c) In a straight tube of 60mm dia water is flowing at a velocity of 12 m/s. The tube surface temperature is maintained at 70°C and flowing water is heated from inlet temperature of 15°C to an outlet temperature of 45°C. Taking properties of water at mean temperature Determine 1) Convection coefficient 2) Heat transferred 3) Length of tube. (10)

OR

X a) Derive an expression for LMTD for counter flow heat exchanger. (10)

b) Oil (C_p = 3.6 KJ/Kg°C) at 100°C flows at the rate of 30,000 Kg/hr. and enters into a parallel flow heat exchanger. Cooling water (C_p = 4.2 KJ/Kg°C) enters the heat exchanger at 10°C at the rate of 50,000 Kg/hr. The heat transfer area is $10m^2$ and U = $1000 w/m^{2 \circ}C$. Calculate

(i) Outlet temperature of oil and water.

(ii) Maximum possible outlet temperature of water. (10)

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ME

Code No. BTS 003(D)

B.Tech. Degree III Semester Examination in Mechanical Engineering, January 2001

ME 303 THERMAL ENGINEERING - I

Time: 3 Hours *Max. Marks: 100*

(Answer all questions)

I a) State Clausius inequality of second law. Discuss. (5)

b) Air enters the compressor of a gas turbine at 0.9 bar and 15°C with a velocity of 150 m/sec. The air leaves the compressor at a pressure of 6 bar, 350°C, with a velocity of 60 m/sec. The process is adiabatic. Calculate the reversible work and irreversibility per kg for the process. (10)

c) Discuss entropy as a criterion of reversibility. (5)

OR

II a) Explain the application of Gibbs function in the second law of analysis of chemical reactions. (5)

b) Explain with an example, how second law of thermodynamics can be applied to chemical reactions. (5)

c) Liquid heptane ($C_7 H_{16}$) has an enthalpy of combustion of –10, 200 k cal /kg at 25°C when the water in the products is in the vapour phase. This fuel is to be turnt adiabatically, in a steady stream of air in a stoichiometric proportions. If the initial temperature of the fuel and air is 15°C determine the temperature of the products. Take C_p of heptane as 0.52 k cal/kgk. (10)

III a) Explain why the specific heat of the gas increases with increasing temperature. Explain the effect of variable specific heat on otto cycle on P-V diagram. (4)

b) A Four cylinder, 4 stroke single acting petrol engine consumes 6 kg. of fuel per minute at 800 r.p.m. when the A:F ratio of the mixture supplied is 9:1. The temperature and pressure at the end of compression stroke are 12.4 bar and 650 K. Find

the specific fuel consumption assuming relative efficiency of 55%. Diameter of cylinder = 8 cm. stroke = 10 cm calorific value of fuel = 40,000 KJ/Kg.
R(for mixture) = 300 Nm/kgk. (10)

c) Compare the effects of load and speed of the SI and CI engines on the following parameters of the engine.

i) Mechanical and thermal efficiency
ii) BMEP and SFC
iii) Volumetric efficiency
iv) Emission from the engine. (6)

OR

a) Draw otto and idesel cycle on PV diagram and show modification if the specific heats change with respect to temperature. (5)

b) What are different methods used in CI engines to create turbulence in the mixture. Explain its effect on power output and thermal efficiency. (5)

c) An engine works on air standard diesel cycle whose compression ratio is 14. The pressure and temperature at the beginning of the cycle are 16 bar and 300K respectively. The maximum temperature of the cycle is limited to 2500^{o}C. Determine thermal efficiency and mean effective pressure of the cycle. (10)

a) Derive an expression for optimum intermediate pressure in a two stage reciprocating air compressor. (6)

b) A single stage double acting air compressor delivers 15 cum of air per minute measured at 1.013 bar and temperature 27^{o}C and delivers at 7 bar. The conditions at the end of suction stroke are pressure 0.98 bar and temperature 40^{o}C. Clearance volume is 4% of swept volume and stroke/bore ratio is 1.3. Compressor runs at 300 rpm. Calculate volumetric efficiency cylinder dimensions, 1 HP, Isothermal efficiency of compressor n for expansion and compression is 1.3. R for air = 0.287 KJ/KgK. (14)

Contd...3

OR

VI a) Discuss merits and demerits of centrifugal compressors over axial flow compressors. (5)

b) $0.17m^3$ of free air is compressed from initial pressure and temperature of 0.98 at a and 15^{o}C to 2.3 at a i) by roots blower ii) by vane blower. Find HP required and isentropic efficiency in each case. Assume that there is back flow occurs in case of vane type blower. (15)

VII a) A furnace wall is made up of three layers of thicknesses 250 mm, 100mm and 150mm with thermal conductivities of 1.65, K and 9.2 $w/m^{o}C$ respectively. The inside is exposed to gases at 1250^{o}C with a convection coefficient of 25 $w/m^{2o}C$ and inside surface is at 1100^{o}C, the outside surface is exposed to air at 25^{o}C with convection coefficient of 12 $w/m^{2o}C$. Determine i) Unknown thermal conductivity k ii) Overall heat transfer coefficient iii) All surface temperatures. (15)

b) Derive an expression for critical thickness of insulation of a cylinder. (5)

OR

VIII a) Explain different theories of radiation. (5)

b) Explain concept of a black body. (5)

c) Calculate the net radiation heat exchange per m^2 area for two large parallel plates at temperature of 427^{o}C and 27^{o}C respectively.
emissivity (hot plate) = 0.9
emissivity (cold plate) = 0.6
if the polished aluminium shield is placed between them. Find percentage reduction in heat transfer.
emissivity (shield) = 0.4 (10)

IX a) Explain Newtons law of convection. (5)

b) Explain significance of Reynold number in heat transfer. (5)

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