CBCS SCHEME

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15MT72

Seventh Semester B.E. Degree Examination, Dec.2018/Jan.2019
Thermal Engineering

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Distinguish between :
i) State and equilibrium
ii) Process and cycles
iii) Intensive and extensive property
iv) Macroscopic and microscopic approaches
v) Diathermic and adiabatic wall. **(10 Marks)**

b. Define :
i) Thermodynamics
ii) Zeroth law of thermodynamics
iii) Temperature
iv) Enthalpy
v) Specific heat at constant volume
vi) Specific heat at constant pressure **(06 Marks)**

OR

2 a. Explain following types of work transfer :
i) Displacement work ii) Electrical work
iii) Stirring work iv) Work done is stretching a wire. **(08 Marks)**

b. Compute the work done by 1kg of a fluid system as it expands slowly behind a piston from an initial pressure of 6×10^5 Pa and initial volume of $0.06m^3$ to a final volume of $0.18m^3$ in the following process:
i) Pressure remaines constant ii) Volume remaines constant iii) $PV^{1.3}$ = constant. **(08 Marks)**

Module-2

3 a. Derive steady flow energy equation on stating assumptions made. **(06 Marks)**

b. A cylinder fitted with a movable piston, contains $0.04m^3$ of air at 10bar pressure and 400k temperature. The air expands according to the law $P = \left(\frac{A}{V^2} - \frac{B}{V}\right)$ to a final pressure of 1 bar and $0.2m^3$. Determine work done, change in internal energy and heat transfer during the expansion, process. Take $C_v = 0.0718$ kJ/kg K. **(10 Marks)**

OR

4 a. Define Kelvin Plank statement, Clausius statement of II law of thermodynamics and show that they are equivalent. **(08 Marks)**

b. Explain Carnot's reversible heat engine with figure. **(04 Marks)**

c. Two Carnot engines work is series between the force and sink temperatures of 550k and 350k respectively. If both engines develop equal power determine the intermediate temperature. **(04 Marks)**

Module-3

5 a. Explain Otto cycle, deriving an expression for its efficiency. **(10 Marks)**

b. Compare among Otto, Diesel and dual cycles. **(06 Marks)**

OR

6 a. Explain the modes of heat transfer with governing law and equation. **(10 Marks)**

b. Describe boundary conditions of 1^{st}, 2^{nd} and 3^{rd} kind with figures. **(06 Marks)**

Module-4

7 a. Derive the 3-D conduction equation in cartesian coordinator and reduce the equation to Fourier's and Laplace equations. **(10 Marks)**

b. Consider 1 – D, steady state heat flow along two stainless steels bar, each of diameter D = 2cm, Length L = 3cm, conductivity K = 20W/mk and pressed together with a pressure of 10atm, The surface has a roughness of about 2.5μm (h_c = 3000 W/m^2 °C) . An overall temperature difference of ΔT = 100°C is applied across the bars. The interface temperature is about 90°C. Calculate the heat flow rate along the bars. Calculate the temperature drop at the interface. **(06 Marks)**

OR

8 a. Using dimensional analysis for free convection heat transfer show that, $N_u = C\,(G_r^n P_r^m)$ with usual notations. **(10 Marks)**

b. A metal plate 0.609m in height forms the vertical wall of an oven and if at a temperature of 171°C. Within the oven is air at a temperature of 93.4°C and atmospheric pressure. Assuming that natural convection conditions hold near the plate and that for this case $N_u = 0.548\,(G_r P_r)^{1/4}$.
Find the mean heat transfer coefficient and heat taken up by the air per second per meter width. For air at 132.2°C. Take K = 33.2 × 10^{-6} kW/m K. μ = 0.232 × 10^{-4} kg/m.s, C_p = 1.005 kJ/kg K. Assume air as an ideal and R = 0.287 kJ/kg K. **(06 Marks)**

Module-5

9 a. Using Buckingham π-theorem for forced convection heat transfer show that, $N_u = C\,(R_e^n P_r^m)$, with usual notations. **(08 Marks)**

b. Explain physical significance of following: i) Reynolds number ii) Prandtl number ii) Nusselt number iv) Stanton number. **(08 Marks)**

OR

10 a. State and explain following radiation laws: i) Plank's law ii) Wien's displacement law iii) Stefan – Boltzmann law iv) Kirchhoff's law. **(08 Marks)**

b. A domestic hot water tank (0.5m diameters an 1m high) is installed in a large space. The ambient temperature is 25°C. If the tank surface is oxidized copper with an emissivity of 0.8, find the heat loss from the tank surface of temperature 80°C by radiation. What would be the reduction in heat loss if a coating of aluminium paint having an emissivity of 0.3 is given to the tank? What would be the increase in heat loss if a white paint having an emissivity of 0.97 is given to the tank? **(08 Marks)**

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