R16

Code No: 136CA

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech III Year II Semester Examinations, March - 2024

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.
iv) Approved data book is permitted.

PART – A

(25 Marks)

1.a) From a heat transfer point of view, what is the difference between isotropic and un-isotropic materials? [2]

b) How does one-dimensional heat transfer differ from two-dimensional heat transfer? [3]

c) What is heat generation in a solid? Give examples. [2]

d) Consider heat transfer between two identical hot solid bodies and the air surrounding them. The first solid is being cooled by a fan while the second one is allowed to cool naturally [3]

e) In which mode of heat transfer is the convection heat transfer coefficient usually higher, natural convection or forced convection? Why? [2]

f) What is external forced convection? How does it differ from internal forced convection? Can a heat transfer system involve both internal and external convection at the same time? Give an example. [3]

g) How does a cross-flow heat exchanger differ from a counter-flow one? What is the difference between mixed and unmixed fluids in cross-flow? [2]

h) What is natural convection? How does it differ from forced convection? What force causes natural convection currents? [3]

i) What is the difference between pool boiling and flow boiling? [2]

j) State and explain the Wien – Displacement Law. [3]

PART – B

(50 Marks)

2.a) Consider a cold canned drink left on a dinner table. How would you model the heat transfer to the drink? As one-, two-, or three-dimensional? Would the heat transfer be steady or transient? Also, which coordinate system would you use to analyze this heat transfer problem, and where would you place the origin? Explain.

b) State and explain the different types of boundary conditions applied to heat conduction problems. [5+5]

OR

3.a) Consider a round potato being baked in an oven. Would you model the heat transfer to the potato as one-, two-, or three-dimensional? Would the heat transfer be steady or transient? Also, which coordinate system would you use to solve this problem, and where would you place the origin? Explain.

b) Give three applications of heat transfer that involve all the three modes of heat transfer. Explain each one in detail. [5+5]

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

b) Derive an expression for the heat loss per square meter 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]

OR

5.a) What criterion are considered while deigning and selecting a fin?

b) Define the effectiveness of a fin while justifying its usage. [5+5]

6.a) What is meant by dimensional analysis? Explain in brief.

b) Discuss briefly thermal and hydrodynamic boundary layer and obtain Reynold's analogy in forced convection. [5+5]

OR

7.a) How are the average friction and heat transfer coefficients determined in flow over a flat plate?

b) Engine oil at 80^0C flows over a 6-m-long flat plate whose temperature is 30^0C with a velocity of 3 m/s. Determine the total drag force and the rate of heat transfer over the entire plate per unit width. [5+5]

8. Determine the hydrodynamic entry length for flow at a bulk temperature of 60^0C at a rate of 0.015 kg/s of water through a circular tube of inside diameter 2.5cm. [10]

OR

9.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 $1000 W/m^2$. 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]

10.a) What is the difference between film and drop-wise condensation? Which is a more effective mechanism of heat transfer?

b) Consider film condensation on the outer surfaces of a tube whose length is 10 times its diameter. For which orientation of the tube will the heat transfer rate be the highest: horizontal or vertical? Explain. Disregard the base and top surfaces of the tube. [5+5]

OR

11.a) Derive an expression for the shape factor in case of a radiation exchange between two surfaces.

b) Show that the emissive power if a black body is π – times the intensity of emitted radiation. [5+5]

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