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

II B.Tech II Semester Examinations,April/May 2012
PROCESS HEAT TRANSFER
Chemical Engineering

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

Answer any FIVE Questions
All Questions carry equal marks

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1. What is Fourier's law of heat conduction? Derive the equation for heat flow through cylinder. [16]

2. A 50mm dia steel pipe lagged with asbestes is exposed to ambient air at 300^0k. Determine
   (a) Critical radius of insulation
   (b) Heat loss per unit length of tube covered with critical radius of insulation and without insulation. If the tube and Insulation interface temperature is 480^0K.
   thermal conductivity of steel pipe = 45w/m^{0}K.
   thermal conductivity of asbestas insulation = 0.17w/m^{0}K.
   Convective heat transfer coefficient of air = $3w/m^{2\,0}$K. [16]

3. (a) A heat exchanger is to cool organic liquid from 105 to 50^0C. The hot fluid liquid flow rate is 2.8 kg/sec. cooling medium is water which enters at 25^0C and leaves at 40^0C. It is proposed to use 1-2 heat exchanger for the above duty.
   Specific heat of water= 4180 J/kg ^{o}k.
   Specific heat of hot liquid = 26850 J/kg ^{o}k.
   LMTD correction factor = 0.85.
   Over all heat transfer coefficient is 600 W/m^{2o}k.
   Calculate the heat transfer area for a heat exchanger.
   (b) A hot process stream available at 300^0C is to be cooled to 200^0C. The heat is used for heating cold stream from 25^0C to 175^0C. Calculate the log mean temperature difference if the streams flow in counter current manner and co current manner. [10+6]

4. Liquid mercury at a velocity of 1 m/s flows through a tube having inside diameter 25mm. If the wall temperature is maintained constant, calculate the heat transfer coefficient. Properties of mercury are: Density = 12870 kg/m^3; thermal conductivity = 14.0 w/m ^{0}K; Viscosity = 0.863×10^{-3} N-s/m^2; Specific heat = 134 J/kg ^{0}K.Use Nu = 7 + 0.025 (Nre Npr)$^{0.3}$. [16]

5. A panel 0.35 m × 0.35m is maintained at a temperature of 90 ^{0}C. One surface of the panel is insulated. If the surrounding air temperature is 12 ^{0}C, Calculate the average value of the free convection heat transfer coefficient between the panel and the surrounding air when,

(a) Heated surface is in vertical position

(b) Heated surface is in horizontal position facing upward

(c) Heated surface is in horizontal position facing downward.

Physical properties of water are: Density = 1.09 kg/m^3; Viscosity = 1.965 $\times$ 10^{-5} N-s/m^2; Specific heat = 1005 J/kg ^{0}C; thermal conductivity = 0.0284 w/m ^{0}C; Pr = 0.695; Volume coefficient of expansion = 3.086 $\times$ 10^{-3} ^{0}K^{-1}. Use for vertical: Nu = 0.59(Gr Pr)$^{0.25}$; Horizontal Nu = 0.54(Gr Pr)$^{0.25}$ [16]

6. (a) Determine the net heat transfer by radiation between the two surfaces A and B per hour per unit area if the temperatures of A and B are 800^{0}C and 350oC respectively. Emissivities of A and B are 0.9 and 0.25 respectively. Both surfaces are gray and are infinite parallel lines, 3.5 m apart.

   (b) Explain the significance of Stefan-Boltzmann's law. [10+6]

7. A vertical tubular condenser is to be used to condense 2100 kg/h of ethyl alcohol, which enters at atmospheric pressure. Cooling water is to flow through the tubes at an average temperature of 30^{0}C. The tubes are 31mm OD and 27mm ID. The water-side coefficient is 2800 W/m^2 -^{0}C. Fouling factors and resistance of the tube wall may be neglected. If the available tubes are 3m long, how many tubes will be needed? Data: Boiling point of alcohol : T_h = 78.4 ^{0}C.
   Heat of vaporization = 856 j/kg. Density of Liquid = 769 kg/m^3. [16]

8. (a) What are advantages of multiple effect evaporator over single effect evaporator.

   (b) Write in detail on different types of evaporators.

   (c) Indicate the various methods of improving the overall efficiency of evaporators. [4+6+6]

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

II B.Tech II Semester Examinations,April/May 2012
PROCESS HEAT TRANSFER
Chemical Engineering

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

Answer any FIVE Questions
All Questions carry equal marks

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   (a) Critical radius of insulation
   (b) Heat loss per unit length of tube covered with critical radius of insulation and without insulation. If the tube and Insulation interface temperature is 480^0k.
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   Convective heat transfer coefficient of air = $3w/m^{2\,0}k$. [16]

2. (a) What are advantages of multiple effect evaporator over single effect evaporator.
   (b) Write in detail on different types of evaporators.
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3. What is Fourier's law of heat conduction? Derive the equation for heat flow through cylinder. [16]

4. Liquid mercury at a velocity of 1 m/s flows through a tube having inside diameter 25mm. If the wall temperature is maintained constant, calculate the heat transfer coefficient. Properties of mercury are: Density = 12870 kg/m^3; thermal conductivity = 14.0 w/m ^{0}K; Viscosity = 0.863×10^{-3} N-s/m^2; Specific heat = 134 J/kg ^{0}K.Use Nu = 7 + 0.025 (Nre Npr)$^{0.3}$. [16]

5. (a) A heat exchanger is to cool organic liquid from 105 to 50^0C. The hot fluid liquid flow rate is 2.8 kg/sec. cooling medium is water which enters at 25^0C and leaves at 40^0C. It is proposed to use 1-2 heat exchanger for the above duty.
   Specific heat of water= 4180 J/kg ^{o}k.
   Specific heat of hot liquid = 26850 J/kg ^{o}k.
   LMTD correction factor = 0.85.
   Over all heat transfer coefficient is 600 W/m^{2o}k.
   Calculate the heat transfer area for a heat exchanger.
   (b) A hot process stream available at 300^0C is to be cooled to 200^0C. The heat is used for heating cold stream from 25^0C to 175^0C. Calculate the log mean temperature difference if the streams flow in counter current manner and co current manner. [10+6]

6. A panel 0.35 m × 0.35m is maintained at a temperature of 90 ^{0}C. One surface of the panel is insulated. If the surrounding air temperature is 12 ^{0}C, Calculate the average value of the free convection heat transfer coefficient between the panel and the surrounding air when,

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   Physical properties of water are: Density = 1.09 kg/m^3; Viscosity = 1.965×10^{-5} N-s/m^2; Specific heat = 1005 J/kg ^{0}C; thermal conductivity = 0.0284 w/m ^{0}C; Pr = 0.695; Volume coefficient of expansion = 3.086×10^{-3} ^{0}K^{-1}. Use for vertical: Nu = 0.59(Gr Pr)$^{0.25}$; Horizontal Nu = 0.54(Gr Pr)$^{0.25}$ [16]

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   Heat of vaporization = 856 j/kg. Density of Liquid = 769 kg/m^3. [16]

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

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Chemical Engineering

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1. (a) What are advantages of multiple effect evaporator over single effect evaporator.
   (b) Write in detail on different types of evaporators.
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Code No: 07A40801 **R07** **Set No. 3**

II B.Tech II Semester Examinations,April/May 2012
PROCESS HEAT TRANSFER
Chemical Engineering

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

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