MK-part

Introduction/Motivation: Meaning of Thermodynamics, Significance for Mankind (Historical perspective), Timeline of evolution of Thermodynamics with a brief description of various Laws, Macroscopic and Microscopic approach, Generality of application of Thermodynamics Laws. Concepts and Definitions: System, Surrounding, Energy, Thermodynamic work, Heat, Thermodynamic Equilibrium. MK- (2)

Thermodynamic Properties of pure substance: T-V, P-T. P-V diagram, some discussion on genesis/definition of enthalpy, Mollier diagram. Various equations of state (in brief), some illustrations. MK-(2)

Zeroth Law of Thermodynamics and its significance, First law of thermodynamics: Statement, mathematical expression, path function, state function, control mass (closed system) and control volume approach (open system/continuous flow process). Applications in real life: Turbine, Compressor, Nozzle, Diffuser, throttling and refrigeration. Transient flow process: Charging/Discharging of a cylinder. MK-(3)

Some illustrations/examples on first law for flow process. MK-(2)

Second Law of Thermodynamics: Motivation, Example of heat engine & heat pump, Various statements of second law (Kelvin-Planck, Clausius) and their equivalence. PMM of second kind.

MK-(3)

Reversible and Irreversible process, Criterion for Irreversible process, Carnot Cycle (& Carnot theorems 1, 2), Thermodynamic Temperature scale, Clausius Inequality, genesis of Entropy.

MK-(3)

Calculations of Entropy: adsorption of energy by constant temperature bath, heating/cooling of a matter, phase change, mixing of gasses, Principle of Entropy increase. MK-(2)

Entropy balance for steady flow process, Availability in non-flow and flow process, Irreversibility

MK-(2)

Thermodynamic Potentials: Postulates, Intensive properties, Criteria for equilibrium (Mechanical, Thermal, Chemical), Euler relation, Gibbs-Duhem relation, various thermodynamics potential (U, H, A, G): their origin with physical insight. MK-(2)

Thermodynamic property relation: fundamental relations between various thermodynamics potentials, Maxwell's relations (partial derivative and Jacobian method, Specific Heat relations, Joule-Thompson co-efficient, Clapeyron equation, Gibbs Phase rule. MK-(2).

Power and Refrigeration cycle MK-(2)

First Law for Chemically reactive systems MK-(2)

Equations of State for real gasses (revisited in detail)

Thermodynamic properties of real gasses: Revisiting various thermodynamic relations very briefly (already covered by MK) followed by Departure function for various thermodynamic potentials, Departure function from equation of state, Departure function from compressibility factor correlation, from Viirial Coefficient. MK-3

JC-part

Multicomponent mixtures: motivation, Partial Molar properties (mathematical definition, significance), Gibbs-Duhem relation, Chemical potential (mathematical definition starting from $U(S,V, N_i)$, already covered by MK), some physical insight on chemical potential, fugacity & fugacity coefficient: estimation for pure gases through equation of state/compressibility factor correlation.

Thermodynamic properties of real gas mixtures: mixing rules, P-v-T properties of real gas mixtures, Departure functions for real gas mixtures, fugacity and fugacity coefficient for real gas mixtures

fugacity of a component in a mixture, fugacity of liquid and solid.

Stability and phase transition in thermodynamic systems, stability criteria, phase transition in a pure substance, Gibbs phase rule.

Solutions Thermodynamics: Ideal solutions, phase equilibrium in Ideal solutions, Phase diagram for Ideal solutions, Phase equilibrium problems

Excess properties, Gibbs-Duhem relation

Excess Gibbs free energy models: margules equation, Redlich-Kister equation, Wohl's equation, Van Laar equation, Wilson and NRTL equations, Wilson equation, Non- random two liquid (NRTL)

equation, UNIQUAC equation prediction of activity coefficients - group contribution methods, UNIquac Functional group Activity Coefficient (UNIFAC) method, Henry's law

Vapor – liquid equilibrium: basic equation for Vapor – liquid equilibrium, reduction of VLE data, VLE at low to moderate pressure - Excess Gibbs free energy models, Azeotropic data, VLE at high pressures, Multicomponent Vapor – liquid equilibria, Bubble point and dew point calculations, Thermodynamic consistency test of VLE data

Text Books: An Introduction to Thermodynamics (Y. V. C. Rao)

Chemical Engineering Thermodynamics (Y.V.C. Rao)

Reference Books: Engineering Thermodynamics: Fundamentals & Applications (F ranchis F. Huang)

Thermodynamics: An engineering Approach (Y. A. Cengel & M. A. Boles)