Q. Code:424847

Reg. No. | | | | | | | | | | | | | |

B.E. / B.TECH. DEGREE EXAMINATIONS, MAY 2024

Third Semester

CH22302 – MOMENTUM TRANSFER

(Chemical Engineering)

(Regulation 2022)

TIME: 3 HOURS **MAX. MARKS: 100**

COURSE OUTCOMES	STATEMENT	RBT LEVEL
CO 1	Analyze the fluid properties and flow behavior of fluids.	**2**
CO 2	Apply various equations governing fluid statics and fluid kinematics.	**3**
CO 3	Discuss the pressure drops during the flow of fluids through different physical systems like pipes, valves, fixed and fluidized beds.	**4**
CO 4	Analyze several machineries used to transport the fluid and their performance including the flow measurements.	**4**
CO 5	Compare the fluid flow characteristics during the turbulent conditions using the analogies.	**3**

PART- A (20 x 2= 40 Marks)

(Answer all Questions)

		CO	RBT LEVEL
1.	The drag force F on a sphere of diameter D in a fluid stream of low velocity V, density ρ and viscosity μ is given by the equation $F = 3\pi\mu DV + (9/16)\ \rho V^2D^2$. Check the dimensional consistency of the equation.	**1**	**2**
2.	The space between two parallel plates kept 2 mm apart is filled with an oil of dynamic viscosity 0.2 Pa.s. Calculate the shear stress on the fixed lower plate, if the upper plate is moved with a velocity of 2.5 m/s.	**1**	**3**
3.	Elucidate the effect of temperature and pressure on viscosity of fluids.	**1**	**2**
4.	If the apparent viscosity of a fluid is given by the relation $\mu = 0.03\left\|\frac{dy}{dx}\right\|^{0.25}$ identify the type of fluid and sketch the relationship between shear stress Vs velocity gradient.	**1**	**3**
5.	Distinguish between pressure and pressure head.	**2**	**2**
6.	Illustrate the various forces acting on a fluid at rest.	**2**	**2**
7.	Write the equation for pressure at a point P (x – δx/2, y, z) in a fluid element.	**2**	**2**
8.	Determine the head loss in a 90^0 elbow if the flow velocity is 0.3 m/s. Use k = 0.9.	**2**	**3**
9.	Calculate the friction factor for a turbulent flow having Reynolds number 15,480.	**3**	**3**
10.	Elucidate on the loss of head due to a sudden enlargement in a flow through a conduit.	**3**	**2**
11.	Distinguish between shear drag and pressure drag with suitable illustrations.	**3**	**2**
12.	Differentiate superficial and interstitial velocity.	**3**	**2**

13.	Write the working principle of a rotameter.	**4**	**2**	
14.	Classify the different types of pumps.	**4**	**2**	
15.	Write the working principle of a diaphragm pump.	**4**	**2**	
16.	Annotate NPSH and write its significance for pump operation.	**4**	**2**	
17.	Show that the Reynolds number is dimensionless and write its physical meaning.	**5**	**2**	
18.	Elucidate the applications of Froude and Euler model law.	**5**	**2**	
19.	Explicate the characteristics of turbulent flow.	**5**	**2**	
20.	Write a short note on Rayleigh's method of dimensional analysis.	**5**	**2**	

PART- B (5x 10=50 Marks)

			Marks	CO	RBT LEVEL
21.(a)	**(i)**	An oil film of viscosity μ and thickness h << R, lies between a solid wall and a circular disc. The disc is rotated steadily at an angular velocity **Ω**. Both the velocity and shear stress varies with the radius. Derive an expression for the torque.	**(5)**	**1**	**3**
	(ii)	Derive the velocity profile equation for fluid motion between parallel plates shearing a liquid if the lower plate is stationary. If the shear stress is 43.5 Pa, viscosity of the fluid is 0.29 kg/m.s and the distance between the plates is 2 cm, calculate the velocity.	**(5)**	**1**	**3**
		(OR)			
(b)	**(i)**	A torpedo moving in fresh water at 10°C has a minimum pressure point given by the equation $p_{min} = p_o - 0.35\ \rho v^2$, where p_o is 115kPa. Determine the velocity at which cavitation bubbles form on the torpedo if the vapour pressure of water is 1.227 kPa.	**(4)**	**1**	**3**
	(ii)	Oil is contained between two identical parallel plates of 2 m^2 area each. The top plate is pulled to the left (-x direction) with a force of 0.43 N at a velocity of 0.3 m/s. The bottom plate is pulled in the opposite direction with a force of 0.15 N at a velocity of 0.15 m/s. Calculate the viscosity of the oil if the plates are 5 mm apart.	**(6)**	**1**	**3**
22.(a)		Derive the Bernoulli's equation for an incompressible flow of a fluid along a stream line.	**(10)**	**2**	**3**
		(OR)			

(b)	A U-tube differential manometer is connected between two pipes 'x' and 'y'. Pipe 'x' contains CCl_4 with a specific gravity 1.59, under a pressure of 103 kN/m^2 and pipe 'y' contains oil with a specific gravity 0.8 under a pressure of 172 kN/m^2. Pipe 'x' is 3 m above pipe 'y'. The mercury level in the limb connected to the pipe 'x' is 1.5 m below the centerline of pipe 'y'. Determine the manometer reading shown by a centimeter scale attached to it.	**(10)**	**2**	**3**
23.(a)	A siphon consisting of a 25 cm diameter tube is used to drain water from a tank. The outlet end of the tube is 2 m below the water surface in the tank. Calculate the discharge if the peak point of the siphon is 1.4 m above the water surface in the tank. Estimate the pressure of the fluid at the peak point of the siphon.	**(10)**	**3**	**3**
	(OR)			
(b)	Derive an expression for finding the volumetric flow rate when an incompressible fluid flows through a pipe under laminar conditions.	**(10)**	**3**	**3**
24.(a)	Analyze the construction, working and limitations a Venturimeter. Derive the expression for volumetric flow rate through the Venturimeter.	**(10)**	**4**	**4**
	(OR)			
(b)	Analyze construction, working, advantages and limitations of positive displacement pumps with neat illustrations.	**(10)**	**4**	**4**
25.(a)	The power required by an agitator in a tank is a function of the diameter of the impeller, rpm of the impeller, Viscosity of the liquid, Density of the liquid and acceleration due to gravity. From dimensional analysis, formulate a relationship for power consumption. The power consumption is found experimentally to be proportional to the square of speed of rotation.	**(10)**	**5**	**3**
	(OR)			
(b)	A sphere advancing at 1.8 m/s in a stationary mass of water experiences a drag of 4.5 N. Calculate the flow velocity required for dynamic similarity of another sphere twice the diameter placed in a wind tunnel. Determine the drag at this velocity if the kinematic viscosity of air is 13 times that of water and its density is 1.25 kg/m^3.	**(10)**	**5**	**3**

PART- C (1x 10=10Marks)

(Q.No.26 is compulsory)

		Marks	CO	RBT LEVEL
26.	Water is to be pumped at the rate of 50 litre/min from a storage tank resting on the floor, to the top of an overhead tank. The suction and delivery lines are connected by a 5 cm diameter pipe. The point of discharge is at a level of 15 m above the flow. The water level in the storage tank is maintained at a constant head of 1.6 m. Assume frictional loss is 2.5 J/N and the efficiency of the pump is 75%. Determine the horse power and the pressure developed by the pump.	**(10)**	**2**	**5**

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