**Code No: 136CA** **R16**

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**
**B. Tech III Year II Semester Examinations, May - 2019**
**HEAT TRANSFER**
**(Mechanical Engineering)**

**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) Define Newton's law of cooling. [2]
b) Explain the term boundary conditions. [3]
c) Discuss the physical interpretation of thermal diffusivity. [2]
d) How does the fin efficiency differ from fin effectiveness? [3]
e) What is the difference between local and average convection heat transfer? [2]
f) Draw a neat sketch showing laminar and turbulent regions of the boundary layer during flow over a flat plate. [3]
g) Define Reynolds analogy. [2]
h) List out the assumptions made during derivation of expression for LMTD. [3]
i) State and explain the Wien – Displacement Law. [2]
j) Differentiate between film wise and drop wise condensation. [3]

## PART - B

**(50 Marks)**

2.a) What is meant by thermal resistance? Explain the electrical analogy for solving heat transfer problem.
b) A mild steel tank of wall thickness 10mm contains water at $90^0$C. Calculate the rate of heat loss per $m^2$ of tank surface area when the atmospheric temperature is $15^0$C. The thermal conductivity of mild steel is 50 W/m K and the heat transfer co-efficient for inside and outside the tank is 2800 and 11 $W/m^2K$ respectively. Calculate also the temperature of the outside surface of the tank. [5+5]

**OR**

3.a) What is the critical thickness of insulation on a small diameter wire or pipe. Explain its physical significance and derive the expression for same.
b) The wall of a cold room is composed of three layers. The outer layer is brick 30cm thick. The middle layer is cork 20 cm thick, the inside layer is cement 15 cm thick. The temperatures of the outside air is $25^0$C and on the inside air is $-20^0$C. The film co-efficient for outside air and brick is 55.4 $W/m^2K$. Film co-efficient for inside air and cement is 17 $W/m^2K$. Find heat flow rate. [5+5]
Assume
k for brick = 2.5 W/mK
k for cork = 0.05 W/mK
k for cement = 0.28 W/mK

4. A 12 cm diameter cylindrical bar initially at a uniform temperature of $40^0C$ is placed in a medium at $650^0C$ with a convective heat transfer coefficient of 22 $w/m^2$ K. Determine the time required for centre to reach $255^0C$. Also calculate the temp of the surface. Take k=0.2 w/mK; P = 580 $kg/m^3$, $C_p$ = 1050 kJ/kg. [10]

**OR**

5.a) Develop an expression for temperature distribution in a slab made of single material.

b) Sheets of brass and steel, each of thickness 1cm, are placed in contact. The outer surface of brass is kept at $100^0C$ and the outer surface of steel is kept at $0^0C$. What is the temperature of the common interface? The thermal conductivities of brass and steel are in the ratio of 2:1. [5+5]

6.a) Explain the Raleigh's method of dimensional analysis giving an example.

b) How do you determine Grasshof number? State its physical significance. [5+5]

**OR**

7.a) What do you understand by hydrodynamic and thermal boundary layers? Illustrate with reference to flow over a heated flat plate. How is the boundary layer thickness defined?

b) A water heater is fabricated by a resistance wire wound uniformly over a 10 mm diameter and 4m long tube. The resistance element maintains a uniform heat flux of $1000W/m^2$. The mass flow rate of water is 12kg/hr and its inlet temperature is $10^0C$. Estimate the surface temperature of tube at the exit. [5+5]

8.a) Discuss how the geometric parameter of the pipe, physical properties of the fluid and its velocity influence the heat transfer coefficient in the fluid flow in a pipe.

b) Water at $30^0C$ is flowing through a pipe of 25 mm inner diameter at a rate of 1 $m^3/hr$. Find the heat transfer coefficient in water if the length of the pipe is 50 cm. The thermal conductivity, density and kinematic viscosity of water are 0.63 $W/m^0K$, 980 $Kg/m^3$, and $0.6 \times 10^{-6}$ $m^2/s$ respectively. [5+5]

**OR**

9. In a heat exchanger, water flows through a 0.02 m inner diameter copper tube at a velocity of 1.5 m/s. The water entering the tube at $15^0C$ is heated by steam condensing at $100^0C$ on the outside surface of the tube. What would be heat transfer coefficient for water if it is to leave the pipe at $45^0C$? The physical properties of water at the bulk temperature $30^0C$ are as follows. Thermal conductivity is 0.6172 W/(m.K)
Kinematic Viscosity $0.805 \times 10^{-6}$ $m^2/s$
Density 995 $kg/m^3$.
Specific heat 4171 J/(kg.K). [10]

10.a) A black body is kept at a temperature of 1000k. Determine the fraction of thermal radiation emitted by the surface in the wavelength band 1.0 to 6.0μ.

b) Estimate the rate of solar radiation on a plate normal to the sun rays. Assume the sun to be a black body at a temperature of $5527^0C$. The diameter of the sun is $1.39 \times 10^6$km and its distance from the earth is $1.5 \times 10^8$ km. [5+5]

**OR**

11.a) Define the terms
i) Absorptivity
ii) Reflectivity and
iii) Transmissivity.

b) Differentiate between specular and diffuse reactions.

c) Derive Stefan-Boltzmann's law from Plank's law. [10]

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