QP Code: S253A032 | Reg. No | | | | | | | | | | | AY 23

Gandhi Institute of Engineering and Technology University, Odisha, Gunupur
(GIET University)

B. Tech (Third Semester – Regular & Supplementray) Examinations, November 2025

23BCHPC23001-Heat Transfer

(Chemical Engineering)

Time: 3 hrs | Maximum: 60 Marks

Answer ALL questions

(The figures in the right hand margin indicate marks)

PART – A **(2 x 5 = 10 Marks)**

		CO #	Blooms Level
Q.1.	Answer ***ALL*** questions		
a.	A plane wall of thickness 0.25 m and thermal conductivity 0.6 W/m·K has temperatures of 200°C and 100°C on its two sides. Calculate the heat flux and temperature gradient.	CO1	K3
b.	Define the term "overall heat transfer coefficient (U)" and explain its significance in composite systems	CO2	K2
c.	Differentiate between hydrodynamic and thermal boundary layers with suitable sketches or examples	CO4	K2
d.	List and briefly describe the types of heat exchangers based on flow arrangement.	CO5	K1
e.	Compare conduction, convection, and radiation in terms of the mechanism of heat transfer.	CO6	K2

PART – B **(10 x 5 = 50 Marks)**

		Marks	CO #	Blooms Level
	Answer ***ALL*** the questions			
2. a.	Derive an expression for heat conduction through a hollow cylinder (pipe) under steady-state condition.	5	CO1	K1
b.	A furnace wall is made up of three layers: firebrick (0.15 m, k = 1.4), insulation brick (0.10 m, k = 0.2), and steel plate (0.005 m, k = 45). The inner and outer surface temperatures are 800°C and 100°C respectively. Calculate the rate of heat loss per m² area and the temperature at the interface between each layer.	5	CO1	K2
	(OR)			
c.	Derive the equation for temperature distribution along a fin assuming steady-state condition and constant cross-section.	5	CO1	K2
d.	A pipe with an inner radius of 50 mm and outer radius of 100 mm carries steam at 200°C. The outer surface is at 120°C. Find the heat loss per meter length if the thermal conductivity of the pipe material is 15 W/m·K.	5	CO1	K2
3.a.	Derive the relation for overall heat transfer coefficient (U) for a composite wall having two or more layers in series with convection on both sides.	5	CO2	K3
b.	Calculate the overall heat transfer coefficient (U) from the following data Inside Heat Transfer Coefficient = 5800 W/(m^2·K). Outside Heat Transfer Coefficient = 1750 W/(m^2·K). Outside diameter of tube = 30 mm	5	CO3	K4

	Inside diameter of tube = 20 mm Thermal conductivity of metal wall = 46.52 15 W/m·K.			
	(OR)			
c.	Derive an expression for the critical radius of insulation for a cylindrical surface and spherical surface.	5	CO3	K3
d.	Find the overall heat transfer coefficient (U) if Inside Heat Transfer Coefficient = 12W/(m^2·K). Outside Heat Transfer Coefficient = 11600W/(m^2·K). Outside diameter of tube = 29 mm Inside diameter of tube = 25 mm Thermal conductivity of metal wall = 34.9 W/m·K.	5	CO2	K4
4.a.	Compare the three analogies (Reynolds, Prandtl, and Colburn) and mention their applicability to laminar/turbulent flows.	5	CO4	K2
b.	Explain the development of velocity and thermal boundary layers over a flat plate with a neat sketch.	5	CO4	K3
	(OR)			
c.	A flat plate is exposed to air flow with known friction factor and velocity. Using Colburn analogy, determine the average heat transfer coefficient (h).	5	CO4	K4
d.	Define the thermal boundary layer and derive the relation between thermal and velocity boundary layer thickness in terms of the Prandtl number.	5	CO4	K2
5.a.	Explain different types of heat exchangers based on (a) flow arrangement, (b) heat transfer mechanism, and (c) construction.	5	CO5	K2
b.	Explain the terms capacity and economy of an evaporator.	5	CO5	K3
	(OR)			
c.	Compare parallel flow and counter flow heat exchangers in terms of temperature profiles and efficiency	5	CO5	K2
d.	Describe the shell and tube heat exchanger with a neat sketch and label its components.	5	CO5	K3
6.a.	Derive the Stefan–Boltzmann law for black body radiation.	5	CO6	K4
b.	Derive Planck's law and show how it leads to Wien's and Stefan–Boltzmann laws.	5	CO6	K3
	(OR)			
c.	Explain the theory of multiple-effect evaporators with neat flow diagrams for (a) forward feed, (b) backward feed, and (c) mixed feed arrangements.	5	CO6	K3
d.	What is boiling point elevation (BPE)? Why is BPE important in evaporator design?	5	CO6	K2

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