

XE**Engineering Sciences****XE4: Thermodynamics****Section XE4.1: Basic Concepts**

Continuum, microscopic and macroscopic approaches; Thermodynamic systems (closed and open); Thermodynamic properties, state and equilibrium; State postulate for simple compressible substances, paths and processes on property diagrams; Concepts of heat and work, different modes of work; Zeroth law of thermodynamics, concept of temperature.

Section XE4.2: Properties of Pure Substances

Thermodynamic properties of pure substances in solid, liquid and vapor phases; P-v-T behaviour of simple compressible substances, Concept of triple point and critical point; Ideal and real gases, ideal gas equation of state and van der Waals equation of state.

Section XE4.3: First Law of Thermodynamics

Concept of energy and various forms of energy; Internal energy, enthalpy; Specific heats; First law applied to elementary processes, closed systems and control volumes, steady flow energy equation applied to simple engineering devices.

Section XE4.4: Second Law of Thermodynamics

Limitations of the first law of thermodynamics, concepts of heat engines and heat pumps/refrigerators, thermal efficiency, coefficient of performance; Kelvin-Planck and Clausius statements and their equivalence; Reversible and irreversible processes; Carnot cycle and Carnot principles/theorems; Thermodynamic temperature scale.

Section XE4.5: Entropy

Clausius inequality and concept of entropy, causes of irreversibility; Entropy generation, the principle of increase of entropy, T-s diagrams; Isentropic process and isentropic efficiency; Second law analysis of system and control volume; Second law efficiency; Concept of third law of thermodynamics.

Section XE4.6: Thermodynamic Relations

T-ds relations, Helmholtz and Gibbs functions, Gibbs relations, Maxwell relations, Joule-Thomson coefficient and inversion curve; Coefficient of volume expansion, adiabatic and isothermal compressibilities; Clapeyron and Clapeyron-Clausius equations.

Section XE4.7: Thermodynamic Cycles

Carnot vapor cycle, ideal Rankine cycle; Simple vapor-compression refrigeration cycle; Air-standard cycles - Otto, Diesel, and Brayton cycles.

Section XE4.8: Mixtures of Ideal Gases

Dalton's and Amagat's laws, properties of ideal gas mixtures, air-water vapor mixtures and simple thermodynamic processes; Specific and relative humidities; Dew point, dry bulb and wet bulb temperatures, adiabatic saturation temperature, Simple psychrometric processes.