CBCS SCHEME

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18MT72

Seventh Semester B.E. Degree Examination, Dec.2024/Jan.2025
Thermal Engineering

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Explain Quasistatic process with a neat sketch. **(08 Marks)**

b. Define:
- i) Thermodynamics
- ii) Zeroth law of thermodynamics
- iii) Temperature
- iv) Enthalpy
- v) Open system
- vi) Closed system. **(06 Marks)**

c. Explain thermodynamic equilibrium. **(06 Marks)**

OR

2 a. Explain the following types of work transfer:
- i) Displacement work
- ii) Electrical work
- iii) Stirring work. **(10 Marks)**

b. A spherical balloon has a diameter of 25 cm and contains air at a pressure of 1.5 bar. The diameter of the balloon increases to 30 cm due to heating and during this process, the pressure is directly proportional to the diameter. Calculate the work done by air. **(10 Marks)**

Module-2

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

b. A centrifugal pump delivers 60 kg of water per second. The inlet and outlet pressures are 10 kPa and 400 kPa, respectively. The suction is 2 m below and delivery is 8 m above the centre line of the pump. The suction and delivery pipe diameters are 20 cm and 10 cm, respectively. Determine the capacity of the electric motor to run the pump. **(10 Marks)**

OR

4 a. Derive an expression for COP of refrigerator and heat pump. **(10 Marks)**

b. State Kelvin Planck and Classius statement and explain equitance of two statements. **(10 Marks)**

Module-3

5 a. Explain Otto cycle, derive an expression for its efficiency. **(12 Marks)**

b. Compare among Otto, Diesel and dual cycles. **(08 Marks)**

OR

6 a. Explain the modes of heat transfer with governing laws and equations. **(12 Marks)**

b. Describe boundary conditions of 1st, 2nd and 3rd kind with figures. **(08 Marks)**

Module-4

7 a. Derive the 3D conduction equation in carterisn co-ordinator and reduce the equation to Fourier and Laplace equation. **(12 Marks)**

b. A metallic steam pipe (K = 45 W/mK) 5 cm ID and 6.5 cm OD lagged with a 2.75 cm radial thickness of high temperature insulation having thermal conductivity of 1.1 W/mK. The surface heat transfer coefficient for inside and outside are 4650 and 11.5 W/m^2 K respectively. If the steam temperature is 200°C and the ambient temperature is 25°C. Determine :

i) Heat loss per meter length of pipe
ii) Temperature at the interface
iii) Overall heat transfer coefficient based on inside and outside surface. **(08 Marks)**

OR

8 a. Using Buckingham π theorem for free convection heat transfer show that, $Nu = C\ R_a^{\ m}$ with usual notations. **(12 Marks)**

b. Define the following:

i) Drag coefficient
ii) Grasshoff number
iii) Nusselt number
iv) Natural convection **(08 Marks)**

Module-5

9 a. Using Buckingham π theorem for forced convection heat transfer show that, $Nu = C\left(R_e^{\ m}\ P_r^{\ n}\right)$, with usual notations. **(12 Marks)**

b. A steel pipe 5 cm in diameter with surface temperature of 50°C is placed normally to an air stream moving at 3 m/sec. Determine convective heat transfer coefficient, if the air temperature is 30°C. Use the following equation for finding Nusselt number $N_u = 0.0239\ (R_e)^{0.805}$. **(08 Marks)**

OR

10 a. Explain the following:

i) Planck's law
ii) Wein's displacement law
iii) Stefan – Boltzmann law. **(12 Marks)**

b. Calculate the net radiant heat exchange per unit area for two large plates at temperature of 427°C and 27°C respectively.

$\in_{hot\ plate} = 0.9$, $\in_{cold\ plate} = 0.6$. If a polished aluminium shield is placed between them. Find the percentage reduction in the heat transfer. $E_{shield} = 0.04$. **(08 Marks)**

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