

THERMODYNAMICS

UNIT I - BASIC CONCEPTS AND FIRST LAW OF THERMODYNAMICS

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, Reversible process, Irreversibility and causes of irreversibility, Externally and internally reversible processes. **Zeroth law of thermodynamics** – Pressure, Zeroth law of thermodynamics, Temperature, Ideal gas temperature scale, International practical temperature scale. **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. 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.**

UNIT II - SECOND LAW OF THERMODYNAMICS

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, 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), The clausius inequality. **Problems based on Second law of thermodynamics. Entropy** - Entropy changes for an irreversible process, Temperature - entropy diagram, Change in entropy. **Problems 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, Principle of increase in entropy. **Applications of entropy principle** - Transfer of heat through a finite temperature difference, 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. 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.** **Maxwell relations** - Thermodynamic potentials, Gibbs free energy, Gibbs Helmholtz equation, Review of some mathematical relations, Maxwell Relations, Internal energy and specific heat relationship, Enthalpy and specific heat equation, Entropy and specific heat relationship, Specific heat difference, Joule Thomson coefficient, Statement of third law of thermodynamics. **Problems based on thermodynamics relations.**

UNIT III - PERFECT GAS LAW AND PHASE TRANSFORMATIONS

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, C_p is always more than C_v , Values of 'R' for various gases. **Problems based on ideal and real gases.** **Non flow processes** - 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(P), volume(V) and temperature (T) 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, Change in internal energy of a gas in various processes. **Problems based on Non flow processes.** **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 Vander Waal's. **Pure substance** - Phase transformation-formation of steam, Conditions of steam, Enthalpy, Specific volume, Entropy, External work of evaporation, Clausius Clapeyron Equation. **Property diagrams** - 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.** **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 calorimetry** - Measuring dryness fraction of steam, Barrel or bucket calorimeter, Separating calorimeter, Throttling calorimeter, Combined separating and throttling calorimeter, Problem based on Steam calorimeter.

UNIT IV -MIXTURES OF PERFECT GASES AND PSYCHROMETRIC PROPERTIES

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** - Types of psychrometers, Psychrometric chart, Wet bulb temperature lines, Adiabatic saturation and thermodynamic wet bulb temperature, Problem based on Psychrometers. **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** -Problems based on psychrometric processes.

UNIT V - THERMODYNAMIC CYCLES AND REFRIGERATION CYCLES

Introduction to gas power cycle- Gas power cycle, Reversible process, Irreversible process, Condition for reversibility, Air standard cycle. **Otto cycle** - Otto cycle, Processes of Otto cycle, Air standard efficiency of Otto cycle, Effect of compression ratio on the efficiency of Otto cycle, Problem using otto cycle. **Diesel cycle** - Diesel cycle, Processes of diesel cycle, Processes of diesel cycle, Air standard efficiency of diesel cycle, Mean effective pressure, Assumptions made in diesel cycle, Problem using diesel cycle. **Dual Cycle** - Introduction to dual combustion, Air standard efficiency of dual cycle, Problem using dual cycle. **Stirling cycle** - Stirling cycle, Ericsson cycle, Lenoir cycle, Atkinson cycle. **Comparison of cycles** - Comparison of Otto cycle and Diesel cycle, Comparison of Otto, Diesel and dual combustion cycles. **Bell-coleman cycle** - Bell-coleman cycle, Advantages and limitations of air cycle, Problem based on Bell-coleman cycle. **Vapour compression refrigeration system** - Introduction to refrigeration system, Simple vapour compression refrigeration system, Applications of VCR system, Pressure – enthalpy chart, Temperature – entropy (T-s) chart, Carnot vapour refrigeration cycle, Standard vapour compression refrigeration cycle, Types of compression, Dry compression, Theoretical vapour compression cycle with superheated vapour before compression, Theoretical vapour compression cycle with under cooling or subcooling of refrigerant, Effect of suction pressure, Effect of discharge pressure, Problem on VCR cycle.