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SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

THIRD SEMESTER B.TECH DEGREE EXAMINATION (Regular), DECEMBER 2022
CHEMICAL ENGINEERING
(2020 SCHEME)

Course Code : 20CHT205

Course Name: Fluid and Particle Mechanics

Max. Marks : 100 **Duration: 3 Hours**

PART A

(Answer all questions. Each question carries 3 marks)
Assume any missing data suitably

1. Define the meaning of compressibility coefficient of a fluid.
2. Differentiate between newtonian and non-newtonian fluids with examples.
3. Explain the significance of Reynolds number.
4. Differentiate between stream line, path line and streak line.
5. List the effects of pipe roughness on friction factor.
6. Define hydraulic radius and derive the equation of equivalent diameter for the flow through annulus.
7. Define drag force over a particle in a flowing fluid. Write the expression for drag coefficient in laminar flow region.
8. Explain the boundary layer and wake formation in flow past immersed sphere.
9. Define the affinity laws for pump.
10. Differentiate the operation of gate valve and globe valve.

PART B

(Answer one full question from each module, each question carries 14 marks)

MODULE I

11. a) An oil of specific gravity is 0.8 under a pressure of 137.2 kN/m^2.Calculate the pressure head expressed in (i) m of water and (ii) m of oil? (6)

    b) Draw a sketch and write the principle of i) simple manometer ii) inclined tube manometer. (8)

OR

12. a) A U-tube manometer is used to measure the pressure of water in a pipeline, which is in excess of atmospheric pressure. The right limb of the manometer contains mercury and is open to atmosphere. The contact between the manometer and mercury is in left limb. Determine the pressure of water in the main line if the difference in level of mercury in the limbs of U tube is 10 cm and the free surface of mercury is in level with the center of the pipe. (6)

b) State and prove the Pascal's law (8)

MODULE II

13. a) With a neat sketch explain Reynolds experiment. (7)

b) Derive Euler's equation of motion along a stream line for an ideal fluid, by stating all the assumptions. (7)

OR

14. a) Derive the Bernoulli equation for incompressible fluid without fluid friction. (8)

b) In an air pipeline, the flow has following conditions at point 1: Temperature = 298 K, pressure = 1.8 bar, velocity = 15 m/s, density = 2.1 kg/m^3 and pipe inside diameter = 50 mm. (6)
At point 2, Temperature = 298 K, pressure = 1.3 bar, and pipe inside diameter = 75 mm.
Estimate the mass flow rate of air and the velocity at station 2.

MODULE III

15. a) Acetic acid is to be pumped at a rate of 0.02 m^3/s through a pipe line having an inside diameter of 75 mm. what is the pressure drop in the pipe line over a length of 70m. (7)
Data: Density of acetic acid = 1060 kg/m^3, Viscosity of acetic acid = 0.0025Ns/m^2.

b) Derive the relationship between local velocity and maximum velocity of a Newtonian fluid, which is in laminar flow through a circular channel. Also, determine the ratio of $\bar{V}/u_{max}$ (7)

OR

16. a) Discuss about the frictional losses in a pipe due to sudden expansion and mention the relationship to calculate the expansion loss coefficient. (7)

b) Crude oil is to be transported at a rate of 7500 m^3/day from an oil field to a refinery which is located at 750 km away from the oil field through a 400 mm internal diameter mild steel pipe. (7)

i) Calculate the theoretical power requirement for the pump.

ii) Since the maximum allowable pressure at any section of the pipeline is 2.94 MPa, it will be required to install pumping stations at suitable intervals/distances along the pipeline. Each station increases the pressure which drops

to 165 kPa at the inlet of the next pumping station. Find the minimum number of pumping stations required.

Data: Density of oil = 870 kg/m^3
Viscosity of oil = 48 mPa.s

MODULE IV

17. a) Define superficial velocity and minimum fluidization velocity in a vertical tube filled with granular material and explain the variation in superficial velocity with pressure drop and bed height. (10)

b) A bed of ion-exchange beads 8 ft deep having a density of 1.24 g/cm^3 and average size of 1.1 mm is to backwashed using water at 20 ^oC. Determine the minimum fluidization velocity. (4)
Data: Φ_s =1 and ε_M= 0.40

OR

18. a) Derive the expression for terminal settling velocity of a particle settled in a fluid. Also, explain the relationship between the terminal settling velocity with low and high Reynolds number. (9)

b) A body of length 2.5 m has a projected area 1.8 m^2 normal to the direction of its motion. The body is moving through water with a velocity such that the Reynolds number is 6 x 10^6. The drag coefficient can be taken as 0.5. Calculate the drag coefficient of the body. Take viscosity of water as 0.01 poise. (5)

MODULE V

19. a) Define NPSH and NPSHR. Explain how these two quantities are used to ensure that cavitation does not occur in a pump. (6)

b) Differentiate between brake horsepower and water horsepower. Also, define pump efficiency in terms of these quantities. (8)

OR

20. a) Define equivalent length of pipe with a neat sketch. Explain the applications of any four type of pipe fitting or joints. (9)

b) Discuss the characteristic curves of centrifugal pump. (5)

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