(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

Q1 Attempt any **Four** Questions (20)

a) Explain modes of heat transfer with suitable example.
b) Explain steady, unsteady and lump system.
c) Explain the concept of overall heat transfer coefficient.
d) State and explain Wien's displacement law.
e) Explain Hydrodynamic and Thermal Boundary Layer in accordance with Prandtl Number.
f) Explain the function of fins and its effectiveness.

Q2

a) Derive the relation for heat transfer through fin with insulated tip. State the assumptions clearly. (10)
b) 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°C, K(pipe)=32 W/mK, K(first insulation) = 0.23 W/m°C, K(second insulation)= 0.3W/mK h_i=11.6 W/m^{2}K, ho=23.2 W/m^2.°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)

Q3

a) A longitudinal copper fin (k=380W/m°C) 600mm long and 5mm diameter is exposed to air stream at 20°C. The convective heat transfer coefficient, is 20W/m^2°C. If the fin base temperature is 150°C. Determine: (i) the heat transferred and, (ii) the efficiency of the fin. Assume that fin is insulated at the tip. (10)
b) An egg with mean diameter of 45mm and at 18°C is placed in a boiling water pan for 4.5 min and found to be boiled to consumer's taste. For how long a similar egg for the same consumer should be boiled taken from a refrigerator at 4°C. Take the following properties for egg. Verify whether the lumped heat capacity analysis can be used or not. (10)
k=10W/m°C, ρ=1200kg/m^3,C_p=2kJ/kg°C, and h=100W/m^2°C.

Q4

a) Air at atmospheric pressure and 40°C flows with a velocity of U=5m/s over a 2m long flat plate whose surface is kept at a uniform temperature of 120°C. Determine the average heat transfer coefficient over the 2m length of the plate. Also find out the rate of heat transfer between the plate and the air per 1m width of the plate. (Take air at 1atm. and 80°C, ν = 2.107×10^{-5}m^2/s, k = 0.03025W/m.K, Pr = 0.6965.) (10)
b) Derive the relationship between effectiveness and the number of transfer units for a parallel flow heat exchanger. (10)

Q5 a) Determine the radiant heat exchanger in W/m^2 between two large parallel steel plates of emissivity's 0.8 and 0.5 held at temperatures of 1000K and 500K respectively, if a thin copper plate of emissivity 0.1 is introduced as a radiation shield between the two plates. Use $\sigma=5.67\times10^{-8} W/m^2.K^4$. 10

b) i)Differentiate between the mechanism of filmwise and dropwise condensation. 05

ii) Define : Radiosity and Irradiation 05

Q6 a) In a certain double pipe heat exchanger hot water flows at a rate of 5000 kg/h and gets cooled from 95°C to 65°C. At the same time 50000 kg/h of cooling water at 30°C enters the heat exchanger. The flow conditions are such that overall heat transfer coefficient remains constant at $2270 W/m^2.K$. Determine the heat transfer area required and the effectiveness, assuming two streams are in parallel flow. Assume for the both the streams, $C_p=4.2$ kJ/kg.K. 10

b) Write short note on any **two** of the following 10

i) Heat Pipe.

ii) NTU-effectiveness and LMTD methods

iii) Heisler Charts
