QP Code: R262B007 Reg. No | | | | | | | | | | AY 25

GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

(GIET UNIVERSITY)

M.Tech. (Second Semester) Regular Examinations, May – 2026

24MTEPC12001– Convective Heat Transfer

(Heat Power and Thermal 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)**

Q.1. Answer ***ALL*** questions

		CO #	Blooms Level
a.	Explain convection heat transfer with suitable examples.	CO1	K1
b.	State Newton's law of cooling.	CO1	K1
c.	Briefly explain about Prandtl number and its significance	CO2	K2
d.	Differentiate between thermal entry length and hydrodynamic entry length.	CO3	K1
e.	Define critical Reynolds number for pipe flow.	CO4	K1

PART – B **(10 x 5 = 50 Marks)**

Answer ***ALL*** the questions

		Marks	CO #	Blooms Level
2. a.	Explain the mechanism of convection heat transfer and distinguish between free and forced convection with examples.	5	CO1	K2
b.	A wire of 1.5 mm diameter and 150 mm long is submerged in water at atmospheric pressure. An electric current is passed through the wire and is increased until the water boils at 100^0C. Under the conditions of convective heat transfer coefficient is 4500 W/m^{2}K, find how much electric power must be supplied to the wire to maintained the wire surface at 120^0C.	5	CO1	K3
	(OR)			
c.	Differentiate between forced convection and natural convection in terms of origin of flow, governing equations, and practical applications.	5	CO1	K2
d.	A pipe of k = 9.5 W/mK carries a fluid such that h = 500 W/m^{2}K. The average fluid temperature is 100^0C. The pipe has inner diameter 2.5 cm and outer diameter 5 cm. If the heat transfer rate through the pipe per unit length is 600 W/m. Calculate the outer side surface temperature of the pipe and overall heat transfer coefficient.	5	CO1	K3
3.a.	Discuss the boundary layer development and its effect on heat transfer over a flat plate in external flow.	5	CO2	K3
b.	Air flows over a flat plate of length 1 m at a velocity of 3 m/s. The surface temperature is 80°C and free-stream temperature is 30°C. Estimate the average heat transfer coefficient if the flow is laminar and Pr = 0.7, k = 0.026 W/mK, and $Re < 5 \times 10^5$.	5	CO2	K3
	(OR)			
c.	Explain the physical significance of the skin friction coefficient and its relation to wall shear stress for flow over a flat plate.	5	CO2	K2
d.	Engine oil at 60°C flows over a 5 m long flat plate whose temperature is 20°C with a velocity of 2 m/s. Determine the total drag force and the rate of heat	5	CO2	K3

		Marks	CO	K
	transfer per unit width of the entire plate? The properties of the oil at the film temperature are: $\rho = 876\ kg/m^3$, $k = 0.144\ W/mK$, $Pr = 2870$, $\nu = 242 \times 10^{-6}\ m^2/s$. Velocity profile is $\frac{u}{U} = (y/\delta)$.			
4.a.	Derive the two-dimensional continuity equation for incompressible, steady-state fluid flow.	5	CO3	K3
b.	Write down and explain the physical significance of the x- and y-momentum equations for two-dimensional incompressible flow.	5	CO3	K2
	(OR)			
c.	Discuss the assumptions of the boundary layer theory for laminar flow over a flat plate. Differentiate between the development of velocity and temperature profiles.	5	CO3	K3
d.	Air at 25°C flows over a flat plate at 2 m/s. Estimate the thickness of the hydrodynamic boundary layer at a distance of 0.5 m from the leading edge. Use $\nu = 1.5 \times 10^{-5}\ m^2/s$.	5	CO3	K3
5.a.	Derive the expression for drag force acting on a flat plate using the drag coefficient C_D. State the assumptions involved.	5	CO4	K3
b.	Explain the differences in temperature and velocity profiles between developing and fully developed laminar flow in ducts.	5	CO4	K2
	(OR)			
c.	Water enters a pipe at 30°C and flows with a mean velocity of 0.2 m/s. The pipe diameter is 0.02 m and the length is 1.5 m. Determine whether the flow is hydrodynamically fully developed. Use $\nu = 1 \times 10^{-6}\ m^2/s$.	5	CO4	K3
d.	A horizontal cylinder of diameter 0.05 m and length 1 m is maintained at 100°C in air at 25°C. Estimate the heat loss using the average Nusselt number correlation $Nu = 0.36\ (Gr.Pr)^{1/4}$. Data given: $k = 0.026\ W/mK$, $Gr.Pr = 10^8$.	5	CO5	K3
6.a.	Differentiate between laminar, transitional, and turbulent flow regimes. State the typical range of Reynolds number for each regime in pipe flow and over flat plates.	5	CO5	K3
b.	Determine whether the flow of water through a pipe of diameter 0.01 m with average velocity 0.3 m/s and kinematic viscosity $\nu = 1 \times 10^{-6}\ m^2/s$ is laminar or turbulent.	5	CO5	K3
	(OR)			
c.	Explain the significance of the boundary layer and describe how it influences heat and momentum transfer in laminar external flow.	5	CO6	K3
d.	Estimate the wall shear stress in laminar boundary layer flow at 0.4 m from the leading edge over a flat plate. Data given: $\mu = 0.001$ Pa-s, $u = 2$ m/s, and $\delta = 5 \times 10^{-3}$ m.	5	CO6	K3

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