of Radar Receiver & Radar Displays- A-scope and PPI.

Mordern Radars:

Height Finding Radars, Synthetic Aperture Radar, Air borne Radar, Secondary surveillance Radar

Course Outcomes:

1. After completion of the course, the student will be able to
2. Demonstrate the understanding of radar fundamentals and various factors affecting the detection process.
3. Differentiate between various types of radar based on their working principles and field of application.
4. Familiarize with different displays and their applications on real time basis.
5. Analyze radar signals and various building blocks affecting it and also the detection process by applying different target centric tracking principles.

6. Understand the concepts of Phasor measurements in power system.

Text Books:

1. Merrill I. Skolnik, Introduction to Radar Systems, Third Edition, Tata McGraw-Hill,2001, New Delhi.

Reference Books:

1. Radar Principles, Byron Edde, Technology, Applications, First Edition, Pearson Education, 2007, New Delhi.
2. Radar Design Principles, Nathanson, Second Edition, Mc-Graw Hill, 1991, New York.
3. Radar Principles, Peyton Z. Peebles, First Edition, Wiley, 1998, New York.
4. Principles of Modern Radar: Basic Principles, Mark A. Richards, James A. Scheer, William A. Holm. Yesdee, P First Edition, Scitech Publishing, 2013, Raleigh, North California

Digital Learning Resources:

Course Name	Radar System Engineering
Course Link	https://nptel.ac.in/courses/108/107/108107113/
Course Instructor	Prof. N P Padhy & Prof. Premalata Jena, Department of Electrical Engineering, IIT Roorkee

Course Code: 19CS5MC02T	**Course Name:** Essence of Indian Tradition Knowledge	**L-T-P** 1- 0- 0	**Credit** 0

Course Objectives:

1. To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.

2. To make the students understand the traditional knowledge and analyze it and apply it to their day to day life.

Syllabus

Module-I **[8 hours]**

Introduction to traditional knowledge: Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, Indigenous Knowledge (IK), characteristics, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge

Module-II **[6 hours]**

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

Module-III **[8 hours]**

Legal framework and TK: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016.

Module-IV **[8 hours]**

Traditional knowledge and intellectual property: Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge

Module-V **[10 hours]**

Traditional Knowledge in Different Sectors: Traditional knowledge and engineering, Traditional medicine system, TK in agriculture, 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 TK.

Course Outcomes: At the end of the Course, Student will be able to:

1. Identify the concept of Traditional knowledge and its importance.
2. Explain the need and importance of protecting traditional knowledge.
3. Illustrate the various enactments related to the protection of traditional knowledge.
4. Interpret the concepts of Intellectual property to protect the traditional knowledge.
5. Explain the importance of Traditional knowledge in Agriculture and Medicine.

Text Books:

1. Traditional Knowledge System in India, by Amit Jha, 2009.
2. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002.
3. Knowledge Traditions and Practices of India" Kapil Kapoor1, Michel Danino2.

SIXTH SEMESTER					
Theory					
Sl. No.	**Category**	**Course Code**	**Course Title**	**L-T-P**	**Credit**
1	BSC	**19CM6BS01T**	Optimization Engineering	3-1-0	4
2	PCC	**19ME6PC01T**	Design of Machine Elements	3-0-0	3
3	PCC	**19ME6PC02T**	Heat Transfer	3-0-0	3
4	PEC	**19ME6PE01T/** **19ME6PE02T/** **19ME6PE03T/** **19ME6PE04T**	Finite Element Methods; Mechanical Vibration; Tribology; CAD/CAM	3-0-0	3
5	PEC	**19ME6PE05T/** **19ME6PE06T/** **19ME6PE07T/** **19ME6PE08T**	Compressive Flow and Gas Dynamics; Advanced Fluid Mechanics; Industrial Automation and control Total Quality Management	3-0-0	3
6	OEC	**Open Elective – 3 (for Non-ME Students)**			
		19ME6OE01T **19ME6OE02T**	Introduction to Hybrid Vehicle Engineering Materials	3-0-0	3
		Open Elective – 3 (for ME Students)			
		19EE6OE02T/ **19CS6OE01T/** **19CE6OE01T/** **19BS6OE01T**	Introduction to Robotics and Autonomous Vehicle Data Analytics Plastic Waste Management Partial Differential Equation and Numerical Methods	3-0-0	3
				Total Credit (Theory)	**19**

Practical					
1	PCC	**19ME6PC01L**	Design of Machine Elements Lab.	0-0-2	1
2	PCC	**19ME6PC02L**	Heat Transfer Lab.	0-0-2	1
3	HSMC	**19CM6HS01L**	Business Communication and Interview Skills Lab.	0-0-4	2
4	PSI	**19CM6PS01T**	Lab Based Project	0-0-4	2
				Total Credit (Practical)	**6**
				Total Semester Credit	**25**

Course Code: 19CM6BS01T	Course Name: Optimization Engineering	L-T-P: 3- 1- 0	Credit: 4

Course Objectives:

1. To understand the theory of optimization methods and algorithms developed for solving various types of optimization problems.
2. To develop and promote and promote research interest in applying optimization techniques in problems of Engineering and Technology.
3. To apply the mathematical results and numerical of optimization theory to different Engineering problems.

Syllabus:

Module-I: **[8 Hours]**

Idea of Engineering optimization, Classification of optimization Problems, Optimization Problem and Model Formulation. Linear programming: Formulation of LPP, Simplex method, Big-M method, Two-phase Method, Dual Simplex method, Sensitivity analysis in linear programming.

Module-II: **[8 Hours]**

Transportation problems: Finding an initial basic feasible solution by Northwest Corner rule, Vogel's approximation method, Degeneracy, Optimality test, MODI method, Stepping stone method. Assignment problems: Hungarian method for solution of Assignment Problems Integer Programming: Integer Programming, Mixed Integer Programming, Branch and Bound method.

Module-III: **[8 Hours]**

Non-linear programming: Introduction to non-linear programming. Constrained optimization, Multivariable optimization: Method of Lagrange Multipliers, Kuhn-Tucker condition. Unconstraint optimization: Powell's Method, Steepest Descent (Cauchy) Method, Conjugate Gradient (Fletcher-Reeves) Method, Newton's Method.

Module-IV: **[8 Hours]**

Game Theory: Concept, Game models, Two persons zero sum games and their solution, Pure & Mixed Strategy, solution of 2Xn and mX2 games by graphical approach. Decision Theory: Concept, Decision under risk (EMV) & uncertainty.

Module-V: **[8 Hours]**

Queuing models: General characteristics, Markovian queuing model, M/M/1 model, Limited queue capacity, multiple server, Finite sources, Queue discipline.

Text Books:

1. S. S. Rao, Engineering Optimization, New Age International Publications.
2. A. Ravindran, D. T. Philips, J. Solberg, Operations Research- Principle and Practice, Second edition, Wiley India Pvt Ltd.
3. H. A. Taha, A. M. Natarajan, P. Balasubramanie, A. Tamilarasi, Operations Research, Pearson Education, Eighth Edition**.**

Reference Books:

1. S. D. Sharma, Operations Research, Kedarnath Publications.
2. F. S. Hiller, G. J. Lieberman, Operations Research, Tata McGraw Hill.
3. P. C. Biswal, Optimization Engineering, Scitech Publications
4. Prem Kumar Gupta, D. S. Hira, Operations Research, S. Chand Publications.

Course Outcomes:

1. Understand importance of optimization of industrial process management.
2. Apply basic concepts of mathematics to formulate an optimization problem.
3. Analyses and appreciate variety of performance measures for various optimization problems

Course Code:	Course Name:	L-T-P	Credit
19ME6PC01T	Design of Machine Elements	3- 0- 0	3

Course Objectivess:

1. To understand procedure of machine design and develop an ability to apply it for simple component design by using design data hand book.
2. Find out the forces in welded and riveted joints and formulate design solution for size of weld and size of rivet
3. Determine forces on transmission shaft and design of transmission shaft
4. Design different type of bearing and its application.
5. Proficient in design of helical and leaf spring

Syllabus:

Module - I **[8 Hours]**

Mechanical Engineering Design: Introduction to design procedure, Design synethesis and analysis, Aesthetic and ergonomic consideration in design, Manufacturing consideration in design, Stages in design, Code andStandardization, Interchangeability, Preferred numbers, Fits and Tolerances, Engineering materials: Ferrous, Non-ferrous, Non-metals, design requirements – properties of materials, Material selection, Use of Data books.

Fundamentals of Machine Design: Types of load, Modes of failure, factor of safety concepts, Theories of Failure, concept and mitigation of stress concentration, Fatigue failure and curve, endurance limit and factors affecting it, Notch sensitivity, Goodman, Gerber and Soderberg criteria..

Module – II **[8 Hours]**

Design of Joints: Rivets, welds and threaded fasteners based on different types of loading, Boiler joints, cotter joints and knuckle joints.

Module – III **[8 Hours]**

Design of Keys, Shaft and Couplings: Classification of keys and pins, Design of keys and pins, Design of shafts: based on strength, torsional rigidity and fluctuating load, ASME code for shaft design, Design of couplings: Rigid coupling, Flexible coupling.

Module – IV **[8 Hours]**

Bearings: Types and selection of ball and roller bearings, Dynamic and static load ratings, Bearing life, Design of sliding contact bearings, Journal bearing, foot step bearing.

Module – V **[8 Hours]**

Design of Mechanical Springs: Types of helical springs, Design of Helical springs, bulking of spring, spring surge, end condition of springs, Design of leaf springs: nipping.

Text Book:

1. Design of Machine Elements, V. B. Bhandari, TMH, 4th edition, 2017
2. Mechanical Engineering Design, Joseph E. Shigley McGraw-Hill, 3rd edition, 2009

Reference Book:

1. Design Of Machine Members, Alex Valance V.I Doughtie, McGraw-Hill, 3rd edition, 1951
2. Fundamentals of Machine design, Rechard M. Phelan, TMH, 3rd edition, 1970
3. Machine Design, V. L. Maleev and J. B. Hartman, Scranton: International Textbook Co.,3rd edition, 1954
4. Machine Design, Robert L. Norton, Pearson, 5th edition, 2014
5. Machine Design, Black & Adams, Mc Graw-Hill, 3rd edition, 1968

Online Resources:

1. Online course on “Machine Design-1” by Prof. G. Chakraborty and Prof. B. Maiti, Prof. S.K. Roychowdhury , IIT Kharagpur available on NPTEL at https://nptel.ac.in/courses/112/105/112105125/

2. Video course on "Machine Design-1" by Prof. G. Chakraborty and Prof. B. Maiti, Prof. S.K. Roychowdhury , IIT Kharagpur available on NPTEL at https://nptel.ac.in/courses/112/105/112105124/

Course Outcomes:

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

1. Identify basic requirements of machine elements and select materials for engineering design.
2. Design keys, cotters and knuckle joints including riveted, bolted and welded joints.
3. Design the shafts and analyze the buclkling of columns.
4. Develop capability to analyze different type of bearings and its selection for engineering applications.
5. To analyze and design mechanical springs.

Course Code:	Course Name:	L-T-P	Credit
19ME6PC01L	Design of Machine Elements Lab	0- 0- 2	1

Course Objectives:

1. To understand design concept and expand the skill to design machine component.
2. To acquire a skill of design and drafting of standard welded and riveted joint.
3. To understand procedure of machine design and develop an ability to apply it for Cotter Joint Design and Knuckle Joint Design etc. and determine resisting areas against failure.
4. Design and Analysis of shaft subjected to direct and combined loading.
5. To acquire a skill of design and drafting the Bolted joint, Coupling, spring and bearing.

Syllabus:

1. Design of any one working model related to Design of machine elements i.e., Module I and II.

2. Design of any one working model related to Design of machine elements i.e., Module III and IV.
3. Design & drawing of Riveted joint
4. Design and drawing of Cotter joint
5. Design and drawing of Knuckle joint
6. Design of shafts subjected to combined loading
7. Design and drawing of Flange coupling
8. Design of spring
9. Design of bearing

Course Outcomes:

1. Be able to apply design knowledge for Design of Cotter Joint and Knuckle Joint etc and formulate the design procedure and acquire skill of finding resisting areas against failure.
2. Develop Logical and Analytical ability to design of Shaft subjected to direct and combined loading.
3. Be able to apply skill of design and drafting for standard welded and riveted joint as per ISO standard.
4. Develop Logical and Analytical ability to apply Knowledge for design of Shaft subjected to direct and combined loading
5. Able to apply design procedure for designing the Coupling, spring and bearing.

Course Code:	Course Name :	L-T-P	Credit
19ME6PC02T	Heat Transfer	3- 0- 0	3

Course Objectives:

1. Analyze problems involving steady and unsteady state heat conduction in simple geometries applies the same in solving real life problem.
2. Understand the mechanism of convective heat transfer through different geometry.
3. To quantify radiative heat transfer for black, grey body and among different bodies interacting with each other.
4. Design and analyze the heat exchanger based on LMTD (Logarithmic Mean Temperature Difference) and Number of Transfer Units (NTU).
5. Heat transfer with phase change boiling and condensation.

Syllabus:

Module-I **[8 hours]**

Introduction to Heat Transfer: conduction, convection, and radiation, Mechanism & basic laws governing conduction, convection, and radiation heat transfer; Thermal conductivity, Thermal conductance &Thermal resistance, Contact resistance, convective heat transfer coefficient, radiation heat transfer coefficient, Electrical analogy, combined modes of heat transfer. Initial condition and Boundary conditions of 1^{st}, 2^{nd}, and 3^{rd} Kind.

Heat Conduction:

The General heat conduction in Cartesian, polar-cylindrical and polar-spherical coordinates, Simplification of the general equation for one and two dimensional steady/ transient conduction with constant/ variable thermal conductivity with / without heat generation.

Module-II **[8 hours]**

Solution of the one dimensional steady state heat conduction problem in case of plane walls, cylinders and spheres for simple and composite cases. Critical insulation thickness, Heat transfer in extended surfaces (pin fins) without heat generation, Long fin, short fin with insulated tip and

without insulated tip and fin connected between two heat sources. Fin efficiency and fin effectiveness. Conduction in solids with negligible internal temperature gradient (Lumped heat analysis).

Module-III **[10 hours]**

Convective Heat Transfer:

Introduction to Convective Flow - Dimensional analysis of free and forced connective heat transfer. Application of dimensional analysis, Physical significance of non-dimensional numbers. Conservation equations for mass, momentum and energy for 2-D convective heat transfer in case of incompressible flow, Hydrodynamic and thermal boundary layers for flow over a flat plate. Reynolds-Colbourn analogy, Local heat transfer coefficient, Average heat transfer Coefficient. Mechanism of heat transfer during natural and forced convection, Experimental heat transfer correlations for natural and forced convection.

Module-IV **[8 hours]**

Radiative Heat Exchange:

Introduction, Radiation properties, definitions of various terms used in radiation heat transfer; Absorptivity, reflectivity & transmissivity. Emissive power & emissivity, Kirchoff's identity, Planck's relation for monochromatic emissive power of a black body, Derivation of Stefan-Boltzmann law and Wien's displacement law from Planck's relation, Radiation shape factor, Relation for shape factor and shape factor algebra. Heat exchange between black bodies through non-absorbing medium. Gray bodies and real bodies, Heat exchange between gray bodies. Radiosity and Irradiation, Electrical analogy and radiation network for 2-body and 3-body radiations exchange in non-absorbing medium, Radiation shields.

Module-V **[8 hours]**

Heat Transfer for Boiling Liquids and Condensing Vapours:

Types of condensation, use of correlations for condensation on vertical flat surfaces, horizontal tube and; regimes of pool boiling, pool boiling correlations. Critical heat flux, concept of forced boiling. Numerical problems.

Heat Exchangers:

Introduction, Types of heat exchanger, The overall heat transfer coefficient and fouling factors, LMTD and - NTU analysis of heat exchangers.

Text Book:

1. Heat Transfer, Incropera and Dewitt, Willey publications, 6th edition, 2018.
2. Heat Transfer, J.P.Holman, TMH Publications, 10th edition, 2009.

Reference Book:

1. Heat Transfer, P.K. Nag, TMH, 3rd edition, 2011
2. Heat and Mass Transfer: A Practical Approach, Y.A.Cengel, TMH, 3rd edition, 2005.
3. A Textbook on Heat Transfer, S. P. Sukhatme, University Press India Ltd., 4th edition 2005.

Online Resources:

1. Online course on “Heat and Mass transfer” by Prof. Pradip Dutta, IISc Bangalore available on NPTEL at https://nptel.ac.in/courses/112/108/112108149/
2. Video course on “Heat and Mass transfer” by Prof. S.P Sukhatme and Prof. U.N Gaitonde, IIT Bombay available on NPTEL at https://nptel.ac.in/courses/112/101/112101097/

Course Outcomes:

1. Compute temperature distribution in steady-state and unsteady-state heat conduction.
2. Understand and analyze heat transfer through extended surfaces.
3. Interpret and analyze forced and free convection heat transfer.
4. Understand the principles of radiation heat transfer.
5. Design heat exchangers using LMTD and NTU methods.

Course Code:	Course Name:	L-T-P	Credit
19ME6PC02L	Heat Transfer Lab.	3- 0- 0	2

Course Objectives:

1. To understand the concept of composite slab and extended surface
2. Gain the knowledge of natural and Forced convection
3. How emissivity of a surface and Stefan Boltzmann law effects radiation
4. Flow through heat exchanger is a important device for gaining heat transfer concept
5. Understand the boiling heat transfer

Syllabus:

1. Determination of Thermal conductivity of composite slab
2. Determination of Thermal conductivity of composites
3. Determination of heat transfer coefficient in forced convention.
4. Determination of heat transfer coefficient in natural convention.
5. Determination of surface emissivity
6. Performance test on parallel flow heat exchanger
7. Performance test on counter flow heat exchanger
8. Efficiency and effectiveness of fins (Natural / Forced convection)
9. Determination of Critical heat flux during boiling heat transfer.
10. Verification of Stefan Boltzman’s law.

Course Outcomes:

1. Concept of conduction understandable from composite slab and fins.
2. Able to understand natural and forced convection
3. Radiation concept understand with the help of emissivity and Stefan Boltzmann constant
4. Effectiveness of the heat exchanger can be determined.
5. Critical heat flux of fluid during boiling heat transfer can be evaluate

Course Code:	Course Name:	L-T-P	Credit
19ME6PE01T	Finite Element Methods	3- 0- 0	3

Course Objectives:

1. Understanding with the Finite Element Analysis fundamentals.
2. Introduce basic aspects like discretization, interpolation, boundary conditions etc…
3. Formulate the design problems into FEA (Axi-symmetric problems).
4. Solve the heat transfer and fluid flow problems using FEM concept.
5. Use of different FEM software for solving engineering problems

Syllabus:

Module – I **[9 hours]**

Introduction to Finite Element Method: General description of the finite element method. Boundary conditions: homogeneous and non-homogeneous for structural, heat transfer and fluid flow problems. Potential energy method, Rayleigh Ritz method, Galerkin's method, Displacement method of finite element formulation. Convergence criteria, Discretization process, Types of elements: 1D, 2D and 3D, Node numbering, Location of nodes. Strain displacement relations, Stress strain relations, Plain stress and Plain strain conditions, temperature effects.

Module – II **[9 hours]**

Interpolation Models: Simplex, complex and multiplex elements, linear interpolation polynomials in terms of global coordinates 1D, 2D, 3D Simplex Elements.

One-Dimensional Elements-Analysis of Bars and Trusses, Linear interpolation polynomials in terms of local coordinate's for 1D, 2D elements. Higher order interpolation functions for 1D quadratic and cubic elements in natural coordinates, , , Constant strain triangle, Four-Nodded Tetrahedral Element (TET 4), Eight-Nodded Hexahedral Element (HEXA 8), 2D Isoperimetric element, Lagrange interpolation functions, Numerical integration: Gaussian quadrature one point, two point formulae, 2D integrals. Fore terms: Body force, traction force and point loads

Module – III **[9 hours]**

Numerical Problems: Solution for displacement, stress and strain in 1D straight bar, stepped bars and tapered bars using elimination approach and penalty approach, Analysis of trusses.

Axi-symmetric Solid Elements: Derivation of stiffness matrix of axisymmetric bodies with triangular elements, Numerical solution of axisymmetric triangular element(s) subjected to point loads.

Module – IV **[9 hours]**

Heat Transfer: Basic equations of heat transfer: Energy balance equation, 1D finite element formulation using variational method, Problems with temperature gradient and heat fluxes, heat transfer in composite sections, straight fins.

Fluid Flow: Flow through a porous medium, Flow through pipes of uniform and stepped sections.

Module – V **[9 hours]**

Dynamic Considerations: Formulation for point mass, Consistent element mass matrix of one dimensional bar element, truss element, lumped mass matrix of bar element, truss element.

Modeling and Simulation: Preprocessing and post processing. Exposure to commercial FE codes such as ANSYS, NASTRAN and IDEAS etc.

Text Book:

1. Finite Elements in Engineering, T.R.Chandraputla and A.D.Belegundu, PHI, 4th edition, 2011
2. The Finite Element Method – Its Basis & Fundamentals, Zienkiewicz, Taylor and Zhu, Elsevier, 6th edition, 2013

Reference books:

1. Introduction to Finite Element Method, A numerical method for Engineering Analysis, C.Desai and J.F.Abel, CBS publishers, 2005.
2. Introduction to Finite Element Method, J.N.Reddy, TMH Publications, 4th edition, 2020.
3. Numerical Methods in Finite Element Analysis, K.J.Bathe and E.L.Wilson, PHI, 2nd edition, 2014.
4. Concepts & Applications of Finite Element Analysis,Cook, D.S.Malkus&M.E.Plesha, Wiley, 4th edition, 2001.
5. The Finite Element Method in Engineering, S. S. Rao, Elsevier, 5th edition, 2010.
6. A First Course in the Finite Element Method, D.L.Logan, Cengage Learning, 5th edition, 2010.

Online Resources:

1. Online course on “Finite Element Method” by Prof. P.M.Dixit, IISc Kanpur available on NPTEL at https://nptel.ac.in/courses/112/104/112104116/
2. Video course on “Finite Element Method” by Prof. C.S. Upadhyay and Prof. U.N Gaitonde, IIT Kanpur available on NPTEL at https://nptel.ac.in/courses/112/104/112104115/

Course Outcomes:

1. To understand Formulation of elemental stiffness matrix and load vector for Plane stress/strain such as Linear Strain Rectangle (LSR), Constant Strain Triangles (CST), Pascal’s triangle, primary and secondary variables, properties of shape functions.
2. To use 1-D and 2D element stiffness matrices and load vectors from various methods to solve for displacements and stresses calculations.
3. To understand steady state heat transfer formulation of 1D element conduction.
4. Predict finite element equations for axi-symmetric bodies.
5. Students will do job as a CAE Engineer in industry and understand and solve complex problem using different CAE software’s.

Course Code:	Course Name:	L-T-P	Credit
19ME6PE02T	Mechanical Vibration	3- 0- 0	3

Course Objectives:

1. Understand the basic concepts and behavior of vibrations in machines.
2. Understand the fundamental to Mechanical Free Undamped and damped Vibration and review single degree of freedom.
3. Understand the determination of frequencies and other parameters in forced vibration systems
4. To conversant for development of differential equation or equation of motion for nonlinear vibrating system.
5. To Set up and solve eigenvalue problems for determining natural frequencies and mode shapes for continuous system.

Syllabus:

Module – I **[9 Hours]**

Introduction & Importance of Mechanical Vibration: Brief history of Mechanical Vibration, Types of Vibration, Simple Harmonic Motion (S.H.M.), and Principle of superposition applied to S.H.M., Beats, Fourier analysis, and Concept of degree of freedom for different vibrating systems.

Undamped Free Vibration of Single Degree Freedom Systems: Modeling of Vibrating Systems, Evaluation of natural frequency – differential equation, Energy & Rayleigh's methods, Equivalent systems.

Module – II **[9 Hours]**

Damped Free Vibration of Single Degree Freedom Systems: Different types of damping, Equivalent viscous damping, structural damping, Evaluation of damping using free and forced Vibration technique, Concept of critical damping and its importance, study of vibration response

of viscous damped systems for cases of under damping, critical damping and over damping, Logarithmic decrement.

Module – III **[9 Hours]**

Forced Vibration of Single Degree Freedom Systems: Steady state solution with viscous damping due to harmonic force, Reciprocating and rotating unbalance mass, vibration isolation and transmissibility due to harmonic force excitation and support motion. Vibration measuring instruments – vibrometer and accelerometer. Whirling of shaft with single disc and without damping, Concept of critical speed and its effect on the rotating shaft.

Module – IV **[9 Hours]**

Undamped Vibration of Two Degree Freedom Systems: Free vibration of spring coupled and mass coupled systems, Longitudinal, Torsional and transverse vibration of two degree freedom systems, influence coefficient technique, Undamped vibration Absorber.

Module – V **[9 Hours]**

Introduction to Multi-Degree Freedom Systems: Normal mode vibration, Co-ordinate coupling-close coupled and far coupled systems, Orthogonality of mode shapes, Methods of matrix iteration, Holzer's method and Stodola method. Torsional vibration of two, three and multi-rotor systems. Dunkerley's lower bound approximate method.

Continuous Systems: Vibration of strings, longitudinal vibration of rods, Torsional vibration of rods, Transverse vibration of Euler-beams.

Text Book:

1. Theory of Vibration with Applications, W. T. Thomson and Marie Dillon Dahleh, Pearson Education, 5th edition, 2007.
2. Mechanical Vibrations, S. S. Rao, Pearson Education Inc, 4th edition, 2003

Reference Book:

1. Mechanical Vibrations, V. P. Singh, Dhanpat Rai & company Pvt. Ltd. 3rd edition, 2006

2. Elements of Vibration Analysis, Leonard Meirovitch, TMH Publications, Special Indian edition, 2007
3. Mechanical Vibrations, S. Graham Kelly, Schaum's outline series, TMH Publications, Special Indian edition, 2007

Online Resources:

1. Video course on "Introduction to Mechanical Vibration" by Prof. Anil Kumar , IIT Rookee available on NPTEL at https://nptel.ac.in/courses/112/107/112107212/

Course Outcomes:

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

1. Explain the concepts of mechanical vibrations and undamped vibrations.
2. Develop the mathematical model of Damped vibrations.
3. Demonstrate the response of Forced Vibrations for single degree of freedom system.
4. Describe the concept of vibration in undamped two degree of freedom systems.
5. Discuss the Multi-degree of freedom and continuous vibration systems

Course Code:	Course Name:	L-T-P	Credit
19ME6PE03T	Tribology	3- 0- 0	3

Course Objectives:

1. Understand the concept of tribology for applying lubrication in bearings and other machine elements.
2. Design the tribological systems consisting bearings.
3. Apply modern technologies of surface texturing for performance improvements of bearings
4. Derive governing equations of all types of bearings using knowledge of fluid mechanics.
5. Solve General Reynolds equation for lubrication problems using FDM.

Syllabus:

Module – I **[8 Hours]**

Function and Requirements of Lubrication System: Lubricant and lubrication, Types of bearings, properties and testing of lubricants, Basic equations: Generalized Reynolds equation, Flow and Shear Stress, Energy equation, Equation of state

Module – II **[8 Hours]**

Hydro Dynamic Lubrication: Mechanism of pressure development and load carrying capacity, Plane-slider bearing, Idealized slider bearing with a pivoted shoe, Step bearing, Idealized journal bearing. – Infinitely long journal bearing, Petroffs equation for a lightly loaded bearing, narrow bearing.

Module – III **[8 Hours]**

Oil Flow and Thermal Equilibrium: Heat transfer analysis of Hydrostatic Bearing: Principles, Component of hydrostatic lubrication, Hydrostatic circular thrust bearing, calculation of pressure, load carrying capacity, flow rate, power loss in bearing due to friction.

Module – IV **[8 Hours]**

Lubrication in Bearing: Concept of gas lubricated bearing, Concept of Elasto-hydrodynamic lubrication, Design and selection of anti-fiction bearing, types of bearings

Module – V **[8 Hours]**

Friction and Wear of Metals: Theories of friction, surface contaminants, Effect of sliding speed on friction, Classification and mechanism of wear, Wear resistant materials.

Text Book:

1. Introduction to Tribology of Bearing, B. C. Majumdar, S. Chand & Co, 2010.
2. Fundamentals of Tribology, S. K. Basu, A. N. Sengupta, B. B. Ahuja, PHI, 1st edition, 2006.

References:

1. Basic Lubrication Theory, A. Cameron, John Wiley & sons, 2nd edition, 1977.
2. Theory and Practice of Lubrication for Engineers, D. Fuller, New York company, 3rd edition 1998
3. Principles and Applications of Tribology, D. F. Moore and D. W. Hopkins,Amsterdam: Pergamon press, 2013.

Online Resources:

1. Online course on “Tribology” by Dr. Harish Hirani, IIT Delhi available on NPTEL at https://nptel.ac.in/courses/112/102/112102015/
2. Video course on “Tribology” by Dr. Harish Hirani, IIT Delhi available on NPTEL at Kanpur available on NPTEL at https://nptel.ac.in/courses/112/102/112102014/

Course Outcomes:

At the end of the course, a student should be able to:

1. Explain the basic concepts of bearing friction, wear, and lubrication
2. Describe the hydro-dynamics lubrication system.
3. Analysis of heat transfer and power loss in bearing.

4. Demonstrate the gas lubrication in bearings.
5. Study the phenomenon of Friction and wear metals.

Course Code:	Course Name:	L-T-P	Credit
19ME6PE04T	CAD/CAM	3- 0- 0	3

Course Objectives:

The objective of the course is to enable students to:

1. Provide basic foundation in computer aided design / manufacturing.
2. Get acquainted with the basic CAD software designed for geometric modeling.
3. Learn working principles of NC machines CNC control and part programming.
4. Understand CNC programming using M-code and G-code.
5. Understand concept of different advanced manufacturing systems like CNC, DNC, CIMS, lean manufacturing etc…

Syllabus:

Module – I **[8 Hours]**

CAD: Need of machine design, use of computer, computer fundamentals, computer aided design process, CAD configuration, and CAD tools, advantage and disadvantage of CAD, CAD and CAM integration.

Newer Techniques of CAD: Adaptive control- definition, meaning, block diagram, sources of variability and applications.

Flexible Manufacturing System (FMS) - concept, evaluation, main elements and their functions, layout and its importance, applications

Module – II **[8 Hours]**

Computer Graphics Software and Database: Configuration, Graphics Packages, Constructing the Geometry, Transformations of geometry, Database structure and content, Wire frame versus solid modeling, Constraint– Based modeling, Geometric commands, Display control commands, Editing.

Module – III **[8 Hours]**

CAM: Numerical Control, Numerical Control elements, NC Coordinate system, NC motion control system, Manual and Computer Aided programming, the APT language, Miscellaneous Functions, Advanced part-programming methods.

Module – IV **[8 Hours]**

CNC Part Programming: Definition and importance of various, positions like machine zero, home position, and work piece zero and program zero, G and M codes for turning and milling-meaning and applications of important codes. Practice of simple and complex part programming in turning and milling.

Module – V **[8 Hours]**

Comparison of Conventional NC, NC Technology: CNC, DNC, Combined DNC/ CNC system, Adaptive control manufacturing systems, Computer Integrated Manufacturing system, Machine Tools and related equipment, Materials Handling system: AGV, Robots, Lean manufacturing.

Test Book:

1. M. P. Groover, W. E. Zimmer, CAD/CAM: computer aided design and manufacturing, Prentice Hall, 1st edition, 2011.
2. I. Zeid, CAD / CAM Problem & Practice, TMH Publications, 3rd edition, 2001.

Reference Books:

5. P. N. Rao, CAD/CAM Principles & Applications, TMH Publications, 3rd edition, 2010.
4. A. M. Kuthe, Computer Graphics Including CAD, AutoCAD & C, S. Chand Publications, 1st edition, 2005

Online Resources:

1. Online course on "Computer Aided Design and Manufacturing" by Prof. Anoop Chawla, IIT Delhi available on NPTEL at https://nptel.ac.in/courses/112/102/112102101/

2. Online course on "Computer Aided Design and Manufacturing" by Prof. P.V. Madhusdan Rao, IIT Delhi available on NPTEL at https://nptel.ac.in/courses/112/102/112102103/
3. Video course on "Computer Aided Design and Manufacturing" by Prof. Anoop Chawla, Prof. P. V. Madhusdan Rao, IIT Delhi available on NPTEL at Kanpur available on NPTEL at https://nptel.ac.in/courses/112/102/112102101/

Course Outcomes:

After successful completion of this course student should be able to:

1. Describe basic concepts of CAD with its application in recent technology.
2. Explain the concept of geometrical transformation, database and its application.
3. demonstrate a basic and advanced understanding of numerical controlled (NC) programming strategies
4. Develop CNC program using M-code and G-codes for specific applications.
5. Describe the different advanced manufacturing systems.

Course Code:	Course Name:	L-T-P	Credit
19ME6PE05T	Compressive Flow and Gas Dynamics	3- 0- 0	3

Course Objectives:

1. Conservation laws, propagation of disturbances, isentropic flow, compressible flow in ducts with area changes.
2. Normal and oblique shock waves and applications, Prandtl-Meyer flow and applications,
3. Flow characteristics of variable flow in a nozzle can be determine,
4. Simple flows such as Fanno flow and Rayleigh flow with applications to nozzles, and propulsion related concepts.
5. The method of characteristics will be described in one dimensional unsteady isentropic flow.

Syllabus:

Module-I **[8 hours]**

Fundamentals of compressible flow: Ideal gas relationship, The adiabatic energy equation, Mach number and its significance, Mach waves, Mach cone and Mach angle, static and stagnation states, relationship between stagnation temperature, pressure, density and enthalpy in terms of Mach number, stagnation velocity of sound, reference speeds, various regions of flow, Effect of Mach number on compressibility, Area velocity relationship

Module-II **[8 hours]**

One Dimensional Isentropic flow: General features of isentropic flow, performance curve, Comparison of adiabatic and isentropic process, One dimensional isentropic flow in ducts of varying cross-section- nozzles and diffusers, operation of nozzles under varying pressure ratio, mass flow rate in nozzles, critical properties and choking, area ratio as function of Mach number, Impulse function, non-dimensional mass flow rate in terms of pressure ratio, area ratio and Mach number, Working charts and gas tables, Application of Isentropic flow

Module-III **[8 hours]**

Normal shock Waves: Development of shock wave, Thickness of shock wave, governing equations, Strength of shock waves, Prandtl-Mayer relation, Rankine-Hugoniot relation, Mach number in the downstream of normal shock, variation of flow parameters across the normal shock, normal shock in Fanno and Rayleigh flows, impossibility of a rarefaction shock, supersonic diffusers, supersonic pitot tube

Module-IV **[8 hours]**

Flow in constant area duct with friction (Fanno flow): Fanno curve and Fanno flow equations, solution of Fanno flow equations, variation of flow properties, variation of Mach no. with duct length, isothermal flow in constant area duct with friction, tables and charts for Fanno flow, Experimental friction coefficients.

Module-V **[8 hours]**

Flow in constant area duct with heat transfer (Rayleigh flow): Simple heating relation of a perfect gas, Rayleigh curve and Rayleigh flow equations, variations of flow properties, maximum heat transfer, tables and charts for Rayleigh flow

Text Book:

1. Fundamental of Compressible flow With Aircraft And Rocket Propulsion, S. M. Yahya, New age international Publication, 6th edition, 2018
2. Fundamentals of compressible fluid dynamics, P. Balachandran, PHI Learning Pvt. Ltd., 2006
3. The dynamics and thermodynamics of Compressible fluid low Volume-I, Ascher H. Shapiro, Wiley, 1st edition, 1991
4. Gas Dynamics, E. Rathakrishnan, PHI Learning Pvt. Ltd, 7th edition, 2020
5. Compressible Fluid Flow, P. H. Oosthuizen and W. E. Carscallen, NY, McGraw-Hill, 1st edition 1997.

Reference Books:

1. Elements of Gas Dynamics, H. W. Liepmann, and A. Roshko, Dover Pub, 1st edition 2001
2. Compressible Fluid Flow, M. A. Saad, Upper Saddle River, NJ: Prentice-Hall, 2nd edition, 1993.
3. Viscous Fluid Flow , F. M. White, New York: McGraw-Hill, 2nd edition, 1991.

Online Resources:

1. Online course on "Gas Dynamics" by Dr. Vinayak Kulkarni, IIT Guwahati available on NPTEL at https://nptel.ac.in/courses/112/103/112103021/
2. Video course on "Gas Dynamics" by Prof. A. Sameen, IIT Madras available on NPTEL at Kanpur available on NPTEL at https://nptel.ac.in/courses/112/106/112106196/

Course Outcomes:

1. Understand the basic concept of Gas Dynamics.
2. Understand Behavior of Gas under various conditions.
3. Use the Gas tables
4. Understand basics of compressible flow
5. Correlate fundamentals of Gas Dynamics with various mechanical systems

Course Code:	Course Name:	L-T-P	Credit
19ME6PE06T	Advanced Fluid Mechanics	3- 0- 0	3

Course Objectives:

1. The course provides the elements to understand the basic tools for the analysis and solution of different types of flows, from the ideal to the viscous flow.
2. The various types of fluid flow of solutions of N-S equation
3. The course provides the numerical results for different applications of N-S equation.
4. The students will be able to understand and assimilate of hydrodynamics of lubrication.
5. The students will develop practical skills to work and develop analysis of diverse problems related problems.

Syllabus:

Module-I: **[8 hours]**

Definition of a Fluid: Concept of Continuum, Body and surface forces, stress tensor, Scalar and vector fields, Eulerian and Lagrangian description of flow. Motion of fluid element - Translation, Rotation and Vorticity; Strain rate tensor, continuity equation, stream function and velocity potential.

Module-II: **[8 hours]**

Transport Theorems: constitutive equations, derivation of Navier Stokes equations for compressible flow. Exact solutions of Navier Stokes equations: plane Poiseuille flow and Couette flow, Hagen-Poiseuille flow

Module-III: **[8 hours]**

Application of Navier Stokes equations: Flow between two concentric rotating cylinders, Stoke's first and second problem, Hiemenz flow, flow near a rotating disk, flow in convergent-divergent channels. Slow viscous flow: Stokes and Oseen's approximation

Module-IV: **[8 hours]**

Theory of Hydrodynamic Lubrication: Boundary layer: derivation, exact solutions, Blasius, Falkner Skan, series solution and numerical solutions.

Module-V: **[8 hours]**

Turbulent Flow: Description of turbulent flow, velocity correlations, Reynold's stresses, Prandtl's Mixing Length Theory, Karman's velocity defect law, universal velocity distribution.

Text Books:

1. Advanced Fluid Mechanics, S. K. Som and G. Biswas, TMH Publications, Revised 2nd edition, 2010.
2. Fluid Mechanics, A. K. Mohanty, PHI Publications, 2nd edition, 1994

Reference Books

1. Fluid Mechanics, F. M .White, TMH Publications, 8th edition, 2016.
2. Fluid Mechanics, Yunus A. Cengel and John M. Cimbala, TMH Publications, 4th edition, 2017.

Online Resources:

1. Video course on “Advance Fluid Mechanics” by Prof. Suman Chakraborty, IIT Kharagpur available on NPTEL at Kanpur available on NPTEL at https://nptel.ac.in/courses/112/105/112105218/

Course Outcomes:

1. Describe and deduce the potential flow equations and solve them for simplified cases select the appropriate boundary conditions.
2. Formulate the equations of fluid motion for compressible and incompressible Newtonian fluids

3. Write a problem in dimensionless form and select the appropriate dimensionless numbers with the application of N-S equation.
4. Basic knowledge of hydrodynamics lubrication theory will be gain
5. Learning detailed information regarding turbulent flow

Course Code:	Course Name:	L-T-P	Credit
19ME6PE07T	Industrial Automation and Control	3- 0- 0	3

Course Objectives:

1. To understand the importance of automation in the of field machine tool based manufacturing.
2. To get the knowledge of data acquisition and control in industrial environments, issues encountered and ways to mitigate them, ensuring reliability by redundancy.
3. To get the knowledge of various elements of manufacturing automation – sensors, drives and their control, pneumatics, hydraulics and CNC
4. To understand the concepts of automation using robots, automation of material handling using computer based tools, use of computation to model and simulate the process to reduce in-process inventory.
5. To get the knowledge of various off-the shelf automation systems hardware and communication protocols to automate processes at minimized cost.

Syllabus:

Module-I: **[8 hours]**

Introduction: Evolution of Industry 4.0 and requirement of plant automation, Types of plant automation: fixed, programmable and flexible. Level of automation, Different systems for Industrial automation: PLC, HMI, SCADA, DCS and Drives. Advantages and challenges in factory automation. Characteristics of measurement systems (accuracy, precision, repeatability, range, scaling, level).

Module-II: **[8 hours]**

Data acquisition and Control: Analog and digital data acquisition (ADC/DAC), Control system : linear and adaptive feedback control systems, feed forward control ratio, adaptive control, PID algorithm: parameters and tuning. Basics of comparator circuitry (Opamp, Gain). Transmission and logging of measured data (analog vs digital, RF/EM interference). Cloud infrastructure for

industrial automation and control (comparison of latency, redundancy, reliability and availability, cost).

Module-III: **[8 hours]**

Plant automation and Process control:

FMS, Sequence control, Scan control, RRL program, Electric drives (types, functions, characteristics, four quadrant operation), Pulse Width Modulation, Flow control valves, AC and DC drive controls. Variable Frequency Drives, Direct torque control, linear and rotary actuators, Industrial hydraulic and pneumatic circuit.

Module-IV: **[8 hours]**

Robotic automation: Commercial robotic platforms (Configuration, degrees of freedom, application area), Robotic Process Automation (RPA), training of robots, Process route modeling, Optimization techniques, Introduction to process simulation software (Anylogic, GFDL, FlexSim, Siemens PLM, Simio etc.)

Automated Material handling: Assembly, Flexible fixturing.; Sorting, grading and labeling systems; Computer vision systems for material tracking and quality control (multispectral vision), basic algorithms for object detection and classification in images and videos. Types of sensors for material tracking. Queuing system and in-process inventory. JIT scheduling (introduction only).

Module-V: **[8 hours]**

Affordable automation solutions: Common PLCs, components and accessories, comparison of features. IO modules, RTUs. Micro-controllers, Single board computers: Raspberry Pi, ESP, Intel NUC, NVIDIA Jetson, Beaglebone, Arduino. IP rating and EMC rating of enclosures.

Communication tools and protocols: Zigbee, Fieldbus, CANbus, ProfiBus, MODBus, Serial (RS-232, RS-485), I2C, GPRS, LoRa etc.

Text Books:

1. Automation, Production Systems, and Computer-integrated Manufacturing, Mikell P. Groover, PHI Publications, 4th edition, 2016.
2. Manufacturing – Engineering and Technology, Serope Kalpakjian and Steven R. Schmid, Pearson Publications, 7th edition, 2013.

Reference Books

1. Computer control of manufacturing system, Yoram Koren, Mc Graw Hill India,1st edition, 2007.
2. CAD/CAM : Theory & Practice, Ibrahim Zeid, Mc Graw Hill Education, 2nd edition. 2009.

Online Resources:

1. Online course on “Mechatronics and Manufacturing Automation” by Dr. Shrikrishna N. Joshi, IIT Guwahati available on NPTEL at https://nptel.ac.in/courses/112/103/112103174/
2. Video course on “Mechatronics and Manufacturing Automation” by Dr. Shrikrishna N. Joshi, IIT Guwahati available on NPTEL at https://nptel.ac.in/courses/112/103/112103293/
3. Video course on “Manufacturing Automation” by Prof. Sounak Kumar Choudhury, IIT Kanpur available on NPTEL at https://nptel.ac.in/courses/112/104/112104288/

Course Outcomes:

Upon completion of this course, the students:

1. A comprehensive picture of computer-based automation of manufacturing operations.
2. Will be familiar with various automation technologies in manufacturing and process industries.
3. Will implement various control and automation method in process industries.
4. Will be able to apply PLC programming and implement it on PLC kits

5. Will be able to design and implement electro-pneumatic/hydraulic solutions for automated systems.

Course Code:	Course Name:	L-T-P	Credit
19ME6PE08T	Total Quality Management	3- 0- 0	3

Course Objectives:

1. Understand the historical perspective of quality management, basics of feedback-based quality assessment and control.
2. Learn about principles, tools and techniques for TQM implementation in an organization.
3. Learn about traditional and modern tools for quality control of product or service delivery.
4. Learn techniques to implement TQM at workplace (production or services based).
5. Learn about quality certifications for product, production, environment and personnel.

Syllabus:

Module-I: **[8 hours]**

Introduction: Definition of quality, need for quality, product quality and service quality; Evolution of quality, Quality statements, Customer perception of quality, customer orientation & satisfaction, customer complaints, customer retention; costs to quality. Basic concepts of TQM, TQM framework, contributions of Deming, Juran and Crosby. Barriers to TQM

Module-II: **[8 hours]**

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; PDCA cycle, 5S, Kaizen; Supplier partnership, Partnering, Supplier rating & selection.

Module-III: **[8 hours]**

Traditional Tools of Quality: The seven traditional statistical tools of quality; New management tools; Six sigma- concepts, methodology, applications to manufacturing, service

sector including IT, Benchmarking of process; Failure Mode and Effects Analysis (FMEA) - stages, types.

Module-IV: **[8 hours]**

Total Quality Management Tools and Techniques: Process capability, Steps to achieve six sigma quality level, Quality Function Deployment (QFD), Taguchi quality loss function; TPM-concepts, improvement needs, performance measures. Reliability concepts: definition, reliability of series and parallel systems, product life characteristics curve. Total productive maintenance. Terotechnology, POKA YOKE

Module-V: **[8 hours]**

Quality Systems: Standardization and benchmarking. 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. Personnel certification for implementation of quality (PMP, TQM certifications).

Text Books:

1. Total Quality Management, D. H. Besterfield, et al., Pearson Education Asia, 3rd edition, 2006.
2. The management and Control of Quality, J. R. Evans and W. M. Lindsay, Cengage Learning, 8th edition, 1st Indian edition, 2012.

Reference Books:

1. Total Quality Management, B. Janakiraman and R. K. Gopal, Prentice Hall India, 1st edition, 2006.
2. Total Quality Management, L. Suganthi and A. Samuel, Prentice Hall India Pvt. Ltd., 2006.

Online Resources:

1. Online course on "Total Quality Management" by Prof. Raghunandan Sengupta, IIT Kanpur available on NPTEL at https://nptel.ac.in/courses/110/104/110104080/

Course Outcomes:

Upon completion of this course, the students will get:

1. Implement TQM in industries
2. Manage quality improvement teams
3. Will develop thinking towards Quality systems.
4. Will know about customer satisfaction through defined quality processes.
5. Will be able to reduce costs and better cost management.

Course Code:	Course Name:	L-T-P	Credit
19ME6OE01T	Introduction to Hybrid Vehicle	3- 0- 0	3

Course Objectives:

1. Understand the basic functional blocks of a modern vehicle, need for and degree of hybridization.
2. Analyze various drives suitable for electric and hybrid electric vehicles.
3. Learn about electric propulsion unit and design considerations of EVs and hybrids.
4. Discuss different energy storage technologies used for hybrid electric vehicles and their control.
5. Learn about Energy Management Strategies used in electric vehicles and hybrid vehicles.

Syllabus:

Module-I: **[8 Hours]**

Basics of Modern Vehicles: History of hybrid and electric vehicles. Societal and environmental importance of fuel, electric and hybrid vehicles. Degrees of hybridization.

Conventional Vehicles: Features and sub-systems in a modern vehicle, Motion and dynamics equations for vehicles, Basics of vehicle performance, vehicle power source characterization, transmission characteristics and mathematical models to describe vehicle performance.

Module-II: **[8 Hours]**

Electric vehicle drive-trains: Basic concept of electric traction, Electric drive-train topologies and power flow analysis, electric components used in EVs, Configuration and control of DC Motor drives, induction motor drives, permanent magnet motor drives, switched reluctance motor drives. Drive system efficiency.

Hybrid vehicle drive trains: Basic concept of hybrid traction, degree of hybridization, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, energy efficiency analysis.

Module-III: **[8 Hours]**

Power for Propulsion: Resistance to motion, rolling resistance, air resistance, gradient resistance, power required for propulsion, tractive effort and traction, road performance curves.

Design consideration for EV chassis and body: Modularity in chassis, NVH level requirements, IP rating of drive train, configuration of traction device for damping,

Module-IV: **[8 Hours]**

Energy Storage: Introduction to energy storage requirements in hybrid and electric vehicles, Battery based energy storage and its analysis (charge-discharge rate and cycles limit), Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices, Regenerative braking, AC-DC converter.

Module-V: **[8 Hours]**

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification and comparison of different energy management strategies, implementation issues of energy management strategies. Challenges in battery charging / swapping infrastructure. Grid connected energy transfer, wireless energy transfer.

Case Studies: Design of a Plug-in Hybrid Electric Vehicle (PHEV), Design of a Battery Electric Vehicle (BEV), Design of Series-Parallel HEV Drive train

Text Books:

1. Electric and Hybrid Vehicles: Design Fundamentals, I. Husain, CRC Press, 2nd edition, 2010.
2. Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, Mehrdad Ehsani, Yimin Gao, Stefano Longo and Kambiz Ebrahimi, CRC Press, 3rd edition, 2018.
3. Electric Vehicle Technology Explained, James Larminie, John Lowry, Wiley, 2nd edition, 2012.

Reference Books:

1. Vehicular Electric Power Systems, A. Emadi, M. Ehsani and Jihn M. Miller, CRC Press, 1st edition, 2003.
2. Electric Vehicles: Prospects and Challenges, James Larminie and John Lowry, Wiley, 2nd edition, 2012.
3. Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Sheldon S. Williamson, Springer, 2013.

Online Resources:

1. Online course on “Introduction to Hybrid and Electric Vehicles” by Dr. Praveen Kumar and Prof. S. Majhi, IIT Guwahati available on NPTEL at https://nptel.ac.in/courses/108/103/108103009/
2. Video Course on “Electric Vehicles” by Prof. Amit Kumar Jain, IIT Delhi available on NPTEL at https://nptel.ac.in/courses/108/102/108102121/

Course Outcomes:

1. Demonstrate the working of electric and hybrid electric vehicles.
2. Choose a suitable drive scheme for developing an electric hybrid vehicle depending on resources.
3. Design and develop the propulsion system of electric vehicles and hybrid electric vehicles.
4. Choose proper energy storage systems for vehicle applications.
5. Analyze and model the power management systems for electric and hybrid vehicles.

Course Code:	Course Name:	L-T-P:	Credit:
19ME6OE02T	Engineering Materials	3:0:0	3

Course Objectives:

1. To acquaint students with the basic concepts and properties of Material Science
2. To impart a fundamental knowledge of Engineering materials.
3. Understand the structure-property relationship in materials.
4. To understand some of the binary phase diagrams of commonly used alloy systems.
5. To develop futuristic insight into Materials used in construction, electronics and biomedical engineering domains.

Syllabus:

Module -I

[8 Hours]

Properties and Characteristics of Engineering Materials: properties of materials. Characteristic property of metals, bonding in solids, primary bonds like ionic, covalent and metallic bond, crystal systems, common crystal structure of metals, representations of planes and directions in crystals, atomic packing in crystals, calculation of packing density, voids in common crystal structures and imperfections in crystals

Module - II

[8 Hours]

Performance of Metals: Critical resolve shear stress, dislocation theory, deformation by slip and twin, plastic deformation in polycrystalline metals, yield point phenomenon and related effects, concept of cold working preferred orientation. Annealing, recovery; recrystallization and grain growth; hot working. fatigue failure, effect of hysteresis.

Concept of alloy formation, types of alloys, solid solutions, factors governing solids solubility viz. size factor, valency factor, crystal structure factor and chemical affinity factor; order-disorder transformation.

Module - III

[8 Hours]

Binary phase diagrams of common alloy systems: (a) Isomorphism system, (b) Eutectic system, (c) Peritectic system, (d) Eutectoid system and (e) Peritectoid system. Allotropic transformation. Lever rule and its application, Interpretation of solidification behaviors and microstructure of different alloys belonging to those systems (Fe-Fe3C, Pn-Sn, Cu-Zn-Sn). Effect of non-equilibrium cooling, coring and homogenization.

Module - IV **[8 Hours]**

Materials for specific uses: High melting and low melting solder and brazing filler, conductive ink, conductive tape, masking layers, paints and coatings for oxidation and UV protection (Red oxide, silicone, wax, resin), braided copper desoldering wick, resin flux and liquid flux, materials for flexible PCB, materials and profiles for heat dissipation, thermal barrier coatings, functionally graded materials (sandwiched panels for thermal insulation, graded profiles for sound and vibration isolation etc.). Shape memory alloys, Composites, materials for magnetic cores. Introduction to Semiconductor materials (Si, Ge, GaAs, GaN, SiC) and availability. Introduction to energy storage materials, performance comparison and availability.

Module -V

[8 Hours]

1. **Polymer:** Uses, thermosetting and thermoplastics. Ceramics: Types, structure, Mechanical properties, Composite materials: properties and application of composite materials. Reinforced Materials: Reinforced Concrete. Fiber reinforced plastics, Properties of composites, Metal matrix composites, manufacturing procedure for fiber reinforced composite. Agglomerated Materials: Cermets. Nano materials for surface coatings and novel drug delivery.

2. **Bio Materials:** Biomaterials for implants, prosthesis, biosensors, artificial muscles, etc. Novel materials for drug delivery.

Text Books:

1. Introduction to Physical Metallurgy, Sidney, H. Avner, TMH Publications, 2nd edition, 2017.
2. Materials Science and Engineering, W. D. Callister, Wiley and Sons Inc, 2nd edition, 2013.

Reference Books:

1. Physical Metallurgy: Principles and Practice, Ragahvan, PHI Learning Private limited, 3rd edition, 2015.

Online Resources:

1. Online course on "Material Science" by Prof. Satish V Kailas, IISc Bangalore available on NPTEL at https://nptel.ac.in/courses/112/108/112108150/

Course Outcomes:

On completion of the course, learner will be able to

1. Understand the basic concepts and properties of Material.
2. Select proper metal, alloys, nonmetal and powder metallurgical component for specific requirement
3. Detect the defects in crystal and its effect on crystal properties.
4. Evaluate the different properties of material by studying different test
5. Recognize how metals can be strengthened by cold-working and hot working

Course Code: 19EE6OE02T	Course Name: Introduction to Hybrid Vehicle and Autonomous Vehicle	L-T-P: 3:0:0	Credit: 3

Course Objectives:

1. Understand the basic functional blocks of a modern vehicle, need for and degree of hybridization.
2. Analyze various drives suitable for electric and hybrid electric vehicles.
3. Learn about electric propulsion unit and design considerations of EVs and hybrids.
4. Discuss different energy storage technologies used for hybrid electric vehicles and their control.
5. Learn about Energy Management Strategies used in electric vehicles and hybrid vehicles.

Syllabus:

Module-I: **[8 Hours]**

Basics of Modern Vehicles: History of hybrid and electric vehicles. Societal and environmental importance of fuel, electric and hybrid vehicles. Degrees of hybridization.

Conventional Vehicles: Features and sub-systems in a modern vehicle, Motion and dynamics equations for vehicles, Basics of vehicle performance, vehicle power source characterization, transmission characteristics and mathematical models to describe vehicle performance.

Module-II: **[8 Hours]**

Electric vehicle drive-trains: Basic concept of electric traction, Electric drive-train topologies and power flow analysis, electric components used in EVs, Configuration and control of DC Motor drives, induction motor drives, permanent magnet motor drives, switched reluctance motor drives. Drive system efficiency.

Hybrid vehicle drive trains: Basic concept of hybrid traction, degree of hybridization, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, energy efficiency analysis.

Module-III: **[8 Hours]**

Power for Propulsion: Resistance to motion, rolling resistance, air resistance, gradient resistance, power required for propulsion, tractive effort and traction, road performance curves.

Design consideration for EV chassis and body: Modularity in chassis, NVH level requirements, IP rating of drive train, configuration of traction device for damping

Module-IV: **[8 Hours]**

Energy Storage: Introduction to energy storage requirements in hybrid and electric vehicles, Battery based energy storage and its analysis (charge-discharge rate and cycles limit), Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices, Regenerative braking, AC-DC converter.

Module-V: **[8 Hours]**

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification and comparison of different energy management strategies, implementation issues of energy management strategies. Challenges in battery charging / swapping infrastructure. Grid connected energy transfer, wireless energy transfer.

Case Studies: Design of a Plug-in Hybrid Electric Vehicle (PHEV), Design of a Battery Electric Vehicle (BEV), Design of Series-Parallel HEV Drive train

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Reference Books:

1. Vehicular Electric Power Systems, A. Emadi, M. Ehsani and Jihn M. Miller, CRC Press, 1st edition, 2003.
2. Electric Vehicles: Prospects and Challenges, James Larminie and John Lowry, Wiley, 2nd edition, 2012.
3. Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Sheldon S. Williamson, Springer, 2013.

Course Outcomes:

1. Demonstrate the working of electric and hybrid electric vehicles.
2. Choose a suitable drive scheme for developing an electric hybrid vehicle depending on resources.
3. Design and develop the propulsion system of electric vehicles and hybrid electric vehicles.
4. Choose proper energy storage systems for vehicle applications.
5. Analyze and model the power management systems for electric and hybrid vehicles.

Online Resources:

Course Name	Introduction to Hybrid and Electric Vehicles
Course Link	https://nptel.ac.in/courses/108/103/108103009/
Course Instructor	Dr. Praveen Kumar and Prof. S. Majhi, IIT Guwahati

Course Name	Electric Vehicles
Course Link	https://nptel.ac.in/courses/108/102/108102121/
Course Instructor	Prof. Amit Kumar Jain, IIT Delhi

Course Code: 19CS6OE01T	Course Name: Data Analytics	L-T-P: 3-0-0	Credit: 3

Course Objectives:

To optimize business decisions and create competitive advantage with Big Data analytics

1. To explore the concepts regression and classification.
2. To learn to analyze the complexity of different techniques.
3. To understand the various additive models and boosting techniques.
4. To understand the Neural Networks, Support Vector Machines, and K-nearest Neighbor.

Syllabus:

Module: I **[8 Hours]**

Linear Methods for Regression and Classification: Overview of supervised learning, Linear regression models and least squares, Multiple regression, Multiple outputs, Subset selection, Ridge regression, Lasso regression , Linear Discriminant Analysis , Logistic regression, Perceptron learning algorithm.

Module: II **[8 Hours]**

Model Assesment and Selection : Bias, Variance, and model complexity, Bias-variance trade off, Optimisim of the training error rate ,Esimate of In-sample prediction error, Effective number of parameters, Bayesian approach and BIC, Cross- validation ,Boot strap methods, conditional or expected test error.

Module: III **[8 Hours]**

Additive Models, Trees, and Boosting: Generalized additive models, Regression and classification trees, Boosting methods-exponential loss and AdaBoost, Numerical Optimization via gradient boosting, Examples (Spam data, California housing, NewZealand fish, Demographic data).

Module: IV **[8 Hours]**

Neural Networks (NN) , Support Vector Machines(SVM),and K-nearest Neighbor: Fitting neural networks, Back propagation, Issues in training NN, SVM for classification, Reproducing Kernels, SVM for regression, K-nearest –Neighbour classifiers(Image Scene Classification)

Module: V **[8 Hours]**

Unsupervised Learning and Random forests: Association rules, Cluster analysis, Principal Components, Random forests and analysis. (II) Inferential Statistics and Prescriptive analytics.

Text Books:

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman , The Elements of Statistical Learning Data
2. Mining, Inference, and Prediction ,Second Edition , Springer Verlag, 2009.
3. G.James,D.Witten,T.Hastie,R.Tibshirani-An introduction to statistical learning with applications in R,Springer,2013.
4. E.Alpaydin, Introduction to Machine Learning, Prentice Hall Of India,2010,(Chapter-19)

References:

1. C.M.Bishop –Pattern Recognition and Machine Learning, Springer,2006
2. L.Wasserman-All of statistics.

Digital Learning Resources

Course Name	Data Analytics with Python
Course Link	Computer Science and Engineering – NOC: Data Analytics with Python
Course Instructor	Prof. A. Ramesh, IIT Roorkee

Course Code: 19CE6OE01T	Course Name: Plastic Waste Management	L-T-P: 3-0-0	Credit: 3

Course Objectives:

1. To know the sources of plastics
2. To know plastic waste management system
3. To know the recycling of waste plastic.
4. To know the plastic waste management practices.
5. To know about the biodegradable plastics.

Module: I **[8 Hours]**

Plastics –What it is? Types, Uses and Global Statistics, Plastic Waste –Sources, Production, Global and Indian Contex, Plastic Waste Management Rules 2016 (India) and Global Rules and Regulations

Module: II **[8 Hours]**

Plastics waste management-4 R & I approach viz. Source reduction, Reuse, Repair, Recycling, and Incineration with examples. Plastics recycling, Classification Code of practice-Primary, secondary, territory and quaternary recycling with examples-Coextrusion and co-injection moulding-Waste plastics as fillers.

Module: III **[8 Hours]**

Mechanical recycling of commonly used plastics, such as PP, PE. PET, etc. mixed waste recycling-co-extruded films waste, commingled waste extrusion flow moulding for production of plastics lumbers, chemical recycling/feed Stochrecycling processes for recovery of oil, monomer and energy-thermolytic processes. Solvolysis-process outline for PMMA, PET, etc.

Module: IV **[8 Hours]**

Plastic Waste Management Practices –Use of Plastic waste in roads, issues and challenges,

Possible Alternate Materials to Plastics –Greener Alternatives, Plastics Resource Recovery and Circular Economy, Plastic Bans including China Sword Policy implication on global plastic waste management, Impact of Plastics on Marine Life, Effect on Wildlife, Human Health and Environment.

Module: V **[8 Hours]**

Biodegradable plastics-an overview. Environmental issues, policies and legislation in India. Plastics-Energy saving, Eco-Friendly-Case studies. Life cycle analysis-a model.

Course Outcomes:

After completion of the course the student can

1. Students will able to explain the sources of plastics.
2. Students will be able to explain the plastic waste management.
3. Students will be able to explain the recycling process of plastic.
4. Students will able to explain waste management practices.
5. Students will able to explain biodegradable plastics.

Text Books:

1. R.J. Brandrup, *Recycling and recovery of plastics*, First Edition, Hanser Publishers, 1996 New York

2. N. Mustafa, *Plastics Waste Management*, Disposal Recyding and Reuse, First Edition, Marcel Dekker, Inc. 1993, New York.

Reference Books:

1. A. L. Andrady, *Plastics and the Environment*, First Edition Wiley Inter science, 2003, New York.

2. R.J. Ehrig, *Plastics Recycling, Products and Processes*, First Edition Hanser Publishers, 1992, New York.

3. *Technologies in Plastics Recycling*, American Chemical Society, Washington, DC 1992.

Digital Learning Resources

Course Name	Plastic Waste Management
Course Link	https://nptel.ac.in/courses/105/105/105105184
Course Instructor	Prof. B. K. Dubey, Department of Civil Engineering, IIT Kharagpur

Course Code: 19BS6OE01T	Course Name: Partial Differential Equation and Numerical Methods	L-T-P: 3-0-0	Credit: 3

Course Objectives:

4. Understand the fundamentals of PDE's
5. Mathematical model of physical phenomena using PDE's
6. Applications of PDE's in solving heat and wave equations
7. Computational techniques to solve ODE's & PDE's

Syllabus:

Module-I **[8 Hours]**

Partial differential equation of first order: Formation of Partial differential equation of first order, linear partial differential equation, Non-linear partial differential equation, Charpit's Method (without proof) Higher order linear Partial differential equation: Homogeneous partial differential equation, non-homogeneous partial differential equation with constant coefficient, Cauchy type.

Module-II **[8 Hours]**

Application of Partial Differential Equations: Method of separation of variables of Second order partial differential equation, One dimensional wave equation, D'Alembert's Solution of wave equation, Characteristics of partial differential equation and Classification and normal form of partial differential equation, One dimensional heat equation, Steady state two-dimensional heat problems, Laplace's equation
of two variables.

Module-III **[8 Hours]**

Two-dimensional wave equation and its solution: Laplace equation in polar, Circular membrane, Fourier Bessel Series, Laplace equation in Cylindrical and spherical coordinates, solutions with Bessel's function and Legendry functions, Solution of partial differential equation by Laplace Transformation.

Module-IV **[8 Hours]**

Numerical method for ordinary differential equation: Numerical method for solving systems of first order differential equations, Successive approximation method, Numerical method for solving second order IVP by RK 4th order, Numerical method for solving Boundary value problem (only 2nd order) Finite difference method.

Module-V

[08 Hours]

Numerical method for partial differential equation: Finite Difference solutions of two-dimensional Laplace Equation and Poisson Equations, implicit and explicit methods for one dimensional heat equations (Bender-Schmidt and Crank-Nicholson methods) Finite Difference explicit method for wave equations, Neumann and Mixed problems, Hyperbolic Equations of one space & two space dimension.

Course Outcomes:

1. Understand the basic properties and techniques to find the solutions of partial differential equations.
2. Demonstrate accurate and efficient use of Fourier analysis techniques and their applications in the theory of partial differential equations. Demonstrate capacity to model physical phenomena.
3. Understand the basic difference between IVP & BVP and know the Numerical techniques to find the solutions of IVP & BVP. Also understand the system of differential equations and its solutions.
4. Understand the basic concept of Numerical technique for solving partial differential equations. Also know the technique of classification of partial differential equations and Finite Difference.

Textbooks:

1. Erwin Kreyszig, Advance Engineering Mathematics, John Wiley & Sons, 10th Edition,

2. B S Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition.
3. T.Amarnath, "An Elementary Course in Partial Differential Equations" , Narosa, 2nd Edition.

Reference books:

1. M K Jain, S R K Iyengar and R K Jain, Numerical Method for Scientific and Engineering Computation, New Age International Publishers, 7th Edition.
2. S S Sastry, Introductory Methods for Numerical Analysis, PHI, 4th Edition.

Course Code: PSI	Course Code 19CM6HS01L	Course Name: Business Communication and Skills for Interview	L-T-P: 0-0-4	Credit: 2

This is an activity based course that has been specifically designed to cater to the needs of the Pre-Final Year (6th Semester) students. This course will aim at preparing and facilitating the students for the Interview and its related activities. There will be ten labs, all of which deal with various aspects and stages of Interview.

Syllabus:

LAB 1 : Ice breaking, Professional Introduction

LAB 2 : Professional Introduction, Professional Ethics

LAB 3 : Non-verbal aspects in an Interview/a G.D./Meeting, Business/Professional Etiquette

LAB 4 : Team Management Skills

LAB 5 : Leadership and Managerial Skills

LAB 6 : Time and Stress Management

LAB 7 : Present yourself in the context of your dream company

LAB 8 : Present yourself in the context of your dream company (contd…)

LAB 9 : Basics of drafting a Job Application and Resume (Fundamental differences between CV/Resume/Bio-data)

LAB 10: Summarizing (Reviewing Final Resume and Job Application of students)

Course Code PSI	Course Code 19CM6PS01T	Course Name: Lab Based Project/	L-T-P: 0-0-4	Credit 2

Course Objectives:

1. Understand the concept of doing research project
2. Software tool can be used for doing research
3. Understand the working of Automation
4. Material behavior easily understand
5. Alternative energy and its need will be understand

Syllabus:

1. Modeling using any CAD Software
2. Analysis physical phenomenon using ANSYS
3. CNC Milling
4. CNC Lathe
5. 3D Scanning
6. 3D Printing
7. Wear Measurement
8. Micro-Structure Analysis
9. Wind-tunnel
10. Bio-gas Generation
11. Vapour Absorption Refrigeration System Analysis
12. Solar Collector

Course Outcomes:

1. Basic knowledge about research will be gain
2. Get knowledge on software analysis tools
3. Automation machine tool concept will be gain
4. Gaining micro-structure behavior of composite material
5. Thermal energy knowledge able to enhance