Code No: 156BC **R18**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B. Tech III Year II Semester Examinations, February - 2023
HEAT TRANSFER
(Mechanical Engineering)

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

Note: i) Question paper consists of Part A, Part B.
ii) Part A is compulsory, which carries 25 marks. In Part A, Answer all questions.
iii) In Part B, Answer any one question from each unit. Each question carries 10 marks and may have a, b as sub questions.

PART – A

(25 Marks)

1.a)	What are the applications of heat transfer?	[2]
b)	What do you understand by initial and boundary conditions?	[3]
c)	What is meant by Lumped heat analysis? Explain with the help of an example.	[2]
d)	Define Fin efficiency and fin effectiveness.	[3]
e)	State Buckingham π- theorem.	[2]
f)	What are the advantages and limitations of dimensional analysis?	[3]
g)	What is fouling factor? Explain.	[2]
h)	Define Grashoff Number and Stanton Number.	[3]
i)	What is condensation? How does it occur?	[2]
j)	Write the use and importance of Plank's Law.	[3]

PART – B

(50 Marks)

2.a) With relevant examples, explain mechanism of conduction, convection and radiation.
b) Explain clearly basic laws of heat transfer. [5+5]

OR

3.a) A Stainless steel plate is of 2 cm thick is maintained at a temperature of 550 ^{0}C at one face and 50 ^{0}C on the other. The thermal conductivity of stainless steel at 300 ^{0}C is 19.1 W/m K. Calculate the heat transferred through the material per unit area.
b) In what way is the science of heat transfer different from thermodynamics? Explain. [5+5]

4.a) Explain why the conductivity of metals decreases and conductivity of insulating material increases with increases in temperature.
b) A metallic plate, 3cm thick is maintained at 400 ^{0}C on one side and 100 ^{0}C on the other side. How much heat is transferred through the plate? Take k for the metallic plate as k=370 W/m-K. [5+5]

OR

5.a) Discuss briefly thermal and hydrodynamic boundary layer and obtain Reynold's analogy in forced convection.
b) A plate 20 cm 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]

6.a) Describe Buckingham's method of π-terms to formulate a dimensionally homogenous equation.

b) A flat plate 1m wide and 1.5 m long is to be maintained at 90 ^{0}C in air when free stream temperature is 10 ^{0}C. Determine the velocity at which air must flow over the plate so that the rate of energy dissipation from the plate is 3.75 kW. [5+5]

OR

7. Air at 27^{0}C and 1 atm flows over a flat plate at a speed of 2m/s. Calculate the boundary layer thickness at a distance of 20 and 40 cm from the leading edge of the plate. Calculate the mass flow which enters the boundary layer between x= 20 cms and x = 40 cms. The viscosity of the air is at 27 ^{0}C is 1.85 × 10 $^{-5}$ kg/m s. Assume the unit depth in the z- direction. [10]

8.a) A flat electrical heater of 0.4 m × 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. [5+5]

OR

9. A Counter flow heat exchanger consisting of two concentric flow passages is used for heating 1200 kg/hr of oil (specific heat=2.1kJ/kgK) from an initial temperature of 27 ^{0}C. The oil is flowing through the inner pipe and the convective heat transfer coefficient on the oil side is 750 W/m ^{2}K. The inner and outer radii of the inner pipe are 12 mm and 15 mm and the thermal conductivity of the pipe materials is 350 W/mK. The oil is heated by hot water supplied at the rate of 400 kg/hr at the inlet temperature of 92 ^{0}C. The waterside heat transfer coefficient is 1470 W/m ^{2}K. The length of the heat exchanger is 9 m. What are the terminal temperatures of the two fluids? [10]

10. A drying plant needs hot air at 135^{0}C. This is obtained by passing 2.45 kg/Sec of atmospheric air at 1 bar pressure and 27^{0}C over tubes through which hot glycerin is circulated. The tubes have 20mm diameter, 1.5mm thickness, with a thermal conductivity of the material of the tube 50 W/m-K. The hot glycerin enters at 210 ^{0}C and leaves at 305^{0}C. Assuming counter flow, Find:
a) Overall heat transfer coefficient
b) Total heating surface. [5+5]

OR

11.a) i) Distinguish between a black body and grey body.
ii) Prove that intensity of radiation is given by $I_b = E_b/\pi$.

b) State and explain Kirchoff's identity. What are the conditions under which it is applicable? [5+5]

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