(3 Hours) **[Total Mark: 80]**

N.B. (1) Question No. 1 is compulsory.
(2) Attempt any **Three** Question from Q. No. 2 to Q. No.6
(3) Make suitable assumption if required.
(4) Illustrate answers with sketches wherever required.

Q.1 Solve any four (5 Marks each) **20**

a Explain with neat sketch parallel and counter type heat exchanger and write a short note on NTU.
b Explain heat pipe
c Explain the significance of critical radius of insulation in steam pipeline and electrical Conductors.
d Explain concept of black body and shape factor.
e Derive the generalized heat conduction equation in rectangular coordinates with assumptions.

2 A An insulated steam pipe of 160mm inner diameter & 180mm outer diameter is covered with First layer of insulation 40mm thickness & second layer of insulation 20 mm thick carries steam At 200^{o}C, K(pipe)=29 W/mK, K(first insulation) = 0.23 W/moC, K(second insulation)= 0.3W/mK h_i=11.6 W/m^{2o}C, h_o=23.2 W/m2^{o}C. If the temp. of the air surrounding the pipe is 25oC, Calculate the rate of heat loss from the pipe of 5m length. Also find the interface temperature. **10**

2 B A solid sphere of radius 5cm and thermal conductivity of 20 W/mK is heated uniformly through its volume at the rate of 2 x10^{6} W/m^{3}, and heat is dissipated by convection to ambient air at 25^{0}C with convection coefficient of 100 W/m^{2} K. Determine the steady state temperature at the centre and the surface of the sphere. Determine temp. Distribution Equation. **10**

3 A A copper cylinder of diameter 8 cm and length 20 cm is removed from liquid nitrogen bath at -196^{o}C & exposed to air at 25^{o}C. Find the time taken by the cylinder to attain the temperature of -100^{o}C. Assume h=15W/m^{2}K, ρ = 8000 kg/m^{3} , Cp= 4.0 kJ/kgK **10**

3 B A thermometer pocket is inserted in a pipe of 150 mm diameter carrying hot air. The pocket is made of brass (K=70W/mK). The inner and outer diameters of the pocket are 10 mm &15mm resp. The heat transfer coefficient between the pocket and air is given by N_u=0.174 (R_e)$^{0.618}$ K_{air}=0.035 W/mK and depth of pocket = 50mm , R_e of air flow=25000. Find the actual error in temperature measurement if the oil well is at 50^{o}C and air temp. is 150^{o}C. **10**

4 A With the help of dimensional analysis prove that for free convection. Nu = Φ (Re, Pr) **10**

4 B Air at 30^0C flows with a velocity of 5 m/sec over a plate maintained at 100^0C. The length, width & thickness of plate is 1000 X 500 X 20mm. If the thermal conductivity of the plate material is 30 w/m^0C. Calculate, **10**
1) Heat lost by the plate.
2) Bottom temperature of the plate for the steady state condition.

5 A Hot water at 2.5 kg/sec & 100^oC enters a concentric tube counter flow heat exchanger having a total area of 23 m^2 cold water at 20^oC enters at 5 kg/sec & the overall heat transfer coefficient is 1000W/m^{2o}K. Determine the total heat transfer rate & outlet temperature of hot & cold fluids. **10**

5 B Calculate the net radiant heat exchange per m^2 area for two large parallel plates at temperature of 427^oC & 27^oC respectively $\varepsilon_{hot\ plate} = 0.9$, $\varepsilon_{cold\ plate} = 0.6$. If a polished aluminum shield is placed between them, find the percentage reduction in the heat transfer $\varepsilon_{Shield} = 0.4$ **10**

6 Solve any four **20**
A Explain different regimes of boiling.
B Explain methods of enhancing heat transfer rate in convection mode
C Explain the method of evaluating overall heat transfer coefficient of water to air heat exchanger.
D Explain Heisler chart and its significance
E Explain numerical method of heat transfer.
