Code No. : 5198/M

FACULTY OF ENGINEERING

B.E. 3/4 (Mech./A.E.) II Semester (Main) Examination, May/June 2012

HEAT TRANSFER

Time: 3 Hours] [Max. Marks:75

Note : *Answer **all** questions from Part **A**, answer **any five** questions from Part **B**.*

PART – A (25 Marks)

1. Write the governing equation for temperature in two dimensional steady state conditions and boundary conditions applicability. (2½)
2. What is 'time constant' and what is its significance ? (2½)
3. How are friction of flow on a plate and heat transfer related ? (2½)
4. What are the practical conditions under which a real surface can be considered as black body ? (2½)
5. When hot water is poured into a bucket of cold water, what type of heat exchanger it is ? (2½)
6. State unsteady, three dimensional and heat generation case in form of governing equation. (2½)
7. What is the difference between dimesionless heat transfer coefficient and biot number ? (2½)
8. In an internal flow, how does rate of heat transfer vary in a developing layer and developed layer ? (2½)
9. Human skin is a black body. How can you prove it ? (2½)
10. How do you calculate natural convection boiling heat transfer ? Draw the diagram and write formulae. (2½)

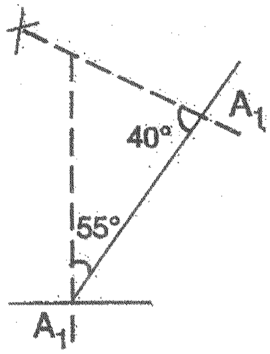
PART – B (50 Marks)

11. Consider a steam pipe of length 10 m, inner radius of 5 cm and outer radius of 7 cm with thermal conductivity of 20 W/m°C. The inner and outer surfaces are at 473° K and 373°K respectively.
    i) Calculate the temperature distribution in the thickness of the pipe.
    ii) If for the same inner temperature if the outer temperature also needs to be same i.e, uniform temperature in the thickness of the pipe, what is the minimum thickness required ? Temperature distribution from highest to lowest can be within 10°K.

12. A long 20 cm diameter cylindrical shaft made of stainless steel comes out of an oven at a uniform temperature of 873° K. The shaft cools in an environment of 473° K with a heat transfer coeff. of 80 $w/m^2°C$. Determine the temperature at the center of the shaft 45 min after the start of cooling process. Determine the rate of heat transfer per unit length during this span.

13. Consider two large isothermal plates separated by 2 mm thick oil film. The upper plate moves at a constant velocity of 12 cm/sec while the lower plate is stationary. Both plates are maintained at 20°C.
    a) Obtain relations for velocity and temperature distributions in the oil.
    b) Determine the maximum temperature in the oil and the heat flux from the oil to each plate.

14. A small surface of area $A_1 = 3\ cm^2$ emits radiation as a black body at $T_1 = 600$ ° K part of radiation emitted by A_1 strikes another small surface of area $A_2 = 5\ cm^2$ oriented as follows. Determine solid angle subtended by A_2 when viewed from A_1 and rates at which radiation emitted by A_1 that strikes A_2.



15. Water is boiled at 1 atm pressure on a stainless surface. Calculate :
    a) Peak heat flux
    b) Minimum heat flux.

16. Consider a long resistance wire of radius 0.2 cm and thermal conductivity 15 w/m°C in which heat is generated uniformly as a result of resistance heating at a constant rate of 50 W/cm^3. The wire is embedded in a 0.5 cm thick layer of ceramic whose thermal conductivity is 1.2 W/m°C. If the outer surface temperature of the ceramic layer is measured to be 45°C, determine the temperatures at the center of the resistance wire and the interface of the wire and ceramic layer under steady state conditions.

17. A hot surface at 100°C is to be cooled by attaching 3 cm long, 0.25 cm diameter aluminium pin fin of K = 237 w/m°C, to it. The temperature of the surrounding medium is 30°C and the heat transfer coefficient on the surfaces is 35 $W/m^2°C$. Determine the rate of heat transfer from the surface, fin effectiveness, fin efficiency. Assume fin with negligible heat loss from the tip.

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