**R15**

**Code No: 126VF**

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**

**B. Tech III Year II Semester Examinations, April - 2018**

**HEAT TRANSFER**

**(Common to AME, MSNT, ME)**

**Time: 3 hours** **Max. Marks: 75**

**Note:** This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

## PART - A

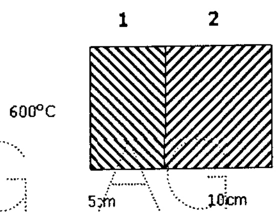
**(25 Marks)**

1.a) What do you mean by steady state heat transfer. [2]
b) What are the initial and boundary conditions for conduction of heat transfer? [3]
c) What is heat generation in a solid? Give examples. [2]
d) What is lumped heat capacity method? Explain. [3]
e) Draw boundary layer over a flat plate in moving fluid and mark various salient points. [2]
f) What is the significance of non- dimensional numbers? [3]
g) Define critical heat flux. [2]
h) Define Stefan Boltzmann constant. [3]
i) What is LMTD correction factor? [2]
j) List out the applications of heat exchangers. [3]

## PART - B

**(50 Marks)**

2. Find the steady state heat flux through the infinite composite slab made up of two materials. Also find the interface temperature $T_i$. The thermal conductivities of the two materials vary linearly with temperature as [10]
$k_1 = 0.05\,(1+0.008T)$ W/mK
$k_2 = 0.04\,(1+0.075T)$ W/mK
Where T is $^0$C




**OR**

3. A furnace wall is built up of two layers laid of fireclay 12cm thick and red brick 25 cm thick while the annular space between the two is filled with diatomite brick (15cm). What should be the thickness of the red brick layer if the wall is to be constructed without diatomite brick, so that the heat flow through the wall remains constant? The thermal conductivities of fireclay, diatomite and red brick being 0.929, 0.129 and 0.699 W/m$^0$c respectively. [10]

4. Derive the equation for steady-state heat transfer through a spherical shell of inner radius $r_1$ and outer radius $r_2$ and compare the result with the solution obtained for a thick walled cylinder. [10]

**OR**

5.a) Derive an expression for heat flow through solid sphere with heat generation.

b) Derive an expression for the heat loss per square metre of the surface area for a furnace wall when the thermal conductivity varies with temperature according to the relation, $K = a + bT^2$. [5+5]

6.a) Discuss briefly thermal and hydrodynamic boundary layer and obtain Reynold's analogy in forced convection.

b) A plate 20cm height and 1m wide is placed in air at $20^0$C. If the surface of the plate is maintained at $100^0$C calculate the boundary layer thickness and local heat transfer coefficient at 10cm from the leading edge. Also calculate the average heat transfer coefficient over the entire length of the plate. [5+5]

**OR**

7. Determine the heat transfer rate by free convection from a plate 0.3m × 0.3m for which one surface is insulated and the other surface is maintained at $110^0$C and exposed to atmosphere air at $30^0$C for the following arrangements:

a) The plate is vertical

b) The plate is horizontal with the heating surface facing up

c) The plate is horizontal with the heating surface facing down. [10]

8.a) Using dimensional analysis obtain an expression for Nusselt number in terms of Reynolds and Prandtl numbers.

b) A light oil with $20^0$C inlet temperature flows at the rate of 500 kg/minute through 5cm inner diameter pipe which is enclosed by a jacket containing condensing steam at $150^0$C. If the pipe is 10 meter long, find the outlet temperature of the oil. [5+5]

**OR**

9.a) Two parallel plate 3m × 2m are spaced at 1m apart one plate is maintained at $500^0$C and other at $200^0$C. The emissivity of the plates are 0.3 and 0.5. The plates are located in a large room and room walls are maintained at $40^0$C. If the plates exchange heat with each other and with the room, find the heat lost by the hotter plate.

b) Define absorptivity, reflectivity and transmissivity. [7+3]

10. Calculate the heat transfer area required for a 1-1 shell and tube heat exchanger which is used to cool 55000 kg/hr of alcohol from 66 $^0$C to 40 $^0$C using 40,000 kg/hr of water entering at 5 $^0$C. $U = 580$ W/m$^2$ K, consider

a) counter flow b) parallel flow.

$C_P$ water = $4.18 \times 10^3$ J/kg K

$C_p$ alcohol = $3.76 \times 10^3$ J/kg K [10]

**OR**

11. It is required to design a shell and tube heat exchanger for heating 9000 kg/hr of water from 15 $^0$C to 88 $^0$C by hot engine oil (Cp = 2.35 kJ/kg-K ) flowing through the shell of the heat exchanger . The oil makes a single pass, entering at 150 $^0$C and leaving at 95 $^0$C with an average heat transfer coefficient of 400 W/m$^2$-K, the water flow through 10 thin walled tubes of 25mm diameter with each tube making 8 passes through the shell. The heat transfer efficient on the water side is 3000 W/m$^2$-K. Find the length of the tube required the heat exchanger. [10]

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