QP Code: R252B046 Reg. No | | | | | | | | | | | AY 24

GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

(GIET UNIVERSITY)

M.Tech. (Second Semester) Regular Examinations, July – 2025

24MCHPC12001– Advanced Transport Phenomena

(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)**

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

		CO #	Blooms Level
a.	What is the physical significance of the pressure drop in a packed bed system?	CO2	K2
b.	What is meant by non-Newtonian viscosity? Give one example.	CO1	K2
c.	Mention any two practical applications of power-law fluid behaviour.	CO1	K1
d.	Define heat transfer coefficient and explain its physical significance.	CO1	K1
e.	Define macroscopic energy balance for a non-isothermal system.	CO2	K1

PART – B **(10 x 5 = 50 Marks)**

Answer ***ALL*** the questions

		Marks	CO #	Blooms Level
2. a.	Describe the development of the velocity profile in fully developed laminar flow in a pipe.	5	CO3	K3
b.	Compare and contrast steady and unsteady transport mechanisms with relevant examples.	5	CO1	K3
	(OR)			
c.	Establish the relationship between wall shear stress and pressure drop for laminar flow in a circular pipe and obtain the corresponding friction factor expression.	5	CO3	K3
d.	Discuss the concept of transport analogies and explain how momentum transfer is analogous to heat and mass transfer.	5	CO4	K4
3.a.	Explain how viscosity varies in Newtonian and non-Newtonian fluids. How do generalized Newtonian models describe this behavior?	5	CO1	K4
b.	Discuss how viscous losses affect energy consumption in pipeline flow systems. Relate this to the estimation of power required.	5	CO2	K3
	(OR)			
c.	Describe the basic concepts of linear viscoelastic models and their role in understanding elasticity in polymeric fluids.	5	C04	K4
d.	What is rheometry? Discuss how it helps in characterizing non-Newtonian fluids using material functions.	5	CO1	K2
4.a.	Why is Newton's law of cooling not always accurate for free convection around horizontal cylindrical surfaces? Explain.	5	CO1	K5
b.	Explain why convective heat transfer is generally lower in packed beds compared to straight tubes, based on flow and surface characteristics.	5	CO2	K5
	(OR)			
c.	Obtain the analytical expression for convective heat transfer coefficient in	5	CO3	K3

	laminar flow through a circular pipe.			
d.	Explain the method to determine the heat transfer coefficient in a convection experiment using measured temperature and heat input data.	5	CO2	K3
5.a.	Explain how energy conservation principles are applied to determine the outlet conditions during steady-state mixing of two ideal gases.	5	CO2	K3
b.	Discuss the factors that complicate the application of macroscopic energy balances in systems involving compressible fluids.	5	CO4	K5
	(OR)			
c.	Analyze the differences between parallel-flow and counter-flow heat exchangers in terms of energy transfer efficiency and temperature distribution.	5	CO4	K4
d.	Explain how macroscopic energy balance principles are applied to analyze the cooling process of an ideal gas under steady-flow conditions.	5	CO2	K3
6.a.	Compare the three modes of heat transfer conduction, convection, and radiation, with emphasis on their role in chemical process equipment design.	5	CO1	K4
b.	A fluid flows through a horizontal pipeline with a diameter of 0.1 m. The average velocity of the fluid is 2 m/s and its density is 1000 kg/m^3. Calculate the pressure drop over a 10 m length of the pipe if the friction factor is 0.02. Use the mechanical energy balance.	5	CO2	K2
	(OR)			
c.	Why is understanding condensation heat transfer important in the thermal design of condensers and reboilers?"	5	CO2	K2
d.	A non-Newtonian power-law fluid flows through a circular tube of radius 0.02 m. The flow is fully developed and laminar. The flow behavior index (n) is 0.5 and the consistency index (K) is 1.2 $Pa \cdot s^n$. Calculate the shear stress at the wall and the pressure drop per meter of the pipe if the average velocity is 0.6 m/s.	5	CO3	K3

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