B.E. Mechanical Engineering Fifth Semester

ME505 - Heat Transfer

P. Pages : 3 **GUG/W/18/1650**

Time : Three Hours * 1 2 9 9 * Max. Marks : 80

Notes :
1. All questions carry equal marks.
2. Answer Q.1 or Q. 2, Q. 3 or Q. 4, Q. 5 or Q. 6 Q. 7 or Q. 8, Q. 9 or Q. 10
3. Due credit will be given to neatness and adequate dimensions.
4. Assume suitable data wherever necessary.
5. Illustrate your answers wherever necessary with the help of neat sketches.
6. Use of slide rule, Logarithmic Tables, Steam Tables, Mollier's chart Drawing instruments, Thermodynamic tables for moist air, Psychometric charts and Refrigeration charts is permitted.
7. Use of heat transfer data hand book non-programmable calculator is permitted.

1. a) Derive general 3 dimensional heat conduction equation for rectangular coordinates System. **8**

b) A composite wall is made up of 3 layers of thicknesses 25 cm, 10 cm and 15 cm with thermal conductivities of 1.7 K_B and 9.5 W/mk. The outside surface is exposed to air at 20º C with convection coefficient of 15 W/M^2K and the inside is exposed to gases at 1200ºC with a convection Co-efficient of 28 W/m^2 k and the inside surface is at 1080ºC Determine the unknown thermal conductivity all surface temperatures, Resistances of each layer and the overall heat transfer coefficient compare the temperature gradients in the three layers. **8**

OR

2. a) Derive expressions for temperature distribution under one dimensional steady state heat conduction for plane wall with uniform thermal conductivity. **4**

b) A spherical vessel of ID 0.3 m and thickness of 20 mm is made of steel with conductivity of 40 W/Mk. The vessel is insulated with two layers of 60 mm thickness of conductivity 0.05 and 0.15 W/mk. The inside surface is at – 196ºC The out side is exposed to air at 30ºC with convection coefficient of 35 W/m^2 k. There is a contact resistance of 1×10^{-3} m^2 ºC/W between the two insulations Determine the heat gain and also the surface temperatures and the overall heat transfer coefficient based on the outside surface area of the metallic vessel. **6**

c) Explain critical thickness of insulation Derive expression for critical thickness of insulation for cylinder. **6**

3. a) Explain the following terms: **6**

i) Error in temperature measurement.

ii) Biot number and Fourier number and their significance.

iii) Lumped parameter analysis and Heisler chart.

b) A solid cylinder 100 mm in diameter generating heat at a uniform rate of $7 \times 10^6 W/m^3$ The thermal conductivity of solid is 190 W/m. K and its surface temperature is maintained at 100ºC. Calculate. **10**

i) Temp at the centre of cylinder.
ii) Temp at the distance 25 mm from the centre.
iii) Temp gradient at 25 mm radius.
iv) Heat flux at the surface.

OR

4. a) Explain fin efficiency & fin effectiveness. Develop the equation for effectiveness. **6**

b) Two ends of a fin of the cross section at area 2 cm^2, perimeter 2 cm, 100 cm long are maintained at 127ºC & 227ºC respectly. It losses heat from the surface due to natural convection to surroundings at 27ºC with heat transfer coefficient of 5 W/m^2 K. Thermal conductivity of fin material is 45 W/m k . Find the minimum temperature in the fin & its location. Also calculate the heat conducted from each end. **10**

5. a) Engine oil at 60ºC flows at 0.5 kg/s in a duct with constant surface temperature of 20ºC. Assuming fully developed flow calculate **8**

i) Heat flux at entry.
ii) Pressure drop per meter length for 3 cm diameter tube and for a 3x1 rectangular duct of equal wall area.

b) A circular disc heater 0.2 m in dia is exposed to ambient air at 25ºC. one surface of the disc is insulated & other surface is maintained at 130ºC calculate the amount of heat transferred from disc when it is **8**

i) Horizontal with hot surface facing up.
ii) Horizontal with hot surface facing down and
iii) Vertical

OR

6. a) Distinguish between. **3x3 =6**

i) Nucleate and film boiling.
ii) Film wise and dropwise condensation.

b) The long 3 cm diameter Carbon steel cylindrical rods $(\in = 0.66)$ at 300ºC are rapidly cooled by immersing them (one at a time) horizontally in a water bath at atmospheric pressure Determine. **10**

i) The minimum heat flux in the film boiling region and the temp at which it occurs.
ii) The heat flux when the surface temp of the cylinder is 300ºC.
iii) Maximum heat flux.

7. Write short notes on the following:

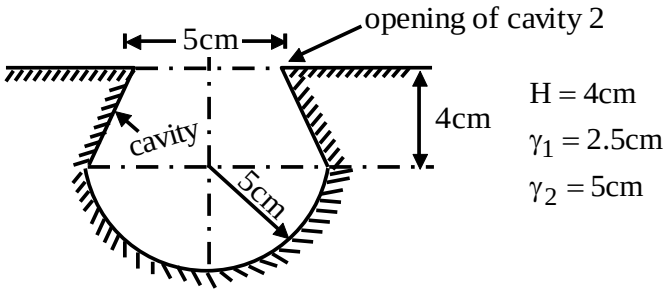
i) Wien's displacement Law. **6**

ii) Kirchhoff's law of radiation. **5**

iii) Planrck's law. **5**

OR

8. a) Figure shows a cavity having surface temperature of 900ºC and emissivity as 0.6. Find the rate of emission from the cavity to the surroundings. **6**



b) Two large parallel planes with emissivity 0.6 are at 900 k & 300k. A radiation shield with one side polished & having emissivity of 0.05, while the emissivity of other side is 0.4 is proposed to be used. Which side of the shield to face the hotter plane, if the temperature of shield is to be kept minimum? Justify your answer. **10**

9. a) Derive an expression for log mean temperature difference of a parallel flow heat exchanger. **8**

b) Write short notes on **any two**. **8**

i) Fouling in heat exchangers.

ii) Effectiveness of the heat exchanger.

iii) NTU method.

OR

10. a) In a heat exchanger hot fluid enters at 180ºC and leaves at 118ºC. The cold water enters at 99ºC and leaves at 119ºC. Find the LMTD, NTU & effectiveness in the following cases of heat exchanger. **12**

i) Counter flow.
ii) One shell pass & multiple tube passes.
iii) Two shell passes & multiple tube passes.
iv) Cross flow both fluid unmixed and
v) Cross flow the cold fluid unmixed.

b) Explain briefly with neat sketch compact heat exchanger. **4**

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