Code No: 07A40801 **R07** **Set No. 2**

II B.Tech II Semester Examinations,APRIL 2011
PROCESS HEAT TRANSFER
Chemical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) What are the advantages and disadvantages of more number of passes on tube side and shell side of shell and tube heat - exchanger.
   (b) Find out the length of the tube required for the following heat transfer where air is heated by exhaust gases.
   Q (heat transfer/hr) = 8000 Kcal.
   Inside (D_i) and outside diameter (D_o) of tube are 5 cm and 6 cm respectively.
   H_i (Inside heat transfer coefficient Air side) = 100 Kcal/m^2hr ^{0}C
   h_o (out heat transfer coefficient gas side) = 160 Kcal/m^2hr ^{0}C
   T_{hi} = 400 ^{0}C T_{ho} = 150 ^{0}C T_{ci} = 50 ^{0}C T_{co} = 100 ^{0}C
   Neglect the tube resistance and assume flow arrangement is parallel.
   If the flow is made counter current then what is the percentage saving in the tube length. [8+8]

2. (a) Discuss the regimes of boiling heat transfer with the help of a boiling curve. Why is heat transfer coefficients lowered in film boiling as compared to nucleate boiling?
   (b) What are the types of condensation? Which type is advantageous. [11+5]

3. A horizontal cylinder 0.025m diameter and 0.5m long is suspended in water at 20 ^{0}C. Calculate the rate of heat transfer if the cylinder surface is at 60 ^{0}C. Use the following correlation. $Nu = 0.53\ (Gr\ Pr)^{0.25}$. Physical properties of water at the mean film temperature are : K = 0.63 w/m ^{0}K; Viscosity = 2.35kg/m.h; Density = 992 kg/m^3; Pr = 4.3. [16]

4. Liquid Benzene at 75^{0}C is to be cooled to 40^{0}C. Flow rate of Benzene is 1.45kg/sec while the cooling water flow rate is 0.95kg/sec. cooling water is circulating through the tubes at a temperature of 15^{0}C. Calculate the heat transfer area required for
   (a) single pass co-current and counter current flow H.E
   (b) Multipass shell and tube heat exchanger.
   Data available; specific heat of Benzene = 1760J/kgk
   specific heat of water = 4180J/kg^{o}k
   LMTD correction factor = 0.94. [16]

5. (a) Derive an expression for steady state conduction through a wall of hollow sphere of inner radius r_1 and outer radius r_0, thermal conductivity 'k' the inside and outside surfaces of the wall are at constant temperatures T_1 and T_2. show that the mean area employ in the equation is equal to $\sqrt{A_1 A_0}$
   (b) A copper plate (k=372 w/m^{0}C) is 3mm thick. It is protected from corrosion by 2mm thick layer of stainless steel (k=17w/m^{0}C) on both the sides. The temperatures of the two outer surfaces of steel are 400^{0}C and 100^{0}C. calculate the temperature at the two interfaces. [8+8]

Code No: 07A40801 **R07** **Set No. 2**

6. A single effect evaporator is to concentrate 9070 kg/hr of a 20% solution of NaOH to 60% solids. The gauge pressure of the steam is 1.5 kgf/cm^2. The absolute pressure in the vapour space is 100mm Hg. The feed temperature is 38^{0}C and the overall heat transfer coefficient is 1220 Kcal/m^2 hr ^{0}C (1420W/m^{0}2 K). Calculate the steam consumption, economy and the heating surface required.
   DATA: Boiling point of water at 100mm Hg = 51^{0}C
   Boiling point elevation = 56^{0}C
   Enthalpy of feed at 38^{0}C = 30.6 Kcal/Kg
   Enthalpy of Thick Liquor = 156 Kcal/Kg. [16]

7. A gas at -15 ^{0}C flows over a flat plate maintained at 5 ^{0}C. Free stream velocity of gas is 12.5m/s. The length of the plate is 3.8m. Calculate the average value of heat transfer coefficient with and without accounting for the laminar boundary layer. Properties of gas: Density = 1.247 kg/m^3; Specific heat = 1005 J/kg ^{0}K; thermal conductivity = 0.0251 w/ m ^{0}K. Viscosity = 1.76 $\times$ 10^{-5} N-s/m^2. [16]

8. Two large parallel planes having emissivitys of 0.4 and 0.6 are maintained at temperatures of 820K and 420K , respectively. A radiation shield having an emissivity of 0.06 on both sides is placed between the two planes. Calculate.
   (a) the heat- transfer rate per unit area if the shield were not present
   (b) the heat - transfer rate per unit area with the shield present. [16]

⋆ ⋆ ⋆ ⋆ ⋆

Code No: 07A40801 **R07** **Set No. 4**

II B.Tech II Semester Examinations,APRIL 2011
PROCESS HEAT TRANSFER
Chemical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. Liquid Benzene at 75^0C is to be cooled to 40^0C. Flow rate of Benzene is 1.45kg/sec while the cooling water flow rate is 0.95kg/sec. cooling water is circulating through the tubes at a temperature of 15^0C. Calculate the heat transfer area required for
   (a) single pass co-current and counter current flow H.E
   (b) Multipass shell and tube heat exchanger.
   Data available; specific heat of Benzene = 1760J/kgk
   specific heat of water = 4180J/kg^{o}k
   LMTD correction factor = 0.94. [16]

2. (a) What are the advantages and disadvantages of more number of passes on tube side and shell side of shell and tube heat - exchanger.
   (b) Find out the length of the tube required for the following heat transfer where air is heated by exhaust gases.
   Q (heat transfer/hr) = 8000 Kcal.
   Inside (D_i) and outside diameter (D_o) of tube are 5 cm and 6 cm respectively.
   H_i (Inside heat transfer coefficient Air side) = 100 Kcal/m^{2}hr ^{0}C
   h_o (out heat transfer coefficient gas side) = 160 Kcal/m^{2}hr ^{0}C
   T_{hi} = 400 ^{0}C T_{ho} = 150 ^{0}C T_{ci} = 50 ^{0}C T_{co} = 100 ^{0}C
   Neglect the tube resistance and assume flow arrangement is parallel.
   If the flow is made counter current then what is the percentage saving in the tube length. [8+8]

3. (a) Discuss the regimes of boiling heat transfer with the help of a boiling curve. Why is heat transfer coefficients lowered in film boiling as compared to nucleate boiling?
   (b) What are the types of condensation? Which type is advantageous. [11+5]

4. A single effect evaporator is to concentrate 9070 kg/hr of a 20% solution of NaOH to 60% solids. The gauge pressure of the steam is 1.5 kgf/cm^2. The absolute pressure in the vapour space is 100mm Hg. The feed temperature is 38^0C and the overall heat transfer coefficient is 1220 Kcal/m^2 hr ^{0}C (1420W/m^{0}2 K). Calculate the steam consumption, economy and the heating surface required.
   DATA: Boiling point of water at 100mm Hg = 51^0C
   Boiling point elevation = 56^0C
   Enthalpy of feed at 38^0C = 30.6 Kcal/Kg
   Enthalpy of Thick Liquor = 156 Kcal/Kg. [16]

5. (a) Derive an expression for steady state conduction through a wall of hollow sphere of inner radius r_1 and outer radius r_0, thermal conductivity 'k' the inside and outside surfaces of the wall are at constant temperatures T_1 and T_2. show that the mean area employ in the equation is equal to $\sqrt{A_1 A_0}$
   (b) A copper plate (k=372 w/m^{0}C) is 3mm thick. It is protected from corrosion by 2mm thick layer of stainless steel (k=17w/m^{0}C) on both the sides. The

temperatures of the two outer surfaces of steel are 400^0C and 100^0C. calculate the temperature at the two interfaces. [8+8]

6. A horizontal cylinder 0.025m diameter and 0.5m long is suspended in water at 20 ^{0}C. Calculate the rate of heat transfer if the cylinder surface is at 60 ^{0}C. Use the following correlation. Nu = 0.53 (Gr Pr)$^{0.25}$. Physical properties of water at the mean film temperature are : K = 0.63 w/m ^{0}K; Viscosity = 2.35kg/m.h; Density = 992 kg/m^3; Pr = 4.3. [16]

7. Two large parallel planes having emissivitys of 0.4 and 0.6 are maintained at temperatures of 820K and 420K , respectively. A radiation shield having an emissivity of 0.06 on both sides is placed between the two planes. Calculate.
   (a) the heat- transfer rate per unit area if the shield were not present
   (b) the heat - transfer rate per unit area with the shield present. [16]

8. A gas at -15 ^{0}C flows over a flat plate maintained at 5 ^{0}C. Free stream velocity of gas is 12.5m/s. The length of the plate is 3.8m. Calculate the average value of heat transfer coefficient with and without accounting for the laminar boundary layer. Properties of gas: Density = 1.247 kg/m^3; Specific heat = 1005 J/kg ^{0}K; thermal conductivity = 0.0251 w/ m ^{0}K. Viscosity = 1.76×10^{-5} N-s/m^2. [16]

⋆ ⋆ ⋆ ⋆ ⋆

Code No: 07A40801 **R07** **Set No. 1**

II B.Tech II Semester Examinations,APRIL 2011
PROCESS HEAT TRANSFER
Chemical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. A horizontal cylinder 0.025m diameter and 0.5m long is suspended in water at 20 ^{0}C. Calculate the rate of heat transfer if the cylinder surface is at 60 ^{0}C. Use the following correlation. Nu = 0.53 (Gr Pr)$^{0.25}$. Physical properties of water at the mean film temperature are : K = 0.63 w/m ^{0}K; Viscosity = 2.35kg/m.h; Density = 992 kg/m^3; Pr = 4.3. [16]

2. Liquid Benzene at 75^{0}C is to be cooled to 40^{0}C. Flow rate of Benzene is 1.45kg/sec while the cooling water flow rate is 0.95kg/sec. cooling water is circulating through the tubes at a temperature of 15^{0}C. Calculate the heat transfer area required for
   (a) single pass co-current and counter current flow H.E
   (b) Multipass shell and tube heat exchanger.
   Data available; specific heat of Benzene = 1760J/kgk
   specific heat of water = 4180J/kg°k
   LMTD correction factor = 0.94. [16]

3. A single effect evaporator is to concentrate 9070 kg/hr of a 20% solution of NaOH to 60% solids. The gauge pressure of the steam is 1.5 kgf/cm^2. The absolute pressure in the vapour space is 100mm Hg. The feed temperature is 38^{0}C and the overall heat transfer coefficient is 1220 Kcal/m^2 hr ^{0}C (1420W/m^{0}2 K). Calculate the steam consumption, economy and the heating surface required.
   DATA: Boiling point of water at 100mm Hg = 51^{0}C
   Boiling point elevation = 56^{0}C
   Enthalpy of feed at 38^{0}C = 30.6 Kcal/Kg
   Enthalpy of Thick Liquor = 156 Kcal/Kg. [16]

4. (a) Discuss the regimes of boiling heat transfer with the help of a boiling curve. Why is heat transfer coefficients lowered in film boiling as compared to nucleate boiling?
   (b) What are the types of condensation? Which type is advantageous. [11+5]

5. Two large parallel planes having emissivitys of 0.4 and 0.6 are maintained at temperatures of 820K and 420K , respectively. A radiation shield having an emissivity of 0.06 on both sides is placed between the two planes. Calculate.
   (a) the heat- transfer rate per unit area if the shield were not present
   (b) the heat - transfer rate per unit area with the shield present. [16]

6. (a) What are the advantages and disadvantages of more number of passes on tube side and shell side of shell and tube heat - exchanger.

(b) Find out the length of the tube required for the following heat transfer where air is heated by exhaust gases.
Q (heat transfer/hr) = 8000 Kcal.
Inside (D_i) and outside diameter (D_o) of tube are 5 cm and 6 cm respectively.
H_i (Inside heat transfer coefficient Air side) = 100 Kcal/m^2hr ^{0}C
h_o (out heat transfer coefficient gas side) = 160 Kcal/m^2hr ^{0}C
T_{hi} = 400 ^{0}C T_{ho} = 150 ^{0}C T_{ci} = 50 ^{0}C T_{co} = 100 ^{0}C
Neglect the tube resistance and assume flow arrangement is parallel.
If the flow is made counter current then what is the percentage saving in the tube length. [8+8]

7. (a) Derive an expression for steady state conduction through a wall of hollow sphere of inner radius r_1 and outer radius r_0, thermal conductivity 'k' the inside and outside surfaces of the wall are at constant temperatures T_1 and T_2. show that the mean area employ in the equation is equal to $\sqrt{A_1 A_0}$

(b) A copper plate (k=372 w/m^{0}C) is 3mm thick. It is protected from corrosion by 2mm thick layer of stainless steel (k=17w/m^{0}C) on both the sides. The temperatures of the two outer surfaces of steel are 400^{0}C and 100^{0}C. calculate the temperature at the two interfaces. [8+8]

8. A gas at -15 ^{0}C flows over a flat plate maintained at 5 ^{0}C. Free stream velocity of gas is 12.5m/s. The length of the plate is 3.8m. Calculate the average value of heat transfer coefficient with and without accounting for the laminar boundary layer. Properties of gas: Density = 1.247 kg/m^3; Specific heat = 1005 J/kg ^{0}K; thermal conductivity = 0.0251 w/ m ^{0}K. Viscosity = 1.76×10^{-5} N-s/m^2. [16]

⋆ ⋆ ⋆ ⋆ ⋆

Code No: 07A40801 **R07** **Set No. 3**

II B.Tech II Semester Examinations,APRIL 2011
PROCESS HEAT TRANSFER
Chemical Engineering

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. Two large parallel planes having emissivitys of 0.4 and 0.6 are maintained at temperatures of 820K and 420K , respectively. A radiation shield having an emissivity of 0.06 on both sides is placed between the two planes. Calculate.
   (a) the heat- transfer rate per unit area if the shield were not present
   (b) the heat - transfer rate per unit area with the shield present. [16]

2. (a) What are the advantages and disadvantages of more number of passes on tube side and shell side of shell and tube heat - exchanger.
   (b) Find out the length of the tube required for the following heat transfer where air is heated by exhaust gases.
   Q (heat transfer/hr) = 8000 Kcal.
   Inside (D_i) and outside diameter (D_o) of tube are 5 cm and 6 cm respectively.
   H_i (Inside heat transfer coefficient Air side) = 100 Kcal/m^2hr ^{0}C
   h_o (out heat transfer coefficient gas side) = 160 Kcal/m^2hr ^{0}C
   T_{hi} = 400 ^{0}C T_{ho} = 150 ^{0}C T_{ci} = 50 ^{0}C T_{co} = 100 ^{0}C
   Neglect the tube resistance and assume flow arrangement is parallel.
   If the flow is made counter current then what is the percentage saving in the tube length. [8+8]

3. Liquid Benzene at 75^{0}C is to be cooled to 40^{0}C. Flow rate of Benzene is 1.45kg/sec while the cooling water flow rate is 0.95kg/sec. cooling water is circulating through the tubes at a temperature of 15^{0}C. Calculate the heat transfer area required for
   (a) single pass co-current and counter current flow H.E
   (b) Multipass shell and tube heat exchanger.
   Data available; specific heat of Benzene = 1760J/kgk
   specific heat of water = 4180J/kg^{o}k
   LMTD correction factor = 0.94. [16]

4. (a) Discuss the regimes of boiling heat transfer with the help of a boiling curve. Why is heat transfer coefficients lowered in film boiling as compared to nucleate boiling?
   (b) What are the types of condensation? Which type is advantageous. [11+5]

5. (a) Derive an expression for steady state conduction through a wall of hollow sphere of inner radius r_1 and outer radius r_0, thermal conductivity 'k' the inside and outside surfaces of the wall are at constant temperatures T_1 and T_2. show that the mean area employ in the equation is equal to $\sqrt{A_1 A_0}$
   (b) A copper plate (k=372 w/m^{0}C) is 3mm thick. It is protected from corrosion by 2mm thick layer of stainless steel (k=17w/m^{0}C) on both the sides. The temperatures of the two outer surfaces of steel are 400^{0}C and 100^{0}C. calculate the temperature at the two interfaces. [8+8]

Code No: 07A40801 **R07** **Set No. 3**

6. A single effect evaporator is to concentrate 9070 kg/hr of a 20% solution of NaOH to 60% solids. The gauge pressure of the steam is 1.5 kgf/cm^2. The absolute pressure in the vapour space is 100mm Hg. The feed temperature is 38^{0}C and the overall heat transfer coefficient is 1220 Kcal/m^2 hr ^{0}C (1420W/m^{0}2 K). Calculate the steam consumption, economy and the heating surface required.
   DATA: Boiling point of water at 100mm Hg = 51^{0}C
   Boiling point elevation = 56^{0}C
   Enthalpy of feed at 38^{0}C = 30.6 Kcal/Kg
   Enthalpy of Thick Liquor = 156 Kcal/Kg. [16]

7. A gas at -15 ^{0}C flows over a flat plate maintained at 5 ^{0}C. Free stream velocity of gas is 12.5m/s. The length of the plate is 3.8m. Calculate the average value of heat transfer coefficient with and without accounting for the laminar boundary layer. Properties of gas: Density = 1.247 kg/m^3; Specific heat = 1005 J/kg ^{0}K; thermal conductivity = 0.0251 w/ m ^{0}K. Viscosity = 1.76 $\times$ 10^{-5} N-s/m^2. [16]

8. A horizontal cylinder 0.025m diameter and 0.5m long is suspended in water at 20 ^{0}C. Calculate the rate of heat transfer if the cylinder surface is at 60 ^{0}C. Use the following correlation. Nu = 0.53 (Gr Pr)$^{0.25}$. Physical properties of water at the mean film temperature are : K = 0.63 w/m ^{0}K; Viscosity = 2.35kg/m.h; Density = 992 kg/m^3; Pr = 4.3. [16]

⋆ ⋆ ⋆ ⋆ ⋆