KATHMANDU UNIVERSITY
End Semester Examination
January/February 2024

Marks Scored:

Level : B.E.
Year : II

05 FEB 2024

Course : CHEG 212
Semester : II

Exam Roll No. :

Time: 30 mins.

F. M. : 10

Registration No.:

Date :

SECTION "A"
[20Q. × 0.5 = 10 marks]

Choose and encircle the most appropriate answer.

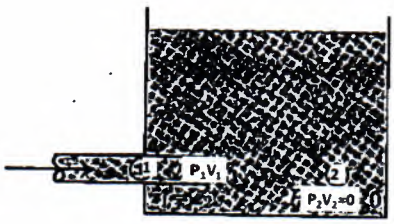
1. Which of the following statements describes a fluid?
   a. A substance that can remain at rest under the action of any shear force
   b. A substance that can only move in one direction under shear force
   c. A substance that cannot remain at rest under the action of any shear force
   d. A substance that exhibits no flow characteristics under any circumstances

2. Pseudoplastic fluids show
   a. An apparent viscosity that increases with increasing velocity gradient.
   b. An apparent viscosity that decreases with decreasing velocity gradient.
   c. An apparent viscosity remains constant with increasing velocity gradient.
   d. An apparent viscosity that decreases with increasing velocity gradient.

3. A cylindrical oil-storage tank is 75 ft deep and contains an oil of density 55 lbm/ft$^3$. Its top is open to the atmosphere. What is the gauge pressure-depth relation in this tank?
   a. 180 kPa  b. 190 kPa  c. 197.4 kPa  d. 200 kPa

4. A typical self-service gasoline pump puts 15 gal (1 gal = 0.133681 ft$^3$ = 0.00378541 m$^3$) of fuel into our tank in 2 min. What is the volumetric flow rate?
   a. 0.0167 ft$^3$/s  b. 0.0170 ft$^3$/s  c. 0.0175 ft$^3$/s  d. 0.0180 ft$^3$/s

5. Bernoulli's equation for between points 1 and 2 (From Figure)




   a. $P_2 - P_1 = \frac{\rho V_1^2}{2} - f$  b. $P_2 + P_1 = \frac{\rho V_1^2}{2} - f$
   c. $P_2 - P_1 = \frac{\rho V_1^2}{2} + f$  d. $P_2 + P_1 = \frac{\rho V_1^2}{2} + f$

6. The velocity at throat of a typical venturi meter is
   a. $V = \left[\frac{2(P_1+P_2)/\rho}{1-(A_2^2/A_1^2)}\right]^2$  b. $V = \left[\frac{2(P_1-P_2)/\rho}{1+(A_2^2/A_1^2)}\right]^2$
   c. $V = \left[\frac{2(P_1+P_2)/\rho}{1+(A_2^2/A_1^2)}\right]^2$  d. $V = \left[\frac{2(P_1-P_2)/\rho}{1-(A_2^2/A_1^2)}\right]^2$

7. For the laminar flow of a fluid in a circular pipe of radius R, the Hagen-Poiseuille equation predicts the volumetric flow rate to be proportional to
   a. $R$  b. $R^2$  c. $R^4$  d. $R^{1/2}$

8. For an ideal fluid flow the Reynolds number is
   a. Infinity  b. Zero  c. One  d. 2100

9. Steady flow occurs when
   a. Conditions change steadily with time.
   b. Conditions are the same at the adjacent points at any instant.
   c. Conditions donot change with time at any point.
   d. Rate of velocity change is constant

10. Stokes number is the ratio of
   a. Pressure force and viscous force  b. Pressure force and gravity force
   c. Pressure force and inertia force  d. Pressure force and surface tension force

11. A centrifugal pump has the following dimensions: inlet pipe 2-in pipe size, (diameter = 2.067 in), outlet pipe 1.5-in pipe size, (diameter =1.61 in), impeller inner diameter = 2.067 in, outer diameter = 6.75 in, rotational velocity = 1750 rpm. What is the value of angular velocity of impeller?
   a. 185.42 $s^{-1}$  b. 183.26 $s^{-1}$  c. 180.35 $s^{-1}$  d. 188.24 $s^{-1}$

12. The hydraulic diameter of an annulus of inner and outer diameter $R_i$ and $R_o$, respectively
   a. $4(R_0 - R_i)$  b. $\sqrt{R_0 . R_i}$  c. $(R_0 - R_i)$  d. $(R_0 + R_i)$

13. For turbulent flow of fluids in rough pipe fanning friction factor does not depend upon
   a. V and μ  b. ε  c. D and ρ  d. L
   Where, V, ρ & μ are fluid velocity, density and viscosity, respectively. ε = roughness projection size; L and D are length and diameter of the pipe respectively.

14. The efficiency of a fan η depends on angular velocity, dynamic viscosity, discharge, density and diameter of rotor. According to Buckingham π theorem, how many variables are there in this statement?
   a. 2  b. 4  c. 6  d. 8

15. To prevent cavitation
   a. The pressure at the pump inlet must be equal to the vapor pressure of flowing fluid.
   b. The pressure at the pump inlet must be less than the vapor pressure of flowing fluid.
   c. The pressure at the pump inlet must surpass the vapor pressure of flowing fluid by a specific amount.
   d. Vapor pressure of flowing fluid has no effect

16. Porosity or void fraction defined as
   a. $\frac{\text{Total volume of system + volume of solids in system}}{\text{Total volume of system}}$
   b. $\frac{\text{volume of solids in system}}{\text{Total volume of system}}$
   c. $\frac{\text{Total volume of system-volume of solids in system}}{\text{Total volume of system}}$
   d. $\frac{\text{Total volume of system}}{\text{volume of solids in system}}$

05 FEB 2024

17. If three pipes (1, 2 & 3) of different diameter, length and friction factors are connected in parallel, then

a. $Q_1 = Q_2 = Q_3$ b. $Q = Q_1 + Q_2 + Q_3$ c. $v_1 = v_2 = v_3$ d. $f_1 = f_2 = f_3$

Where, Q = Flow rate, v = fluid velocity, $f$ = Friction factor

18. The operation of rotameter is based on

a. Variable flow area
b. Pressure drop across the nozzle
c. Rotation of turbine
d. Pressure at a stagnation point

19. If a fluid is moving through a pipe along the x, y, and z directions, with velocity components denoted as $v_x$, $v_y$, and $v_z$, respectively, what is the formulation for the Prandtl boundary-layer equations?

a. $\frac{\partial v_x}{\partial t} = 0$ b. $\frac{\partial v_y}{\partial t} = 0$ c. $\frac{\partial v_x}{\partial t} + \frac{\partial v_y}{\partial t} = 0$ d. $\frac{\partial v_x}{\partial t} + \frac{\partial v_y}{\partial t} + \frac{\partial v_z}{\partial t} = 0$

20. The unit of permeability is

a. Darcy b. Centipoise c. Newton d. Pascal

KATHMANDU UNIVERSITY
End Semester Examination
January/February 2024

Level : B.E.
Year : II
Time : 2 hrs. 30 mins.

05 FEB 2024

Course : CHEG 212
Semester : II
F. M. : 40

SECTION "B"

Attempt *ALL* questions.

1. a. In a concentric-cylinder viscometer, the solid bob has diameter $D_1 = 25.15$ mm and $L = 92.27$ cm. The surrounding cup has $D_2 = 27.62$ mm and is longer than the bob. When the bob is driven at 10 rpm; the observed torque is $\Gamma = 0.005$ Nm. What are $\tau$ and $^{dv}/_{dy}$ ? Where $\tau$ is shear stress and $^{dv}/_{dy}$ is velocity gradient. [2]

   b. At sea level the atmospheric pressure is 14.7 psia and the temperature is 70 °F. Assuming that the temperature does not change with elevation (a poor assumption, but one that simplifies the mathematics), calculate the pressure at 1000, 10,000, and 100,000 ft. For air the molecular weight M is 29 lbm/lbmol.

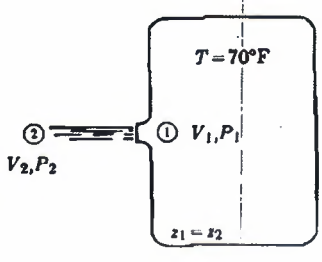
   For z = 1000 ft. Value of $R = \frac{10.73(\text{lbf/in}^2)\text{ft}^3}{\text{lbmol.°R}} = \frac{0.7302\ \text{atm.ft}^3}{\text{lbmol.°R}} = \frac{8.314\ \text{m}^3\text{.Pa}}{\text{mol.K}}$. [2]

2. a. A helium balloon is at the same pressure and temperature as the surrounding air (1 atm, 20°C) and has a diameter of 3 m. The weight of the plastic skin of the balloon is negligible. How much paylpad can the balloon lift? $M_{air}$ = 29 g/mol and $M_{Hellium}$ = 4 g/mol [2]

   b. A rectangular tank of orange juice on a cart is moving in the x direction with a steady acceleration of 1 ft/s$^2$. What angle does its free surface make with the horizontal? [2]

3. a. Derive preliminary form of Bernoulli's equation. The tank in Figure is full of air at 70 °F. The air is flowing put at a steady rate through a smooth, frictionless nozzle to the local atmosphere. $P_1$ is $P_{atm}$ + 0.01 lbf/in$^2$ . What is the flow velocity for various tank pressures? [4]

   b. Derive the general mass balance equation under steady state condition. In a natural gas pipeline at station 1, the pipe diameter is 2 ft, and the flow conditions are 800 psia, 70 °F, and 50 ft/s velocity. At station 2, the pipe diameter is 3 ft, and the flow conditions are 500 psia and 70 °F. What is the velocity at station 2? What is the mass flow rate? [4]



4. a. Derive Hagen-Poiseuille equation for a fluid flowing through a circular pipe. [4]

b. A typical capillary viscometer has the flow diagram shown in Fig. It consists o f a large-diameter reservoir and a long, small-diameter, vertical tube. The sample is placed in the reservoir, and the flow rate due to gravity is determined. The tube is 0.1 m long and has 1 mm inside diameter. The height of the fluid in the reservoir above the inlet to the tube is 0.02 m. The fluid being tested has a density of 1050 $kg/m^3$. The flow rate is 10-8 $m^3/s$. What is the viscosity of the fluid? [2]

c. Demonstrate the independence of economic pipe diameter from pipe length. [2]

5. a. The pressure drop ($\Delta P$) depends on five variables: length (L), diameter (d), density ($\rho$), velocity (v), and viscosity ($\mu$). Using Buckingham pi theorem determine the relationship of the effect on pressure drop ($\Delta P$) of the variables d, L, $\rho$, $\mu$ and v. [2]

b. Derive the equation that relates the pump head to variables such as velocity, impeller speed, and gravitational acceleration. A pump is pumping 50 gal/ min of water from a pressure of 30 psia to a pressure of 100 psia. The changes in elevation and velocity are negligible. The motor which drives the pump is supplying 2.80 hp. What is the efficiency of the pump? [4]

6. Discuss on *ANY FIVE*. [5×2=10]

a. Relative roughness and Fanning friction factor
b. Purchase price, annual capital charge, annual pumping cost and total annual cost
c. Reynolds number, Froude number, Stokes number and Mach number
d. Darcy law
e. Boundary layer
f. Navier stokes equation