Code No. BTS 100(D)

***B.Tech. Degree III Semester Examination in Mechanical Engineering, March 1999***

**ME 304 THERMODYNAMICS AND HEAT TRANSFER**

*Time: 3 Hours* *Max. Marks: 100*

ME

*(All questions carry equal marks)*

I a) Distinguish between the following
   i) Reversible and irreversible process
   ii) Microscopic and macroscopic properties
   iii) Point function and path function
   iv) Available and Unavailable energy

b) The C.O.P. of a refrigerator operating on reversed carnot cycle is 5.4 when it maintains - 5°C in the evaporator. Determine the condenser temperature and refrigerating effect of the refrigerator if the power required to run refrigerator is 5 h.p.

**OR**

II a) Air flows steadily at the rate of 0.5 kg/s through an air compressor, entering at 7 m/s velocity, 100 KPa pressure, 0.95 $m^3$/kg volume, and leaving at 5 m/s, 700 KPa, and 0.91 $m^3$/kg. The internal energy of the air leaving is 90 KJ/Kg. greater than that of air entering. Cooling water in compressor jackets absorbs heat from air at the rate of 58 kw
   (i) Compute rate of shaft input work
   (ii) Ratio of inlet pipe diameter to outlet diameter.

b) Derive steady state steady flow energy equation.

III a) A reversible heat engine operates with three reservoirs at 300 k, 400 k, and 1200 k. It absorbs 1200 KJ energy as heat from reservoir at 1200k and delivers 400 KJ work. Determine the heat interactions with other two reservoirs.

b) In a thermal power plant oeprating on a Runkine cycle, super-heated steam at 2.5 MPa and 250° C enters a reversible adiabatic turbine and leaves at 10 KPa pressure. The low pressure steam is condensed to saturated liquid at 10 KPa and fed back to boiler. Estimate the thermal efficiency of the power plant.

(P.T.O)

**OR**

IV a) Derive an expression for air standard efficiency of Duel combustion cycle.

b) In an air standard Diesel cycle the conditions at the beginning of compression stroke are 300k and 0.1 MPa. The air is compressed to a pressure of 5 MPa and then the fuel is injected such that 20 KJ of energy is added per mole of air. Determine compression ratio, cut-off ratio and thermal efficiency of cycle if $C_p$ of air is 3.5 R (R - universal gas constant).

V a) Derive an expression for general heat conduction equation in cylindrical coordinates.

b) A cold storage room has walls made of 0.23m brick on outside, 0.08 m of plastic foam and finally 1.5 cm wood on inside. Outside and inlet air temperatures are 22° C and -2° C respectively. If inside and outisde heat transfer coefficients are 29 and 12 w/m$^2$ K. Thermal conductivities of brick, foam and wood are 0.98, 0.02 and 0.17 w/mK. Determine i) Rate of heat removal ii) intermediate temperatures.

**OR**

VI a) Derive an expression for maximum temperature at the centre of a cylindrical rod with heat genration if wall temperature is Tw.

b) A plane wall 10 cm thick generates heat at the rate of 4 x 10$^4$ w/m$^3$, when an electric current is passed through it. Convective coefficient between wall and air is 50 w/m$^2$ K. Determine (i) surface temperature (ii) maximum temperature in wall. Ambient temperature is 20° C, thermal conductivity of wall material is 15 w/mK.

VII a) Explain i) White body ii) Kirchoffs law iii) Black body iv) Emissivity

b) A thermos flask consists of two walls, the space between which is evacuated to reduce heat losses. Surfaces facing each other are silvered with emissivity 0.02. If contents of flask are at 100° C and ambient temperature is 24° C. Compute heat loss from flask.

**Contd....3**



**OR**

VIII The surfaces of a double walled spherical vessel used for storing liquid oxygen are covered with silver with emissivity 0.03. Temperature of outer surface of inner wall is - 153°C and temperature of inner surface of outer wall is 27° C. Spheres are 21 cm and 30 cm in diameter, with evacuated space between them. Calculate radiation heat transfer through walls and rate of evaporation of liquid oxygen, if rate of vapourisation is 220 KJ/Kg.

IX A counter flow concentric tube heat exchanger is used to cool engine oil ($C_p$ = 2130 J/Kg K) from 160° C to 60° C with water, avialable at 25° C as cooling medium. Flow of cooling water through inner tube of 0.5 m diameter is 2 Kg/s while the flow rate of oil through outer annulus (outside diameter is 0.7m) is 2 Kg/s. Overall heat transfer coefficient is 250 w/m$^2$ k, determine length of heat exchanger to meat the cooling requirement.

**OR**

X a) Derive an expression for effectiveness of counter flow heat exchanger.

b) Water flow through a long 2.2 cm diameter copper tube at an average velocity 2 m/s. Tube wall is maintained at a constant temperature of 95° C whereas water is heated from 15° C to 60° C while passing through tube. Find heat transfer from pipe surface.

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