

**II B.Tech II Semester Supplementary Examinations, April/May 2005**  
**HEAT TRANSFER**  
**(Chemical Engineering)**

Time: 3 hours

Max Marks: 70

**Answer any FIVE Questions**  
**All Questions carry equal marks**

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1. Heat is flowing through an annular pipe of inside radius  $r_0$  and outside radius  $r_1$ . The thermal conductivity varies linearly with temperature from  $k_0$  at  $T_0$  to  $k_1$  at  $T_1$ . Develop an expression for heat flow through the pipe. Simplify the expression assuming that  $r_1 - r_0$  is very small.  
Interpret the result physically.
2. (a) Develop an expression for temperature distribution in a slab made of single material.  
(b) Calculate the rate of heat loss through a plane of homogeneous wall whose thickness is considerably smaller than its width and length. Assuming the wall to be made from steel ( $k = 40$  W/m K), concrete ( $k = 1.2$ ), Diatomite brick ( $k = 0.12$ ). Wall thickness for all the materials is equal to 5cm. The inner and outer surfaces are at  $1000^\circ\text{C}$  and  $100^\circ\text{C}$  respectively.
3. (a) What is dimensional analysis? Explain any one method of dimensional analysis?  
(b) Ethylene glycol enters a 5 m length of 0.1m diameter copper tube in a cooling system at a velocity of 5 m/s. Estimate the heat transfer rate if the average bulk temperature is  $20^\circ\text{C}$  and the tube wall is maintained at  $100^\circ\text{C}$ . The properties of ethylene glycol at  $20^\circ\text{C}$  are as follows.  
Thermal conductivity is  $0.249 \text{ W/m}^\circ\text{K}$   
Kinematic viscosity is  $1.92 \times 10^{-5} \text{ m}^2/\text{s}$   
 $\text{Pr} = 204$ .
4. (a) Explain the mechanism of forced convection.  
(b) What is Graetz number? When is it computed?  
(c) A straight tube having a diameter of 0.04m carries water with a velocity of 10 m/s. The temperature of tube surface is  $50^\circ\text{C}$  and the flowing water is heated from the inlet temperature  $15^\circ\text{C}$  to an outlet temperature  $25^\circ\text{C}$ . Determine the coefficient of heat transfer from the tube surface to water and the length of the tube required for the above temperature change of water. The physical properties of water at mean bulk temperature  $20^\circ\text{C}$  are:  
Thermal conductivity  $0.5986 \text{ W/(m.K)}$   
Specific heat  $4183 \text{ J/(kg.K)}$   
Kinematic viscosity is  $1.006 \times 10^{-6} \text{ m}^2/\text{s}$   
 $\text{Pr} = 0.702$
5. (a) Explain about film boiling.

- (b) Discuss the merits and demerits of film wise and drop wise condensation.
6. (a) Calculate the net radiant interchange per square meter for two very large planes at temperatures of 600 C and 400 C respectively. Assume that the emissivity of the hot and cold planes are 0.9 and 0.7 respectively.
- (b) A 5 cm oxidized iron pipe at 150 C passes through a room in which the surroundings are at a temperature of 30 C. If the emissivity of the pipe metal is 0.8, what is the net interchange of radiant energy per meter length of the pipe?
- (c) Compute the heat loss from a 10 mm dia circular opening in a large enclosed furnace. The temperature within the furnace is 1000 C and the surrounding temperature is 25 C. Assume black-body radiation.
7. (a) Derive the relationship between effectiveness and number of transfer units for a parallel flow heat exchanger.
- (b) Determine the heat transfer area required for a heat exchanger constructed from a 2 cm OD tube to cool 26,000 kg/hr of an alcohol solution ( $C_p = 3.81$  kJ/kgK) from 90 to 50°C, using  $H_2O$  which enters at 20°C and leaves at 40°C and for the following arrangements:
- co current shell and tube
  - counter current shell and tube heat exchanger, alcohol in shell and  $H_2O$  through the tubes. (Assume correction factor for LMTD = 0.95). Assume that the overall heat transfer coefficient based on the outer tube area is 830 kJ/hrm<sup>2</sup>K.
8. (a) What is meant by economy in evaporation and how does it vary with multiple effect evaporation?
- (b) What are the advantages and disadvantages of multipass heat exchangers over single pass heat exchangers?
- (c) Explain the functions of baffles in shell and tube heat exchangers?

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