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

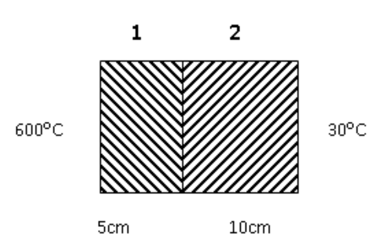
(25 Marks)

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 20^0C. If the surface of the plate is maintained at 100^0C 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 110^0C and exposed to atmosphere air at 30^0C 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 20^0C 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 150^0C. 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 500^0C and other at 200^0C. 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 40^0C. 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 = 4.18×10^3 J/kg K
C_p alcohol = 3.76×10^3 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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R18

Code No: 156BC

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B. Tech III Year II Semester Examinations, August/September - 2021
HEAT TRANSFER
(Mechanical Engineering)

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

Answer any five questions
All questions carry equal marks
- - -

1.a) What is the significance of different modes of heat transfer? Explain with suitable examples.

b) A certain building wall consists of 0.25 m of concrete (k = 1.8 W/m K), 0.05 m of fiber glass insulation and 15 mm of gypsum board (k = 0.03 W/m K). The inside and outside convection coefficient is 15 W/m^2 K and 40 W/m^2 K respectively. The outside air temperature is – 8 ^{0}C and the inside temperature is 28 ^{0}C. Calculate the overall heat transfer coefficient for the wall, the R value, and the heat loss per area. [8+7]

2.a) Explain the need of boundary conditions in solving heat conduction problems? Discuss different types of boundary conditions.

b) A long hollow cylinder has its inner and outer surfaces maintained at temperatures T_b and T_a respectively. The inner and outer radii are b and a respectively. Calculate the temperature profile in the solid section of the cylinder and determine the flux at both surfaces. Assume steady state condition. [7+8]

3. A hair dryer may be idealized as a circular duct through which a small fan draws ambient air and within which the air is heated as it flows over a coiled electric resistance wire. If a dryer is designed to operate with an electric power consumption of 1000 W and to heat the air from an ambient temperature of 25^{0}C to a discharge temperature of 50^{0}C, at what volumetric flow rate should the fan operate? Heat loss from the casing to the ambient air and the surroundings may be neglected. If the duct has a diameter of 75 mm, what is the discharge velocity of the air? The density and specific heat of the air is 1.1089 kg/m^3 and 1005 J/kg K. [15]

4. A brass rod in the form of a fin 100 mm long and 5 mm in diameter extends horizontally from a casting which is at 200^{0}C. The air temperature is 20^{0}C and provides a heat transfer coefficient of 30 W/m^2-K. What is the heat transfer from the rod? Evaluate the temperature of the rod at 50 mm from the base and at the free tip. Now, if this fin is replaced by two identical fins of 50 mm length. All other parameters and dimensions remain the same. What is the heat transfer from this combination? Evaluate the temperature of the fin at the tip. [15]

5.a) Under what conditioning a small mass can be considered as lumped body for unsteady state condition? Explain.

b) Engine oil at 40^{0}C flows with a velocity of 1 m/s over a 2 m long plate plate whose surface is maintained at uniform temperature of 80^{0}C. Determine the local and average heat transfer coefficients. [8+7]

6.a) A horizontal fluorescent tube which is 3.8 cm in diameter and 120 cm long stands in still air at 1 atm. and 20^0C. If the surface temperature of the tube is 40^0C and radiation is neglected, what percentage of power is being dissipated by convection? Take properties of air as $v = 16.19 \times 10^{-6}$ m^2/sec., K air = 0.02652 W/m K, Pr = 0.706, $p = 1.02$ kg/m^3, $C_p = 1.004$ kJ/kg K

b) Explain with neat sketch development of velocity boundary layer on hot and cold vertical plate subjected to Natural Convection. [8+7]

7.a) Discuss the different processes of condensation of vapour on solid surface with suitable diagrams.

b) In an oil cooler, oil enters at 160^oC. If water entering at 35^0C flows parallel to oil, the exit temperature of oil and water are 90^0C and 70^0C respectively. Determine the exit temperature of oil and water if the two fluids flow in opposite directions. Assume that the flow rates of the two fluids and U_o remain unaltered. What would be the minimum temperature to which oil could be cooled in parallel flow and counter-flow operations? [8+7]

8.a) What is a gray body? How does its emissivity value will vary for the real surface?

b) An enclosure measures 1.5 m × 1.7 m with a height of 2 m. The walls and ceiling are maintained at 250^0C and the floor at 130^0C. The walls and ceiling have an emissivity of 0.82 and the floor 0.7. Determine the net radiation to the floor. [8+7]

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R15

Code No: 126VF

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B. Tech III Year II Semester Examinations, December - 2018
HEAT TRANSFER
(Common to ME, AME, MSNT)

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

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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) Give an example of combined convection and radiation mode of heat transfer. [2]
b) What is thermal diffusivity? [3]
c) How the fin thickness influences the efficiency of a fin. [2]
d) What is infinite long cylinder in analysis of transient heat conduction? [3]
e) How Prandtl number links the velocity and temperature fields. [2]
f) What is hydrodynamic layer while analyzing convective heat transfer? [3]
g) What is film wise and drop wise condensation. [2]
h) What is a grey body? [3]
i) How LMTD and AMTD differs. [2]
j) What is NTU method of a heat exchanger? [3]

PART - B

(50 Marks)

2.a) Discuss about the thermal properties of matter.
b) An ice chest whose outer dimensions are 300mm × 400mm × 400mm is made of 30 mm thick Styrofoam (k =0.033W/m ^{0}C). Initially the chest is filled with 40 kg of ice at 0^0C, and the inner surface temperature of the ice chest can be taken to be 0^0C at all times. The heat of fusion of ice at 0^0C is 333.7kJ/kg, and the surrounding ambient air is at 30^0C. Neglecting any heat transfer from the 400mm × 400mm base of the ice chest, determine how long will it take for the ice in the chest to melt completely if the outer surfaces of the ice chest are at 8^0C. [5+5]

OR

3. Derive the heat conduction equation in a cartesian coordinate system. [10]

4.a) What criteria's are considered while deigning and selecting a fin?
b) Define the effectiveness of a fin while justifying its usage. [5+5]

OR

5. Briefly describe about lumped heat capacity system. Give its examples. [10]

6. Air at 27^0C 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 27^0C is 1.85×10^{-5} kg/m s. Assume the unit depth in the z- direction. [10]

OR

7. Liquid bismuth flows at a rate of 4.5 kg/s through a 5 cm diameter stainless steel tube. The bismuth enters at 415^0 C and is heated to 440^0C as it passes through the tube. If a constant heat flux is maintained at along the tube and the tune wall is at a temperature 20^0C higher than bismuth bulb temperature, calculate the length of the tube required to affect the heat transfer. [10]

8. How the condensation and boiling phenomenon heat transfer takes place. Give basic equations. [10]

OR

9. Two perfectly black parallel planes 1.2 by 1.2 m are separated by a distance of 1.2 m. one plane is maintained at 800 K and the other at 500 K. The plates are located in a large room whose walls are at 300K. What is the net heat transfer between the planes? [10]

10.a) What are compact heat exchangers?

b) What is the purpose of a regenerator? [5+5]

OR

11. Hot oil (c_p = 2.09 kJ/kg K) flows through a counter flow heat exchanger at the rate of 0.7kg/s. it enters at 200^0C and leaves at 70^0C. the cold oil (c_p = 1.67 kJ/kg K) exits at 150^0C at the rate of 1.2 kg/s. Determine the surface area of the heat exchanger required for the purpose if the overall heat transfer coefficient is 650W/m^2K. [10]

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R15

Code No: 126VF

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech III Year II Semester Examinations, December - 2018

HEAT TRANSFER

(Common to ME, AME, MSNT)

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Code No: 156BC **R18**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech III Year II Semester Examinations, February/March - 2022

HEAT TRANSFER

(Mechanical Engineering)

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

Answer any five questions

All questions carry equal marks

- - -

1.a) Derive steady state general Heat conduction equation without heat generation in cylindrical systems.

b) Write down the equation for conduction of heat through a slab or Plane wall. [10+5]

2.a) List the assumptions made while analyzing the heat flow from a finned surface.

b) A 2cm thick steel slab heated to 525^0C is held in air stream having a mean temperature of 25^0C. Estimate the time interval when the slab temperature would not depart from the mean value of 25^0C by more than 0.5^0C at any point in the slab. The steel plate has the following thermos-physical properties: ρ = 7950 kg/m^3, c_p = 455 J/kg-^{0}C, k = 46 W/m-^{0}C.h (heat transfer coefficient on plate surface) = 36 W/m^2-^{0}C. [5+10]

3.a) What are repeating variables and how are they selected for dimensional analysis?

b) 3000 kg of water is heated per hour from 30^0C to 70^0C by pumping it through a certain heated section of a 25 mm diameter tube. If the surface of the heated section is maintained at 110^0C, estimate length of the heated section and the rate of heat transfer from the tube to water. [5+10]

4.a) Derive an expression for LMTD for a Parallel Flow Heat Exchangers.

b) A hot square plate of 75 cm × 75 cm at 120^0C is exposed to atmospheric air at 40^0C. Find the heat lost from both surfaces of the plate if it is kept in vertical position. [8+7]

5.a) Water is boiled at atmospheric pressure by a horizontal polished copper heating element of diameter D = 5 mm and emissivity ϵ= 0.05 immersed in water. If the surface temperature of the heating wire is 350^0C, determine the rate of heat transfer from the wire to the water per unit length of the wire.

b) State and explain the Stefan-Boltzmann law of radiation heat transfer, giving the nomenclature involved in it. [8+7]

6.a) It is required to heat the oil to 300^0C for frying purpose. A long ladle is used in frying pan. The section of the ladle is 5 mm ×18 mm. The surrounding air is at 30^0C and the thermal conductivity of the ladle material is 205 W/mK. If the temperature at a distance of 380 mm from the oil should not exceed 40^0C, determine convective heat transfer coefficient.

b) Derive an expression for temperature distribution under steady state in one dimensional heat conduction for a plane wall. [8+7]

7. An electrically heated thin foil of length L= 25mm and width W = 8 mm is to be used as a wind speed meter. Wind with a temperature T_∞ and velocity U_∞ blows parallel to the longest side. The foil is internally heated by an electric heater dissipating Q (Watts) from both sides and is to be operated in air with $T_\infty = 20^0C$, $C_p = 1.005 kJ/kg\ K$, $v = 1.522 \times 10^{-5}\ m^2/s$, $p = 1.19\ kg/m^3$ and Pr = 0.72. The surface temperature, T_s of the foil is to be measured at the trailing edge - but can be assumed to be constant. Estimate the wind speed when $T_s = 32^0C$ and Q = 0.5 W. [15]

8.a) How heat exchangers of classified.

b) A double-pipe (shell-and-tube) heat exchanger is constructed of a stainless steel ($k = 15.1\ W/m\ ^0C$) inner tube of inner diameter D = 1.5 cm and outer diameter Do = 1.9 cm and an outer shell of inner diameter 3.2 cm. The convection heat transfer coefficient is given to be hi = 800 $W/m^2\ ^0C$ on the inner surface of the tube and $h_0 = 1200\ W/m^2\ ^0C$ on the outer surface. For a fouling factor of $R_ri = 0.0004\ m^2\ ^0C/W$ on the tube side and $R_ro = 0.0001\ m^2\ ^0C/W$ on the shell side, determine:

i) The thermal resistance of the heat exchanger per unit length.

ii) The overall heat transfer coefficients, U; and U_o based on the inner and outer surface areas of the tube, respectively. [5+10]

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