P P SAVANI UNIVERSITY

Fifth Semester of B. Tech. Examination

~~December 2022~~

SEME3011 Heat Transfer

22.11.2022, Tuesday **Time: 10:00 a.m. To 12:30 p.m.** **Maximum Marks: 60**

Instructions:

1. The question paper comprises of two sections.
2. Section I and II must be attempted in separate answer sheets.
3. Make suitable assumptions and draw neat figures wherever required.
4. Use of scientific calculator is allowed.

SECTION – I

Q - 1	**Answer the Following: (Any Five)**	**[05]**	**CO**	**BTL**
(i)	What do you mean by Critical Radius of Insulation?		**2**	**1**
(ii)	Define Biot Number.		**2**	**1**
(iii)	What do you mean by Conduction?		**1**	**1**
(iv)	Define Fourier Law of Cooling.		**1**	**1**
(v)	What do you mean by Thermal Resistance?		**1**	**1**
(vi)	State any Five applications of insulation in the Engineering Field?		**1**	**2**
Q - 2 (a)	Write general heat conduction equation for non-homogeneous material, self heat generating and unsteady three-dimensional heat flow in cartesian coordinates. Name and state the unit of each variable. Case 1: Reduce above equation to one dimensional Case 2: Reduce Case 1 equation for Steady State Conduction Case 3: Reduce Case 2 equation for No Internal Heat Generation	**[06]**	**2**	**3**
Q - 2 (b)	A Mild Steel tank of wall thickness 10 mm contains water at 90 ^{0}C. The thermal conductivity of mild steel is 50 W/m ^{0}C and the heat transfer co-efficient for inside and outside are 2800 and 11 W/m^2 ^{0}C respectively. If the atmosphere temperature is 20 ^{0}C, Calculate 1. The rate of heat loss per m^2 of the tank surface 2. The Temperature of the outside surface of the tank	**[05]**	**4**	**4**
	OR			
Q - 2 (a)	Explain Physical significance of critical thickness of insulation in the case of small diameter wire and steam pipe & derive an expression for the same.	**[06]**	**2**	**3**
Q - 2 (b)	An insulated steam pipe of 160 mm inner diameter and 180 mm outer diameter is covered with 40 mm thick insulation and carries steam at 200 ^{0}C. Thermal conductivity of pipe material is 29 W/m ^{0}C and of insulation is 0.23 W/m ^{0}C. The inside and outside heat transfer co-efficient are 11.6 and 23.2 W/m^2 ^{0}C respectively. If the temperature of surrounding air is 25 ^{0}C, Calculate the rate of heat loss to surrounding from the pipe of 5 m length. Also find the interface temperatures.	**[05]**	**4**	**4**
Q - 3 (a)	Derive an expression for heat transfer through Rectangular infinitely long fin.	**[06]**	**2**	**3**
Q - 3 (b)	Estimate the time required to cook the carrot in boiling water at atmosphere pressure. The carrot is initially at room temperature of 32 ^{0}C and cooking require minimum temperature of 97 ^{0}C at the centre of the carrot. Treat the carrot as a long cylinder of 18 mm diameter and having folloeing properties. Density = 1025 kg/m^3 Specific Heat = 4000 J/Kg K	**[05]**	**4**	**4**

Thermal Conductivity = 3.45 W/m ^{0}C
Convective heat transfer co-efficient = 60 W/m^2 ^{0}C

OR

Q - 3 (a)	Define fin effectiveness and Fin efficiency. Derive their equation for infinitely long fin.	**[06]**	**2**	**3**
Q - 3 (b)	A gas turbine blade made of stainless steel (k = 32 W/m ^{0}C) is 70 mm long, 500 m^2 of cross section area and 120 mm perimeter. The temperature at the root of the blade is 500 ^{0}C and it is exposed to the combustion product of the fuel passing from the turbine at 830 ^{0}C. If the film co-efficient between the blade and the combustion gases is 300 W/m^2 ^{0}C, Determine 1. The temperature at the middle of the blade 2. The rate of heat flow from the blade	**[05]**	**4**	**4**
Q - 4	State the assumptions made during lumped parameter analysis.	**[03]**	**2**	**1**

SECTION – II

Q - 1	**Answer the Following: (Any Five)**	**[05]**		
(i)	Define Prandtl Number.		**3**	**1**
(ii)	Define Solid Angle.		**5**	**1**
(iii)	Define Shape Factor.		**5**	**1**
(iv)	State Newton 's law of cooling.		**3**	**1**
(v)	State Stefan Boltzman 's Law for radiation.		**5**	**1**
(vi)	Define Convection.		**1**	**1**
Q - 2 (a)	Derive an expression for LMTD for Parallel Flow heat exchanger.	**[06]**	**4**	**4**

OR

Q - 2 (a)	Derive an expression for Effectiveness for parallel flow heat exchanger.	**[06]**	**4**	**4**
Q - 2 (b)	In a counter flow heat exchanger, water is heated from 25 ^{0}C to 65 ^{0}C by an oil of specific heat 1.45 kJ/Kg K and the mass flow rate of 0.9 Kg/s. The oil os cooled from 230 ^{0}C to 160 ^{0}C. If the overall heat transfer co-efficient is 420 W/m^2 ^{0}C, Calculate following. 1. The rate of heat transfer 2. The mass flow rate of water 3. The surface area of heat exchanger.	**[05]**	**4**	**5**
Q - 3 (a)	Using Buckingham ∏ Theorem, Derive that Nusselt Number is the function of Reynold and Prandtl Number for Forced Convection.	**[06]**	**3**	**4**

OR

Q - 3 (a)	Derive the equation for Momentum Thickness and Energy Thickness.	**[06]**	**3**	**4**
Q - 4	**Attempt any two.**	**[08]**		
(i)	Derive an expression for Radiation exchange between two infinite parallel plates.		**5**	**3**
(ii)	Write a short note on fouling.		**4**	**2**
(iii)	State and prove Kirchoff 's law for Radiation.		**5**	**4**

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CO : Course Outcome Number BTL : Blooms Taxonomy Level

Level of Bloom's Revised Taxonomy in Assessment

1: Remember	2: Understand	3: Apply
4: Analyze	5: Evaluate	6: Create