Time: 3hrs. **Total Marks:80**

N.B.: (1) Question No.1 is **Compulsory**.
(2) Attempt any **THREE** from question No.2 to 6.
(3) Use illustrative diagrams whenever possible.
(4) Assume suitable data if necessary and mention it clearly.
(5) Use of steam table is permitted.

Q1 Attempt any **Four** Questions 20

a) What are the three modes of heat transfer? Define each with an appropriate with suitable example.
b) What is lump system analysis? What are the assumptions made in the lumped system analysis and when is it applicable?
c) What do you mean by Fouling factor? What are the causes of fouling?
d) State and explain Wien's displacement law.
e) Explain Hydrodynamic and Thermal Boundary Layer.
f) Derive the equation of critical thickness of insulation.

Q2 a) Derive the relation for heat transfer through fin with insulated tip. State the assumptions clearly. 10

b) A wall of a furnace is made up of inside layer of silica brick 120mm thick covered with a layer of magnesite brick 240mm thick. The temperatures at the inside surface of silica brick wall and outside surface of magnesite brick wall are 725°C and 110°C respectively. The contact thermal resistance between the two walls at the interface is 0.0035°C/W per unit wall area. If thermal conductivities of silica and magnesite bricks are 1.7W/m°C and 5.8W/m.°C. Calculate: i) The rate of heat loss per unit area of walls, and ii) The temperature drop at the interface. 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
$k=10W/m°C$, $\rho=1200kg/m^3$, $C_p=2kJ/kg°C$, 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, $\nu = 2.107\times10^{-5}m^2/s$, 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^2between 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 5000kg/h and gets cooled from 95°C to 65°C. At the same time 50000kg/h of cooling water at 30°C enters the heat exchanger. The flow conditions are such that overall heat transfer coefficient remains constant at $2270W/m^2.K$. Determine the heat transfer area required and the effectiveness, assuming two streams are in parallel flow. Assume for the both the streams, $C_p=4.2kJ/kg.K$. 10

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

i) Heat Pipe.

ii) Boiling curves and various regimes of boiling.

iii)Heisler Charts
