17560

11718

3 Hours / 100 Marks Seat No. | | | | | | | | |

Instructions – (1) All Questions are *Compulsory.*

(2) Answer each next main Question on a new page.

(3) Illustrate your answers with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Assume suitable data, if necessary.

(6) Use of Non-programmable Electronic Pocket Calculator is permissible.

(7) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. a) **Answer any THREE of the following:** **12**

(i) Explain different modes of heat transfer with examples.

(ii) Define film heat transfer coefficient and give its unit in S.I.

(iii) State and explain Stefan Boltzman law of black body radiation.

(iv) Draw a neat labelled diagram of 1-2 pass shell and tube heat exchanger.

b) **Answer any ONE of the following:** **6**

(i) Derive an expression to find out rate of heat transfer through cylinder.

(ii) Explain the construction and working of calendria type evaporator.

Marks

2. Answer any FOUR of the following: **16**

a) Define Fourier's law. Give its mathematical expression and explain the terms involved.

b) Estimate the heat loss per m^2 of the surface through a brick wall 0.5 m thick when the inner surface is at 400 K and the outside surface is at 310 K. K of brick is 0.7 w/mk.

c) State and explain Kirchoff's law of radiation.

d) Through which side of shell and tube heat exchanger the following liquids are passed? Justify your answer:

(i) Viscous liquid

(ii) High pressure liquid

e) Give difference between single pass and multipass shell and tube heat exchanger.

3. Answer any TWO of the following: **16**

a) Give the mechanism of heat transfer to boiling liquid.

b) Cold fluid is flowing through a double pipe heat exchanger at a rate of 15 m^3/hr. If enters at 303 K and is to be heated to 328 K. Hot thermic fluid is available at the rate of 21 m^3/hr and at 383 K. Find out LMTD for cocurrent and counter current type of flow.

Specific heat of thermic fluid = 2.72 KJ/kg K

Specific heat of water = 4.187 KJ/kg K

Density of thermic fluid = 950 kg/m^3

Density of water = 1000 kg/m^3

c) Draw a neat labeled diagram of a graphite block heat exchanger and state any two advantages of it over shell and tube heat exchanger. State any two applications of graphite block heat exchanger.

Marks

4. a) **Answer any <u>THREE</u> of the following:** **12**

(i) Two ends of an iron block are maintained at 400°C and 250°C. The cross sectional area through which the heat is being transferred is 1.8 m^2. The thickness of the block is 40 cm. K of iron block is 1.2 $\frac{kcal}{hr\,m\,k}$ Calculate the heat flow through this iron block.

(ii) Define capacity and economy of evaporator. How economy of an evaporator can be increased?

(iii) Calculate the rate of heat transfer by radiation from an unlagged steam pipe, 70 mm o.d. at 395 K to air at 293 K. Emissivity e = 0.9. $\sigma = 5.67 \times 10^{-8}$ $W/(m^2K^4)$

(iv) Name various types of heat transfer equipment with its specific application (any four)

b) **Answer any <u>ONE</u> of the following:** **6**

(i) Derive an expression to find out rate of heat transfer through a composite wall of three materials of different thickness having different thermal conductivities.

(ii) Compare forward and backward feed arrangements in multiple effect evaporator. (any four)

5. **Answer any <u>TWO</u> of the following:** **16**

a) What is the fouling factor? Calculate the overall heat transfer coefficient from the following data:

h_i = 5800 w/m^2K

h_o = 1750 w/m^2K

d_o = 0.03m

d_i = 0.02 m

k of metal wall = 46.52 w/mK

Marks

b) A solution containing 5% solid is to be concentrated to 30% solid in a single effect evaporator. Feed rate is 30,000 kg/hr and boiling point elevation is 7 K. Steam is fed to the evaporator at a pressure corresponding to the saturation temperature of 399 K.

Calculate steam economy.

Feed temperature = 298 K

Specific heat of feed = 4.1 KJ/kg K.

Latent heat of condensation of steam at 399 K = 2185 KJ/kg

Latent heat of vaporisation of water at 373 K = 2257 KJ/kg

c) Thermic fluid flowing at a rate of 5000 kg/hr is to be cooled from 423 K to 363 K by circulating water at a rate of 15000 kg/hr.

If water is available at 303 K, find the outlet temperature of water.

Specific heat of thermic fluid = 2.72 KJ/kg K

Specific heat of water = 4.2 KJ/kg K.

6. Answer any <u>TWO</u> of the following: **16**

a) Derive the relation between individual heat transfer coefficient and over all heat transfer coefficient.

b) Give four dimensionless groups and explain the terms involved.

c) With a neat diagram explain the construction and working of forced circulation evaporator with external heating element.

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