## Scheme - I

## Sample Question Paper

**Program Name** : **Diploma in Chemical Engineering**
**Program Code** : **CH**
**Semester** : **Fifth**
**Course Title** : **Heat Transfer Operations**
**Marks** : **70**

**22510**

**Time: 3 Hrs.**

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**Instructions:**
(1) All questions are compulsory.
(2) Illustrate your answers with neat sketches wherever necessary.
(3) Figures to the right indicate full marks.
(4) Assume suitable data if necessary.
(5) Preferably, write the answers in sequential order

**Q.1 Answer any five** **10 Marks**

a) Define thermal conductivity.
b) Define natural convection and forced convection.
c) Give the expression for Nusselt number and state its significance.
d) State Stefan Boltzman law with mathematical expression.
e) Give the classification of shell and tube heat exchanger.
f) Define capacity and economy of an evaporator.
g) Name different flow arrangements used in heat exchangers.

**Q.2 Answer any three** **12 Marks**

a) Explain Fourier's law of heat conduction with mathematical expression.
b) Explain Wilson plot. Give its use.
c) Explain construction of calendria type evaporator with neat sketch.
d) State and explain Kirchhoff's law of radiation.

**Q.3 Answer any three** **12 Marks**

a) A 50 mm i.d. iron pipe at 423 K passes through a room in which the surroundings are at 300 K. If the emissivity of the pipe metal is 0.8, what is the net interchange of radiation energy per meter length of pipe? The outside diameter of pipe is 60 mm.
b) Differentiate between single pass and multi pass heat exchanger.
c) Name the heat exchanger used for handling corrosive fluids. With a neat sketch explain its construction.
d) Explain how various properties of solution affect evaporation operation.

**Q.4 Answer any three** **12 Marks**

a) Explain reflectivity, absorptivity and transmissivity of a body. Give example (one each) for materials whose reflectivity=1 and transmissivity = 1.

b) Calculate the overall heat transfer coefficient from the following data:
Inside heat transfer coefficient = 6000 $W/m^2K$
Outside heat transfer coefficient = 1900 $W/m^2K$
Outside diameter of tube = 20 $W/m^2K$
Inside diameter of tube= 15 $W/m^2K$
Thermal conductivity of metal wall =40 W/mK

c) Derive the expression for rate of heat flow by conduction through a composite wall of different materials.

d) Differentiate between dropwise and filmwise condensation.

e) Identify the feed arrangement for multiple effect evaporation system suitable for handling viscous feed. Explain it in detail.

**Q.5 Answer any two** **12 Marks**

a) Derive the relation between overall and individual heat transfer coefficients.

b) In a double pipe counter current flow heat exchanger, 5000 kg/h of an oil having a specific heat of 2100 J/kg.K is cooled from 350 K to 323 K by 4000 kg/h of water entering at 298 K. Calculate the heat exchanger area for an overall heat transfer coefficient of 300 $W/m^2K$. Cp for water = 4180 J/kg.K.

c) An evaporator is operating at atmospheric pressure. It is desired to concentrate a feed from 8% solute to 30% solute (by weight) at a rate of 10000 kg/h. Dry saturated steam at a pressure corresponding to the saturation temperature of 399 K is used. The feed is at 298 K and the boiling point rise is 6 K. The overall heat transfer coefficient is 2350 $W/m^2K$. Calculate the economy of the evaporator and the area of heat transfer to be provided.
Latent heat of condensation of steam at 399 K = 2185 kJ/kg
Latent heat of vaporisation of water at 373 K and 101.325 kPa = 2257 kJ/kg
Specific heat of feed = 4.187 kJ/kg.K

**Q.6 Answer any two** **12 Marks**

a) 88 mm outside diameter pipe is insulated with a 40 mm thickness of an insulation having a thermal conductivity of 0.057 W/m.K and 30 mm thickness of an insulation having a thermal conductivity of 0.042 W/m.K. If the temperature of the outer

surface of the pipe is 560 k and the temperature of the outer surface of insulation is 310 K, calculate the heat loss per meter of pipe.

b) Calculate the heat transfer coefficient for the fluid flowing through a tube having inside diameter 40 mm at a rate of 5500 kg/h. Assume that the fluid is being heated.
Viscosity of flowing fluid = 0.004 N.s/$m^2$
Density of flowing fluid = 1.07 g/$cm^3$
Specific heat of flowing fluid = 2.72 kJ/kg.K N.s/$m^2$
Thermal conductivity of flowing fluid = 0.256 W/m.K
Make use of Dittus- Bolter equation.

c) Explain construction and working of plate type heat exchanger with neat sketch. Give its advantages.

## Scheme - I

## Sample Test Paper - I

**Program Name** : **Diploma in Chemical Engineering**

**Program Code** : **CH**

**Semester** : **Fifth**

**22510**

**Course Title** : **Heat Transfer Operations**

**Marks** : **20** **Time: 1 Hour**

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**Instructions:**

(1) All questions are compulsory.
(2) Illustrate your answers with neat sketches wherever necessary.
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(4) Assume suitable data if necessary.
(5) Preferably, write the answers in sequential order

**Q.1 Attempt any FOUR.** **08 Marks**

a) List out different modes of heat transfers with examples.
b) Define heat transfer coefficient. Write its S.I. units.
c) Define emissive power.
d) Define optimum thickness.
e) Write formula of Reynold's Number and its significance.
f) Give statement of Fourier's Law.

**Q.2 Attempt any THREE.** **12 Marks**

a) Derive the formula of rate of heat transfer through a cylinder.
b) Write the Sider-Tate and Dittus-Bolter equation for calculating heat transfer coefficients in laminar and turbulent flow. Give the meanings of terms involved in it.
c) .A hollow sphere has an inside surface temperature of 573 K and outside surface temperature 303 K. Find the heat loss by conduction for an inside diameter of 50 mm and outside diameter of 150 mm. (Data K=17.45 W/m.K)
d) A hot fluid enters a double pipe heat exchanger at a temperature of 423 K and is to be cooled to 367 K by a cold fluid entering at 311K and heated to 339 K. Shall they be directed in parallel or counter-current flow.
e) Derive the formula for rate of heat transfer for sphere with variable thermal conductivity, where k = a+bT
f) Find the overall heat transfer coefficient if i) Inside and outside film heat transfer coefficients are 12 and 11600 W/($m^2$.K) respectively.
ii) ID & OD are 25mm and 29mm respectively
iii) Thermal conductivity of metal = 34.9 (W /$m^2$.K)

## Scheme - I

## Sample Test Paper - II

**Program Name** : **Diploma in Chemical Engineering**
**Program Code** : **CH**
**Semester** : **Fifth**
**Course Title** : **Heat Transfer Operations**
**Marks** : **20**

**22510**

**Time: 1 Hour**

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**Instructions:**
(1) All questions are compulsory.
(2) Illustrate your answers with neat sketches wherever necessary.
(3) Figures to the right indicate full marks.
(4) Assume suitable data if necessary.
(5) Preferably, write the answers in sequential order

**Q.1 Attempt any FOUR.** **08 Marks**

a) Give basic difference between evaporation and drying.
b) Define a) Cooler b) Condenser.
c) Draw triangular and square pitch arrangement in shell and tube heat exchanger.
d) Explain why economy of single effect evaporator is always less than "1."
e) Write mathematical statement for Plank'law.
f) Define grey body.

**Q.2 Attempt any THREE.** **12 Marks**

a. Write down and derive the expression of Kirchhoff's Law.
b. Draw the diagram of 2-4 shell and tube heat exchanger with appropriate labeling.
c. Hot oil at rate of 1.2 kg/sec ($C_p$=2083 J/Kg.K) flows through double pipe heat exchanger. It enters at 633 K and leaves at 573 K. Cold fluid enters at 303 K and leaves at 400 K. If the overall heat transfer coefficient is 500 W/$m^2$.K, calculate heat transfer area for counter-current flow.
d. An evaporator operating at atmospheric pressure is fed at the rate of 10,000 Kg/hr of weak liquor containing 4% caustic soda. Thick liquor leaving the evaporator contains 25% caustic soda. Find the capacity of the evaporator.
e. Draw the diagrams which represents the Forward and Backward Feed Multiple Effect Evaporation system.
f. Explain Finned tube heat exchanger system with diagram.