CBCS SCHEME

USN

18AE/AS32

Third Semester B.E./B.Tech. Degree Examination, June/July 2025
Aero Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Classify thermodynamics systems with examples, explain the significance of control surface in an open system. **(10 Marks)**

b. A temperature scale is defined by $T = a\sqrt{p}+b$, where p is a thermodynamic property. At the ice point (0°C), p = 4, and at the steam point (100°C), p = 9. Calculate the temperature when p = 6.25. **(10 Marks)**

OR

2 a. Prove that work is a path function using a PV diagram. Differentiate between displacement work and shaft work. **(10 Marks)**

b. A gas expands from $0.5m^3$ to $1.5m^3$. The initial pressure in 200 KPa. Calculate the work done if : i) Pressure is constant ii) Pressure varies as $P = \frac{100}{V}$ KPa iii) Process follows $PV^{1.2}$ = constant. **(10 Marks)**

Module-2

3 a. Explain Joule's paddle wheel experiment. How does it establish the equivalence of work and heat? **(10 Marks)**

b. Define enthalpy. Prove that for a closed system undergoing a constant-pressure process, $Q = \Delta H$. **(10 Marks)**

OR

4 a. Derive the Steady Flow Energy Equation (SFEE) and simplify it for a centrifugal compressor. **(10 Marks)**

b. A boiler receives water at 20°C and delivers steam at 5 MPa, 400°C. The mass flow rate is 10 Kg/s. Calculate the heat supplied per hour, also calculate the rate of heat transfer to water in boiler. **(10 Marks)**

Module-3

5 a. State the Kelvin-Planck and Clausius formulations of the second law. Prove their equivalence using a heat pump and heat engine combination. **(10 Marks)**

b. A Carnot engine operates between 800 K and 300 K. If it produces 200 KW of power, Calculate : i) Heat supplied ii) Heat rejected iii) Efficiency. **(10 Marks)**

OR

6 a. Define entropy. Prove that entropy change for an irreversible adiabatic process in positive. **(06 Marks)**

b. A 2Kg copper block at 120°C is dropped into 10 Kg of water at 25°C. Calculate the total entropy change. Take C_p of copper = 0.385 kJ/Kg K, C_p of water = 4.18 KJ/Kg K. **(07 Marks)**

c. Represent "available energy" and "unavailable energy" on a T-S diagram for an isothermal heat addition process. **(07 Marks)**

Module-4

7 a. Define : i) Critical point ii) Quality (dryness fraction) iii) Reduced pressure iv) Compressibility chart v) Sublimation. **(10 Marks)**

b. A mixture of 2 Kg O_2 and 3 Kg N_2 is stored at 150 KPa, 25°C. Calculate: i) Partial pressures ii) Gas constant of the mixture. **(10 Marks)**

OR

8 a. Sketch and explain the phase diagram of a pure substance (water) with labelled regions. **(10 Marks)**

b. Using Maxwell's relation $\left(\frac{\partial T}{\partial V}\right)_S = -\left(\frac{\partial P}{\partial S}\right)_V$, prove that $C_p - C_v =$ R for an ideal gas. **(10 Marks)**

Module-5

9 a. Derive the air standard efficiency of Otto cycle with the help of PV and TS diagrams. **(07 Marks)**

b. An Otto cycle has a compression ratio of 9:1. The initial conditions are 100 KPa, 27°C. If the maximum temperature is 1500 K, Calculate :
i) Thermal efficiency ii) Net work output per Kg. **(07 Marks)**

c. Compare Otto and Diesel cycles. **(06 Marks)**

OR

10 a. Explain regenerative feed heating in Rankine cycle with a schematic. **(07 Marks)**

b. Steam enters a turbine at 8 MPa, 500°C, and exits at 10 KPa with 90% dryness. Calculate cycle efficiency neglecting pump work. **(07 Marks)**

c. Why is the Carnot cycle impractical for steam power plants? How does the Rankine cycle address this? **(06 Marks)**

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