ME 55 O

X a) A horizontal pipe 15 cm in diameter is maintained at a temperature of 220° C. It passes through a room in which the ambient air temperature is 34° C. Determine the heat loss per metre of length by free convection.

b) In a chemical plant, 1000 Kg/min. of the product at 700° C (C_p = 3.6 KJ/kgk) are to be used to heat 1200 Kg/min. of the incoming fluid from 100° C (C_p = 4.2 KJ/kg.k). If the installed heat transfer surface is 42 m^2 and the overall heat transfer coefficient is 1 kw/m^2 k, compare the fluid outlet temperatures with counter flow and parallel flow arrangements.

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Code No. BTS 003(D)

B.Tech. Degree III Semester Examination in Mechanical Engineering (CAD/CAM) (1998 admissions), March 2000

ME 303 THERMAL ENGINEERING I

Time: 3 Hours *Max. Marks: 100*

(All questions carry equal marks)

MODULE - I

I a) A domestic food freezer maintains a temperature of – 15° C. The ambient air temperature is 30° C. If heat leaks into the freezer at the continuous rate of 1.75 KJ/sec., what is the least power necessary to pump this heat continuously ?

b) A fluid undergoes a reversible - adiabatic compression from 0.5 MPa, 0.2 m^3 to 0.05 m^3 according to the law, $p\,\vartheta^{1.3}$ = constant. Determine the change in enthalpy, internal energy and entropy, and the heat transfer and work transfer during the process.

OR

II a) Calculate the decrease in available energy when 25 kg. of water at 95° C mix with 35 kg. of water at 35° C, the pressure being taken as constant and the temperature of the surroundings being 15° C. Assume specific heat of water at constant pressure as 4.2 KJ/kg.

b) Determine the adiabatic flame temperature when liquid octane at 25° C is burned with 300% theoretical air at 25° C in a steady flow process.

MODULE - II

III a) Why carnot cycle is not suitable for steam power plants ?

b) What are the advantages of compounding of steam engines ?

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OR

IV a) Explain the concept of mean temperature of heat addition with reference to rankine cycle.

b) Steam at 20 bar, 360° C is expanded in a steam turbine to 0.08 bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler. Assuming that the turbine and the pump have each 80% efficiency find per kg. of steam the net work and the cycle efficiency.

MODULE - III

V a) With a neat sketch explain the actual valve timing diagram for a four - stroke - cycle petrol engine.

b) A four cylinder two stroke cycle petrol engine develops 23.5 kw brake power at 2500 r.p.m. The mean effective pressure on each piston is 8.5 bar and the mechanical efficiency is 85%. Calculate the diameter and stroke of each cylinder, assuming the length of stroke equal to 1.5 times the diameter of cylinder.

OR

VI a) Explain how the Morse test is carried out.

b) An engine uses 6.5 kg. of oil per hour of calorific value 30000 KJ/kg. If the brake power of the engine is 22 kw and mechanical efficiency 85%, calculate the indicated thermal efficiency and brake thermal efficiency.

MODULE - IV

VII a) Two large black plates kept at a small distance apart are maintained, respectively, at 1000° C and 500° C. Determine the net rate of radiant heat transfer between them in KW/m^2.

Contd...3

If the two plates be considered as imperfect gray emitters with emissivities 0.8 and 0.5 respectively, determine the net rate of heat exchange when the plates are maintained at 1000° C and 500°C.

b) Derive the general partial differential equation in cartesian coordinates for the three-dimensional unsteady state heat conduction.

OR

VIII a) Estimate the heat loss by radiation from a high pressure steam pipe at a temperature of 127° C situated in a large room whose walls are at 27° C. Assume emissivity of pipe surface to be 0.8.

b) Steam at 150°C passes through a 2 cm outside diameter pipe which is insulated with asbestos. The outside air temperature is 35° C and outer surface heat transfer coefficient is 6 w/m^2 k. Determine the thickness of asbestos for which the heat loss is maximum. What is the rate of heat transfer for this condition ? Thermal conductivity of asbestos may be taken as 0.2 w/m.k.

MODULE - V

IX a) Derive an expression for the LMTD of a counter flow heat exchanger.

b) A horizontal 40W fluorescent tube which is 3.8 cm in diameter and 100 cm long stands in still air at 1 atm. and 20° C. If the surface temperature is 40°C and radiation is neglected, what percentage of power is being dissipated by convection.

OR

Contd...4