Code No: RR320306

**Set No. 1**

**III B.Tech II Semester Supplementary Examinations, Aug/Sep 2007**
**HEAT TRANSFER**
**( Common to Mechanical Engineering and Automobile Engineering)**

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

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

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1. (a) The surface of steel plate measuring 0.9m long x 0.6m wide x 0.025m thick is maintained at a uniform temperature of $300^0$C, and the plate loses 250 watt by radiation. If air at $15^0$C temperature and 20 w/$m^2$-deg convective heat transfer coefficient blows over the plate, calculate the temperature on inside surface of the plate. Take thermal conductivity of plate as 45w/m-deg.

   (b) Derive expressions for temperature distribution during steady sate heat conduction in a solid sphere with internal heat generation. [8+8]

2. Consider a slab of thickness L and constant thermal conductivity k in which energy is generated at a constant rate of qW/$m^2$. The boundary surface at x=0 is insulated and that at x=L dissipates heat by convection with a heat transfer coefficient into a fluid at temperature of $T_\alpha$. Derive expression for the temperature and heat flux in the slab. Calculate the temperatures at the surfaces x=0 and x=L under the following conditions. L=10mm, k=20W/mK,q=$8\times10^7$ W/$m^3$, h = 4000 W/$m^2$K and $T_\alpha = 100^0$C. [16]

3. A wall of thickness 100 mm is insulated on one side and other side is exposed to $0^0$C. Determine the wall temperature insulated surface if the internal heat generation in the wall is at the rate of $10^6$ W/$m^3$. Take k = 40 W/mK. [16]

4. (a) A flat electrical heater of 0.4 m x 0.4 m size is placed vertically in still air at $20^0$C. The heat generated is 1200 w/$m^2$. Determine the value of convective heat transfer co-efficient and the average plate temperature.

   (b) Explain Grashoff number significance in natural convective heat transfer.[10+4]

5. (a) Calculate the average co-efficient of heat transfer for natural convection for a vertical plate 30.48 cm high at $51.67^0$C. The surrounding air is at $23.9^0$C. Also calculate the boundary layer thickness at the trailing edge of plate.

   (b) What is the criterion for transition from laminar to turbulent flow in free convective heat transfer. [12+4]

6. (a) Distinguish between filmwise and dropwise condensation. Which of the two gives a higher heat transfer coefficient? Why?

   (b) Dry saturated steam at a pressure of 2.5 bar condenses on the surface of a vertical tube of height 1.5m. The tube surface temperature is $120^0$C. Estimate the thickness of the condensate film and the local heat transfer coefficient at a distance of 0.3m from the upper end of the tube. [6+10]

7. (a) Derive a general expression for interchange factor for radiation between two non-black parallel surfaces of same area.

   (b) Two opposed, parallel infinite planes are maintained at $400^0$C and $460^0$C respectively. Calculate the net radiant heat flux between these planes if one has an emissivity of 0.6 and the other an emissivity of 0.4. [10+6]

8. Steam is condensed in a single pass condenser at a pressure of 0.5 bar. The condenser consists of 100 thin walled tubes of 2.5 cm nominal diameter and 2m length .The cooling water enters and leaves at a temperature of $10^0$C and $50^0$C with a mean velocity of 2 m/Sec. The condensing heat transfer coefficient is 5 KW/$m^2$-K . Find

   (a) Overall heat transfer coefficient for heat exchanger

   (b) Condensation rate of steam

   (c) Mean temperature of metal at the center of condenser length. [16]

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Code No: RR320306 **Set No. 2**

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**HEAT TRANSFER**
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**Time: 3 hours** **Max Marks: 80**
**Answer any FIVE Questions**
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1. (a) Set up expressions for temperature distribution during steady state heat conduction in a solid sphere with internal heat generation.
   (b) Explain the mechanism of thermal heat conduction in liquids. Discuss the effect of temperature on thermal conductivity. [8+8]

2. A composite slab consists of 250 mm fire clay brick (k=1.09 W/mK) inside, 100 mm fired earth brick(0.26 W/mK) and outer layer of common brick (0.6 W/mK) of thickness 50 mm. If inside surface is at $1200^0$C and outside surface is at $100^0$C, find
   (a) heat flux,
   (b) the temperature of the junctions and
   (c) the temperature at 200 mm from the outer surface of the wall. [16]

3. Derive the general equation for the temperature distribution along a fin? State different boundary conditions and derive the equations for heat flow for
   (a) fin with insulated end and
   (b) long fin. [16]

4. (a) Give a general equation for the rate of heat transfer by convection.
   (b) List the various factors on which the value of this coefficient depends. [10+6]

5. What do you understand by the hydrodynamics and thermal boundary layers. Illustrate with reference to flow over a flat heated plate. [16]

6. (a) Distinguish between filmwise and dropwise condensation. Which of the two gives a higher heat transfer coefficient? Why?
   (b) Dry saturated steam at a pressure of 2.5 bar condenses on the surface of a vertical tube of height 1.5m. The tube surface temperature is $120^0$C. Estimate the thickness of the condensate film and the local heat transfer coefficient at a distance of 0.3m from the upper end of the tube. [6+10]

7. Two large parallel planes having emissivities 0.3 and 0.5 are maintained at temperatures of 800K and 400K respectively. A radiation shield having an emissivity of 0.5 on both sides is placed between the two plates. 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

(c) the temperature of the shield. [16]

8. (a) In a gas turbine recuperator, the exhaust gases after expansion in the turbine are used to heat the compressed air so that the capacity ratio is very close to unity. show that under the condition , E = 1-exp(-NTU) for counter flow.

   (b) A counter flow heat exchanger operates using river water as coolant. During the winter, water is available at $7.5^0$C . The exchanger cools 2000 kg/hr of oil ($C_p$ = 2.5 kJ/kg-K)entering at $205^0$C to $100^0$C. Find

      i. water flow rate and

      ii. NTU. [8+8]

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Code No: RR320306 **Set No. 3**

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1. (a) Discuss the different modes by which heat be transferred. Give suitable example to illustrate your answer .
   (b) Write the fourier rate equation for heat transfer by conduction. Give the units and physical significance of each term appearing in this equation. [8+8]
2. (a) The rear window of an automobile is defogging by passing warm air at $40^0$C over its inner surface and associated heat transfer coefficient is 30 W/$m^2$K. The out side ambient temperature is $-10^0$C and the associated heat transfer coefficient 65W/$m^2$K. Estimate the inner and outer surface temperatures of the window, if window glass (0.2 W/mK) is 4 mm thick.
   (b) A solid cylinder rod of diameter 10 mm and length 150 mm is the insulated on its cylindrical surfaces. Determine the heat flow rate through the rod if k= 0.78 W/mK. The temperatures of the ends of the rods are $0^0$C and $100^0$C respectively. [8+8]
3. (a) Derive the expression for temperature distribution with solid slab with heat generation of 1. Both surface temperatures of the slab are $T_w$ K and at the center is $T_0$ K.
   (b) A long cylinder rod of radius 50 cm with thermal conductivity of 10 W/mK contains radioactive material, which generates heat uniformly within the cylinder at rate of 3X$10^5$ W/$m^3$. The rod is cooled by convection from its cylindrical surface into the ambient air at $T_\alpha = 50^0$C with a heat transfer coefficient of 60 W/$m^2$K. Determine the temperature at the end center and at the outer surface of the cylindrical rod? [7+9]
4. (a) Give a general equation for the rate of heat transfer by convection.
   (b) List the various factors on which the value of this coefficient depends. [10+6]
5. (a) A thin 80 cm long and 8 cm wide horizontal plate is maintained at a temperature of $130^0$C in a large tank full of water at $70^0$C. Estimate the rate of heat input into the plate necessary to maintain the temperature of $130^0$C.
   (b) Differentiate velocity and thermal Boundary layers by a neat diagram. [8+8]
6. (a) A heated polished copper plate is immersed in a pool of water boiling at atmospheric pressure. If the surface of the copper plate is maintained at a temperature of $125^0$C, find the surface heat flux and the evaporation rate per unit area of the plate.

(b) A 10mm dia, 1m long copper tube with a scored surface is to be used to boil water adjacent to the external surface at atm pr, Calculate the surface temperature of the tube so that it operates at half the maximum heat flux. Find also the heat dissipation rate and the evaporation rate of water. [8+8]

7. (a) Distinguish between a black body and grey body.

   (b) Prove that intensity of radiation is given by $I_b = E_b/\Pi$

   (c) State and explain Kirchoff's identity? What are the condition's under which it is applicable. [4+6+6]

8. A chemical (Sp.heat = 3.55 kj/kg-K ) flowing at the rate of 3.8 kg /Sec enters a parallel flow heat exchanger at $94^0$C. Cooling water enters the exchanger at $10^0$C , the flow rate being 6.30 Kg/Sec . The heat transfer area is 15 $m^2$ and overall heat transfer coefficient is 1.132 kW/$m^2$-K. Find the outlet temperature of chemical and water and the thermal ratio of heat exchanger . If the quantities remain unchanged , Find the area required for a counter flow heat exchanger. [16]

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   (b) Derive expressions for temperature distribution during steady sate heat conduction in a solid sphere with internal heat generation. [8+8]

2. (a) Define the overall heat transfer coefficient? Obtain the expression composite wall with three layer with convective conditions over the wall?
   (b) A wall consists of three layers of 0.2 m concreter, 0.08 m of fibre glass insulation and 0.015 m gypsum board (0.04 W/mK). The convective heat transfer coefficients at inside and outside surfaces are 15 and 45 W/$m^2$K respectively. The inside and outside surface temperatures are $25^0$C and $-10^0$C respectively. Calculate the overall heat transfer coefficients for the wall and heat loss per unit area. [7+9]

3. (a) Derive the expression for temperature distribution with solid slab with heat generation of 1. Both surface temperatures of the slab are $T_w$ K and at the center is $T_0$ K.
   (b) A long cylinder rod of radius 50 cm with thermal conductivity of 10 W/mK contains radioactive material, which generates heat uniformly within the cylinder at rate of $3X10^5$ W/$m^3$. The rod is cooled by convection from its cylindrical surface into the ambient air at $T_\alpha = 50^0$C with a heat transfer coefficient of 60 W/$m^2$K. Determine the temperature at the end center and at the outer surface of the cylindrical rod? [7+9]

4. (a) Explain the Buckingham's $\Pi-$?Theorem for dimensional analysis.
   (b) What are repeating variables and how are they selected for dimensional analysis. [10+6]

5. What do you understand by the hydrodynamics and thermal boundary layers. Illustrate with reference to flow over a flat heated plate. [16]

6. (a) Distinguish between filmwise and dropwise condensation. Which of the two gives a higher heat transfer coefficient? Why?

(b) Dry saturated steam at a pressure of 2.5 bar condenses on the surface of a vertical tube of height 1.5m. The tube surface temperature is $120^0$C. Estimate the thickness of the condensate film and the local heat transfer coefficient at a distance of 0.3m from the upper end of the tube. [6+10]

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8. Two identical counter flow type heat exchangers are available. Water ($C_p = 4.2$ KJ/Kg-K ) at the rate of 1Kg/sec and at $30^0$Cis heated by cooling an oil ($C_p = 2.1$ kJ/kg-K at $90^0$C.the oil flow rate is 0.75 Kg/sec. The heat transfer area in each heat exchanger is $4m^2$. The heat exchangers are connected in series on water side and in parallel on the oil side . The oil flow rate is split in the ratio 2:1 as 0.5 kg/sec in the first and 0.25 Kg/sec in the second exchanger .Water enters the first heat exchangers at $30^0$C.Calculate the final water and oil temperature. Overall heat transfer coefficient in each heat exchangers is 300 W/$m^2$-K. [16]

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