M.Tech-Heat Power Engineering (Old Scheme) / (CBCS) Sem I

916 - Advanced Heat & Mass Transfer

P. Pages : 2 **GUG/S/18/3835**

Time : Three Hours * 0 9 7 2 * Max. Marks : 70

Notes :
1. All questions carry equal marks.
2. Due credit will be given to neatness and adequate dimensions.
3. Assume suitable data wherever necessary.
4. Use of slide rule, Logarithmic tables, Steam tables, Mollier's chart, Drawing instruments, Thermodynamic tables for moist air, Psychrometric charts and Refrigeration charts is permitted.
5. Answer **any five** questions.
6. Data Hand Book is permitted

1. a) Derive the relation for 3 - Dimensional heat conduction equation in Cartesian co-ordinates. Specify conditions & reduce the general heat conduction equation in Fourier equation. Poissons eq^{n} & Laplace eq^{n}. **7**

b) Derive the following : **7**

$$t_{m+1,n} + t_{m-1,n} + t_{m,n} + t_{m,n+1} + t_{m,n-1} - 4t_{mn} = 0$$

2. a) How does numerical sol^{n} differs from analytical one? What are the advantage & disadvantage of above sol^{n}. **6**

b) For in iron sphere [$K = 60\,W/m^{o}C$, Sp. heat $C = 460\,kJ/kg^{o}C$, Density $= 7850\,kg/m^{3}$ & $\alpha = 1.6\times10^{-5}\,m^{2}/sec$] 30mm in diameter is initially at uniform temp. of 225ºC, suddenly the surface of sphere is exposed to ambient at 25ºC with the heat transfer coefficient $h = 500\,W/m^{2}\,^{o}C$. **8**

Calculate :
i) The centre temp. at the time of 2 minutes after the start of cooling.
ii) The temp. at which depth of 1 cm from the surface at time 2 minutes after the start of cooling.
iii) Calculate the energy removed from the sphere during this period.

3. a) Briefly explain Laws of Radiations. **6**

b) A pipe of 500 mm in diameter carrying steam at a temp. of 180ºC & another pipe 180 mm diameter carrying water at 16ºC are buried under the ground with centre to centre distance of 1.5 m. The length of each pipe is 80m, & thermal conductivity (K) of soil is $0.45\,W/m^{o}C$. Assume the pipes run parallel to each other. The earth is infinite & resistance of pipe material is negligible, **8**

Determine :
1) Net heat transfer rate bet^{n} the two pipes.
2) Rise in water temp. due to heat transfer if the velo. of pipe waters in pipe is $0.05\,m/s$.

4. a) Explain the radiation heat transfer coefficient. **6**

b) Oil ($C_P = 3.6\,kJ/kg^oC$) at 100ºC flows at the rate of $30,000\,kg/hr$, & enters into a parallel flow heat exchanger. Cooling water ($C_P = 4.2\,kJ/kg^oC$) enters the heat exchanger at 10^oC at a rate of $50,000\,kg/hr$. The heat transfer area is $10\,m^2$ & $u = 1000\,W/m^{2o}C$. Calculate : **8**

i) Outlet temp. of oil & water.
ii) Maxi. possible outlet temp of water.

5. a) Explain, why convective heat transfer coefficient for dropwise condensation is greater than filmwise condensation. **7**

b) Air at 27ºC and 1 atm flows over a flat plate at a speed of 2 m/s. Calculate boundary layer thickness at a distance of 20 cm & 40 cm from the leading edge of two plate. Also Calculate the mass flow which enters the boundary layer bet^n $X = 20\,cm$ & $x = 40\,cm$. The viscosity of air at 27ºC is $1.85\times10^{-5}\,kg/ms$. Assume unit depth in outer direction. **7**

6. a) Explain the difference bet^n radiation from gases & that from solids. Why gases are called selective radiation? **6**

b) In tabular condenser, steam condense at atm pressure on the external surface of the tubes. Cooling water flowing inside the tubes $\Rightarrow I.D. = 2.5\,cm$, which is 10 m long & No. of tubes is 10. Water enters at 30ºC & leaves at 65ºC. If the flow rate of water is $3600\,kg/hr$. Find out following : **8**

i) Rate of steam condensation.
ii) Effectiveness of Condenser.
iii) NTU.

7. a) Explain heat transfer in Magnate Fluid Dynamic (MFD) system. **6**

b) A 2.0 cm diameter tube having a relative roughness of 0.001 is maintained at a constant wall temp of 90ºC. Water enters the tube at 40ºC & leaves at 60ºC. If the entering velocity is $3\,m/sec$. Calculate the depth of tube necessary to accomplish the heating. **8**

8. Write short note **any three.** **14**

i) What is Heisler Chart. Explain the significance of it in solving transient conduction problem.

ii) Properties of shape factor.

iii) Error in temp. measurement.

iv) Types of Heat exchangers.

v) Mass & Radiation heat transfer.

****