

R18

Code No: 156BC

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 designing 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°C flows over a 6-m-long flat plate whose temperature is 30°C 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°C 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 1000W/m^2 . The mass flow rate of water is 12kg/hr and its inlet temperature is 10°C . 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]