Code No. BTS 051D

B.TECH DEGREE (F.T) III SEMESTER EXAMINATION IN MECHANICAL ENGINEERING (CAD/CAM), MARCH 1998

ME 304 THERMODYNAMICS AND HEAT TRANSFER

ME

Time: 3 Hours Max.Marks:100

I a) Distinguish between the following:
(i) Intensive and extensive properties
(ii) Source and sink
(iii) Point function and path function

b) Air at 32°C and 147 KPa is compressed isothermally from $7m^3$ to $2m^3$. Calculate the final temperature, pressure, work done and the heat transfer during the process.

OR

II a) Derive the steady flow energy equation on mass basis.

b) State the Ist Law of thermodynamics

c) A blower handles 1 Kg/s of air at 20°C and consumes a power of 15 KW. The inlet and outlet velocities of air are 100 m/s and 150 m/s respectively. Find the exit air temperature, assuming adiabatic conditions. Take C_p of air as 1.005 KJ/Kg K.

III a) State and prove Carnot's Theorem and its corollory.

b) A carnot engine operates with reservoirs A, B and C. Engine receives equal amount of heat from A and B at temperatures T_a and T_b and rejects heat to reservoir C at temperature T_c. If the efficiency of this engine is α times the efficiency of another engine operating between A and C only, show that

$$\alpha = \frac{1}{2}\frac{T_a}{T_b}\left\{\frac{T_b}{T_a} + \frac{T_b - T_c}{T_a - T_c}\right\}$$

OR

IV a) Compare the Otto, Diesel and duel combustion cycles on the basis of (i) the same compression ratio; (ii) Same maximum pressure and temperature.

b) A reversed Carnot cycle is used for removing 6,000 KJ/min from a cold storage at -20°C and heat is discharged to the atmosphere at 27°C. Compute the power required to operate this engine.

V a) Develop an expression for the overall heat transfer coefficient in the case of a multilayer cylindrical wall with convective boundary conditions.

b) A steam pipe with 160mm inner diameter and 170mm outer diameter is covered with two layers of insulation. The thickness of the inner layer is 30mm and that of the outer layer is 60mm. The thermal conductivities of the two insulating materials are 0.174 W/mK and 0.003 W/mK respectively. The pipe is made of steel with thermal conductivity 58 W/mk. The inside surface temperature of the pipe is 400°C. and the extreme outside temperture of the insulation is 40°C. Find the heat loss per unit length of the pipe.

OR

VI a) Derive an expression for one dimensional (radial) heat transfer in a hollow cylinder in the steady state with no heat generation. Assume uniform thermal conductivity.

b) The temperature of one face of a slab of thickness L is maintained at T_1 while the other face is maintained at T_2 where $T_1 > T_2$. The temperature dependency of thermal conductivity is given by $K = a + bT$ where a and b are constants and T is the temperature. Derive an expression for heat transfer per unit area of the slab.

VII a) Explain (i) Black body (ii) Stefan Botzmann Law (iii) Planck's Law (iv) Kirchoff's Law

b) Two very large parallel planes with emissivity 0.4 and 0.75 are engaged in radiative heat exchange. Calculate the percentage reduction in heat transfer when a polished aluminium screen of emissivity 0.04 is placed between them.

OR

VIII a) Define (i) Intensity of radiation (ii) Emissive power (iii) Emissivity (iv) Radiosity

b) A long pipe 50 mm in diameter passes through a room and is exposed to air at atmospheric pressure and temperature of 20°C. The pipe surface temperature is 93°C. Assuming that the emissivity of the pipe is 0.6, calculate the radiation heat loss per metre length of the pipe.

IX A parallel flow heat exchanger has a hot and cold water stream running through it. The flow rates are 10 Kg/min and 25 Kg/min respectively and the inlet temperatures are 70°C and 25°C on the hot and cold sides. Calculate the area of the heat exchanger if the individual heat transfer coefficients on both sides are 698 W/m^2K. The exit temperature on the hot side is required to be 50°C. Effect of fouling can be neglected.

OR

X a) Derive the effectiveness-NTU relationship for a counterflow heat exchanger.

b) Water at an average bulk temperature of 25°C flows inside a horizontal smooth tube with wall temperature maintained at 80°C. The tube length is 2 m and tube diameter is 3 mm. The flow velocity is 40 mm/s. Calculate the heat transfer rate.

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