CBCS SCHEME

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21MT71

Seventh Semester B.E./B.Tech. Degree Examination, Dec.2025/Jan.2026

Thermal Engineering

Time: 3 hrs. Max. Marks: 100

Note : 1. ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Use of Thermodynamic and Heat transfer data book are permitted.***

Module-1

1 a. Distinguish between :
i) Open system , Closed system and Isolated system
ii) Intensive property and Extensive property. **(10 Marks)**

b. Define : i) Cyclic process ii) Non – cyclic process iii) Diathermic wall
iv) Mechanical equilibrium v) Thermal equilibrium. **(10 Marks)**

OR

2 a. Derive an expression for displacement work for an adiabetic process with PV diagram. **(10 Marks)**

b. A system receives 200 kJ of heat at constant volume and rejects 220 kJ of heat at P = C, during which 40 kJ of work is done on the system. The system is brought back to its original state by $PV^{\gamma} = C_A$. Calculate the adiabetic work. If the initial internal energy is 240 kJ, then calculate the value of internal energy in all states. **(10 Marks)**

Module-2

3 a. Derive an expression for Steady Flow Energy Equation [SFEE] with suitable assumptions. **(10 Marks)**

b. Air flows steadily at the rate of 0.5 kg/s through an air compressor, entering at 7 m/s velocity, 100 kPa pressure and 0.95 m^3/kg volume and leaving at 5 m/s , 700 kPa and 0.19 m^3/kg. The internal energy of air leaving is 90 kJ/kg greater than that of air entering. Cooling water in the compressor jacket absorbs heat from the air at a rate of 58 kW.
i) Compute the rate of shaft work input to the air in kW
ii) Find the ratio of the inlet pipe diameter to outlet pipe diameter. **(10 Marks)**

OR

4 a. Explain the concept of heat engine , heat pump and thermal reservoir. **(10 Marks)**

b. A reversible heat engine operates between two reservoirs at temperature of 600°C and 40°C. The engine drives a reversible refrigerator which operates between reservoirs at a temperature of 40°C and -20°C. the heat transfer to the heat engine is 2000 kJ and net work output of the combined engine refrigerator plant is 360 kJ. Find the heat transfer to the refrigerant and the net heat transfer to the reservoir at 40°C. **(10 Marks)**

Module-3

5 a. Derive an expression for efficiency of air standard diesel cycle. **(10 Marks)**

b. In an air standard diesel cycle, the compression ratio is 16 and at the beginning of isentropic compression , the temperature is 15°C and the pressure is 0.1 MPa. Heat is added until the temperature at the end of the constant pressure process is 1480°C. Calculate
i) Cut – off ratio ii) The heat supplied per kg of air iii) Cycle efficiency **(10 Marks)**

OR

6 a. Explain the following with governing law and equation i) Conduction ii) Convection iii) Radiation. (12 Marks)

b. Explain three kinds of Boundary condition. (06 Marks)

c. Explain Combined heat transfer mechanism. (02 Marks)

Module-4

7 a. Explain : i) Overall heat transfer co-efficient ii) Thermal contact resistance. (10 Marks)

b. A cylindrical insulation for a steam pipe has an inside radius $r_i = 6$ cm , outside radius $r_o = 8$ cm and k = 0.5 w/m°C. The inside surface of the insulation is at a temperature $T_i = 430$°C and outside surface is at $T_o = 30$°C. Determine i) Heat loss per meter length of this insulation ii) Temperature at mid – thickness of the insulation. (10 Marks)

OR

8 a. The heat transfer co-efficient depends upon the buoyancy force per unit mass ($g\beta\theta$) , density (ρ) , vertical height (L) , viscosity (μ) , thermal conductivity (k) and specific heat (C_p). Thus derive $N_u = B \times G_r^a \; P_r^b$ through dimensional analysis. (10 Marks)

b. Consider a square plate 0.5m by 0.5m with one surface insulated and the other surface maintained at a uniform temperature of T_w = 385 K which is placed in quiescent air atmospheric pressure and T_∞ = 315 K. Calculate the average heat transfer coefficient for free convection for the following orientations of the hot surface i) The plate is horizontal and the hot surface faces up ii) Plate is vertical. (10 Marks)

Module-5

9 a. Using Buckingham π theorem for forced convection heat transfer show that $N_u = C\,(R_e^m \; P_r^n)$. (10 Marks)

b. Air at 20°C flows over a thin plate with a velocity of 3m/s, the plate is 2m long and 1m wide. Estimate the boundary layer thickness at the trailing edge of the plate and the total drag force experienced by the plate. (10 Marks)

OR

10 a. State and explain the following radiation laws :
i) Stefan – Boltzmann law ii) Plank's law iii) Wein's displacement law iv) Kirchoff's law. (12 Marks)

b. Two parallel plates at T_1 = 900 K and T_2 = 500 K have emissivities $\epsilon_1 = 0.6$ and $\epsilon_2 = 0.9$ respectively. A radiation shield having an emissivity $\epsilon_{31} = 0.15$ on one side and emissivity $\epsilon_{32} = 0.06$ on the other side is placed between the plates. Calculate the heat transfer rate by radiation per square meter with and without shield. (08 Marks)

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