Content Product
Detailed syllabus
ENGINEERING THERMODYNAMICS

UNIT I - BASIC CONCEPTS AND FIRST LAW

Basic concepts and definitions - Basic concepts and definitions, Statistical and classical thermodynamics, Concept of continuum, Ideal gas, Thermodynamic system, Types of thermodynamic systems, Thermodynamic properties, Thermodynamic state and equilibrium, Thermodynamic process and cycles, Point and path functions, State postulate and property diagrams, Pressure, Temperature, International practical temperature scale, Zeroth law of thermodynamics. **Work and heat -** Work and heat, Thermodynamic definition of work, Units of work and power, Sign convention of work, Displacement work. **Evaluation of displacement work -** Constant pressure process, Constant volume process, Hyperbolic process, Polytropic process, Reversible adiabatic process, Work is a path function, Indicator diagram, Other work modes, Heat, Modes of heat exchange, Sensible and latent heat, Comparison between work and heat, Problem based on displacement of work. **First law of thermodynamics -** The first law of thermodynamics, First law of thermodynamics for a closed system undergoing a process, Internal energy, The thermodynamic property enthalpy, Flow energy (Flow work), First law of thermodynamics for a control volume (Open system). **Problems based on First law of thermodynamics -** Problems based on First law of thermodynamics. **First law applied to closed system (Non flow process) -** Thermodynamic process on gases, Constant volume process, Constant pressure or Isobaric process, Expression for work done, Hyperbolic process, Isothermal process, Expression for work done by the gas during expansion, Adiabatic process, Expression for workdone by the gas, Expression for adiabatic index, Relation between pressure, volume and temperature for adiabatic process, Polytropic process, Expression for work done, Expression for polytropic index, Relation between pressure (P), volume (V) and temperature (T), Free expansion process, Throttling process, General laws for expansion and compression. **Problems based on First law applied to closed system -** Problems based on First law applied to closed system. **Steady state flow process -** The steady-state flow process, Turbines, Compressors, Pumps, Nozzles, Diffusers, Heat exchangers, Throttling process, First law for a cyclic process, Energy is a property of a system, Specific heat at constant volume and at constant pressure, Work interaction in a reversible steady flow process, First law for an open system under unsteady flow conditions. **Problems based on Steady state flow process -** Problems based on Steady state flow process.

UNIT II – SECOND LAW AND AVAILABILITY ANALYSIS

Second law of thermodynamics - Limitations of first law of thermodynamics, The second law of thermodynamics, Equivalence of Kelvin-Planck and Clausius statements, Difference between heat engine, refrigerator and heat pump, Reversible process, Irreversibility and causes of irreversibility, Externally and internally reversible processes, The Carnot cycle, Reversed Carnot cycle, The Carnot principles, Thermodynamic temperature scale, Reversible heat engines, refrigerators and heat pumps operating in series, Perpetual motion machine of second kind (PMM2). **Problems based on Second law of thermodynamics -** Problem based on Second law of thermodynamics. **Entropy -** Entropy, The Clausius inequality, Entropy changes for an irreversible process, Temperature - entropy diagram, Change in entropy. **Problems based on Entropy -** Problem based on Entropy. **Entropy process -**

Entropy change during constant volume process, Entropy change during constant pressure process, Entropy change during constant temperature process, Change in entropy in terms of temperature and pressure, Change in entropy in terms of pressure and volume, Entropy change during adiabatic process, Change in entropy during polytropic process, Change in internal energy of a gas in various processes, Principle of increase in entropy. **Applications of entropy principle -** Applications of entropy principle, Transfer of heat through a finite temperature difference, Mixing of two fluids, Maximum work obtainable from two finite bodies at temperatures T_1 and T_2, Absolute entropy. **Problems based on entropy process -** Problem based on entropy process. **Availability analysis -** High and low grade energy, Available and unavailable energy, Reversible work in a non-flow process, Reversible work in a steady-state control volume, Availability, Availability change involving heat exchange with reservoirs, Irreversibility, Second law efficiency. **Problems based on Availability analysis -** Problem based on Availability analysis.

UNIT III - PROPERTIES OF PURE SUBSTANCE AND STEAM POWER CYCLE

Pure substance - Pure substances, Phase transformation-formation of steam, Conditions of steam, Enthalpy, Specific volume, Entropy, External work of evaporation. **Property diagrams -** Property diagram, p-T diagram of a pure substance, T-v diagram of a pure substance, T-s diagram for a pure substance, h-s diagram for a pure substance, p-v-T surface, Steam tables, Mollier diagram, Important formulae. **Problems based on pure substances -** Problem based on pure substances. **Expansion of steam -** Introduction, Constant volume (Iso-choric) process, Problem based on Constant volume process, Steam process-constant pressure process, Problem based on constant pressure process, Constant temperature (isothermal) process, Hyperbolic process, Problem based on Hyperbolic process, Polytropic process, Problem based on Polytropic process, Isentropic (reversible adiabatic) process, Problem based on Isentropic process, Throttling process, Problem based on throttling process, Important formulae. **Steam power cycle -** Simple Steam Power Cycle, Rankine Cycle, Reheat Cycle, Regenerate Cycle, Reheat-Regenerative Cycle. **Binary and combined cycle -** Feedwater heaters, Characteristics of an ideal working fluid in vapour power cycles, Binary vapour cycle, Thermodynamics of coupled cycles, Efficiencies in steam power plant. **Problems based on steam power cycle -** Problem based on steam power cycle.

UNIT IV - IDEAL AND REAL GASES, THERMODYNAMIC RELATIONS

Ideal and real gas equation - Introduction, Boyle's law, Charle's law, General gas equation, Universal gas constant, Avogadro's law, Joule's law, Characteristics of ideal gas. **Specific heat -** Specific heat of a gas, Relation between specific heats, Cp is always more than Cv, Values of 'R' for various gases. **Vander Waal's -** Equations of state for real gases, Vander Waal's Equation of State, Compressibility Factor, Compressibility Chart, Generalised Compressibility Chart. **Problems based on ideal and real gases -** Problem based on ideal and real gases. **Thermodynamics relations -** Maxwell Relations, Clausius Clapeyron Equation, Joule Thomson coefficient. **Problems based on thermodynamics relations -** Problem based on thermodynamics relations.

UNIT V – GAS MIXTURES AND PSYCHROMETRY

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Gas mixtures - Gas mixtures, Composition of a gas mixture, Dalton's law of partial pressure, Amagat's law of partial volume, Properties of gas mixture, Mixing of ideal gases, Mixture of real gases. **Problems based on gas mixtures -** Problem based on gas mixtures. **Psychrometry -** Introduction, Psychrometric terms, Dew point temperature (DPT), Relative humidity (RH), Degree of saturation (μ), Problem based on Psychrometry. **Psychrometers -** Psychrometers, Types of psychrometers, Psychrometric chart, Wet bulb temperature lines, Adiabatic saturation and thermodynamic wet bulb temperature, Problem based on Psychrometers. **Psychrometric processes -** Psychrometric processes, Sensible heating, Sensible cooling, By - pass factor, Problem based on Psychrometric processes, Humidification and dehumidification, Method of obtaining humidification and dehumidification, Heating and humidification, Heating and dehumidification (Adiabatic chemical dehumidification), Cooling with adiabatic humidification, Cooling and dehumidification, Mixing of air streams. **Problems based on psychrometric processes -** Problem based on psychrometric processes.