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| Invigilator's Signature : | |

CS/B.Tech(AUE-OLD)/SEM-4/AUE-402/2012 2012

HEAT TRANSFER AND COMBUSTION

Time Allotted: 3 Hours Full Marks: 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP - A (Multiple Choice Type Questions)

1. Choose the correct alternatives for the following :

 $10 \times 1 = 10$

- i) The concept of log mean area is normally used in the analysis of
 - a) composite plane surface
 - b) cylindrical surface
 - c) spherical surface
 - d) any plane surface.

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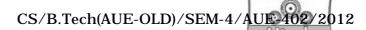
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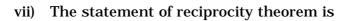


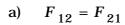
- ii) The value of k' in (w/m^c) for glass is near about
 - a) 20 35
- b) 0.2 0.4
- c) 0.7 0.75
- d) 0.03 0.05.
- iii) The wavelength of thermal radiation in μm is
 - a) $10^2 10^5$
- b) $0.01 10^2$
- c) $10^{-2} 10^{-5}$
- d) $10^5 10^{10}$.
- iv) The rate of radial heat transfer through a hollow cylinder increases as the ratio of outer radius to inner radius
 - a) decreases
- b) increases
- c) remains same
- d) unpredictable.
- v) The unit of the thermal diffusivity is
 - a) m²/hr°C
- b) kcal/hr°C

c) m^2/s

- d) m/s^2 .
- vi) A non-dimensional number not associated with natural convection is
 - a) Reynolds number
- b) Nusselt number
- c) Grashoff number
- d) Prandtl number.







b)
$$A_1F_{12} = A_2F_{21}$$

c)
$$A_2 F_{12} = A_1 F_{21}$$

d) all of these.

viii) For a white body transmissivity is equal to

- a) reflectivity
- b) one
- c) constant
- d) zero.

ix) All grey bodies obey the

- a) Kirchhoff's law
- b) Stefan-Boltzman law
- c) Fourier's law
- d) Wien's law.

x) Nusselt number is given by

a) $\mu C_p/k$

b) $\mu k/C_p$

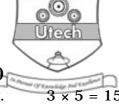
c) hL/k

d) hk/L.

GROUP - B

(Short Answer Type Questions.)

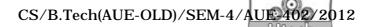
Answer any three of the following.



2

- 2. Derive an expression for heat flow in radial direction for a hollow cylinder (inside radius r_i and outside radius r_o) of length L and uniform thermal conductivity k under steady state and without any heat generation. The inner and outer surface temperatures of the cylinder are T_i and T_o respectively.
- 3. Prove that for unidirectional heat conduction through a slab of uniform thermal conductivity (k) under steady state and with constant heat generation (q) per unit volume, the differential equation is $d^2T/dx^2 + q/k = 0$.
- 4. What is shape factor? Write the various features of shape factor.
- 5. A slab of length 'L' and uniform thermal conductivity k is generating heat at a constant rate (q) per unit volume. The temperatures at two ends are found to be T_1 and T_2 ($T_1 > T_2$). Find out the temperature at a distance x measured from the end where the temperature is T_1 .
- 6. a) Explain the term 'critical radius of insulation'.
 - b) Derive an expression for critical radius of insulation for the case of a cylinder.3

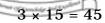
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GROUP - C

(Long Answer Type Questions)

Answer any three of the following.



- 7. a) Derive the general three dimensional differential equation of heat conduction with internal heat generation for a rectangular coordinate system.
 - b) The wall in a furnace consists of 125 mm thick refractory bricks ($k=1.6~\rm W/mK$), 150 mm thick insulating firebricks ($k=0.3~\rm W/mK$). A 15 mm plaster ($k=0.14~\rm W/mK$) covers the outer wall. The inner surface of the wall is at 1100°C and the ambient temperature is 25°C. The heat transfer coefficient on the outside wall to the air is 17 W/m 2 K. Calculate
 - i) the rate of heat loss per unit area of wall surface
 - ii) the two interface temperatures

Draw the equivalent thermal cicuit.

8

- 8. a) Derive an expression for heat flow in radial direction and maximum temperature for a solid cylinder of radius R and length L, uniform thermal conductivity k under steady state and with internal heat generation q/unit volume. The outer surface temperature of the cylinder is T_{w} .
 - b) A spherical ball ($k=0.5~\rm W/m^{\circ}C$) 100 mm diameter generates heat at 6500 W/m 3 . If the external surface temperature is 15 $^{\circ}C$, calculate
 - i) temperature at the centre
 - ii) heat flow from outer surface.

8

CS/B.Tech(AUE-OLD)/SEM-4/AUE-402/2012

- 9. a) Derive an expression for heat flow in a very long fin.
 - b) One end of a very long steel rod is maintained at 200°C while the other end is into a fluid with temperature 25°C. The diameter of the rod is 3 mm and the thermal conductivity of the rod material is 240 W/mK. If the heat transfer co-efficient between the rod surface and fluid is 400 W/m ²K, determine the heat dissipation rate of the fin.
- 10. a) Derive an expression for log mean temperature difference (LMTD) in case of parallel flow heat exchanger.
 - b) a parallel flow heat exchanger hot $(C_p = 4.2 \text{ kJ/kg K})$ flows the of at rate 50000 kg/hr, and gets cooled from 95°C to 65°C. At the same time 13.89 kg/s cooling water at 30°C enters the heat exchanger. The overall heat transfer coefficient is 2270 W/m ²°C. Determine the heat transfer area and the effectiveness of heat exchanger. 7



- 11. a) Derive an expression for the shape factor in case of radiation heat exchange between two black bodies and prove that F_{1-2} $A_1 = F_{2-1}$ A_2 .
 - b) What is the difference between natural and forced convection?