KATHMANDU UNIVERSITY
End Semester Examination [C]
November/December, 2023

Marks Scored:

Level : B.E.
Year : II

Course : CHEG 212
Semester : II

Exam Roll No. :

Time: 30 mins.

F. M. : 10

Registration No.:

Date 05 DEC 2023

SECTION "A"
[20 Q. × 0.5 = 10 marks]

Choose and encircle the most appropriate option.

1. An ideal gas flows in a pipe at 20°C. The density of the gas is 1.9 kg/m$^3$ and its molar mass is 44 kg/kmol. $R_u$=8.314 kJ/kmol-K. The pressure of the gas in kilopascals is:
   a. 7 b. 72 c. 105 d. 460

2. The gage pressure in a pipe is measured by a manometer containing mercury (density = 13,600 kg/m$^3$). The top of the mercury is open to the atmosphere and the atmospheric pressure is 100 kPa. If the mercury column height is 24 cm, the gage pressure in the pipe in kPa is:
   a. 32 b. 24 c. 76 d. 124

3. Find the required wall thickness in inches for a horizontal cylindrical pressure vessel with a diameter of 10 ft, a working pressure of 250 psig, and a design tensile stress of 20,000 psig.
   a. 0.008 b. 0.06 c. 0.75 d. 1.5

4. Water flows in a 5-cm-diameter pipe at a velocity of 0.75 m/s. The mass flow rate of water in the pipe in kg/min is:
   a. 88.4 b. 75 c. 37.5 d. 1.47

5. What is the increase in pressure that accompanies the decrease in velocity?
   a. friction heating b. injection work
   c. pressure recovery d. pressure head

6. In sudden expansion, what happens to the pressure of the fluid flowing into it?
   a. same as the pressure of the fluid into which it flows
   b. less as the pressure of the fluid into which it flows
   c. more as the pressure of the fluid into which it flows
   d. becomes zero

7. Engine oil at 40°C ($\rho$ = 876 kg/m$^3$, $\mu$ = 0.2177 kg/m·s) flows in a 20-cm-diameter pipe at a velocity of 1.2 m/s. The pressure drop of oil for a pipe length of 20 m in pascals is:
   a. 4180 b. 5044 c. 6236 d. 7419

8. Air at 1 atm and 68°F is flowing in a long, rectangular duct whose cross section is 1 ft by 0.5 ft, with $V_{avg}$ = 40 ft /s. What is its hydraulic radius in feet?
   a. 0.083 b. 0.167 c. 0.375 d. 0.5

9. What are the equations of motion?
   a. Mass balances b. Momentum balances
   c. Energy balances d. Darcy's equations

10. What is $V^2/gz$ also known as?
    a. Nusselt number
    b. Prandtl number
    c. Damkohler number
    d. Froude number

11. Consider unsteady fully developed flow between two infinite parallel plates. This problem involves the following parameters: velocity component $u$, distance between the plates $h$, vertical distance $y$, top plate speed $V$, fluid density $\rho$, fluid viscosity $\mu$, and time $t$. The number of expected dimensionless parameters Πs of this problem is:
    a. 3  b. 4  c. 5  d. 6

12. Which one of the following methods is also known as the method of similitude?
    a. force ratios
    b. Buckingham
    c. momentum balance
    d. Bernoulli

13. In a positive displacement pump, what is the suction lift for water under normal atmospheric pressure and room temperature?
    a. $P_{atm}/\rho g$  b. $P_{atm}/RT$  c. $RT/P_{atm}$  d. $\rho g/P_{atm}$

14. Which machine is designed to deliver a very high pressure rise, typically at low to moderate flow rates?
    a. fan  b. turbine  c. blower  d. compressor

15. Countercurrent flow of two immiscible fluids in porous media is strongly influenced by:
    a. available pore space
    b. surface tension
    c. viscosity
    d. solubility

16. Slurries of solid particles in which there is barely enough liquid to keep the solid particles from touching each other are examples of:
    a. Bingham plastic
    b. dilatant fluid
    c. Newtonian
    d. viscoelastic fluid

17. The pressure drop for a given flow is determined to be 100 Pa. For the same flow rate, if we reduce the diameter of the pipe by half, the pressure drop in pascals will be:
    a. 25  b. 200  c. 400  d. 1600

18. Which one of the following is an assumption of Navier-Stokes equation?
    a. compressible flow
    b. Newtonian fluid
    c. turbulent flow
    d. inviscid flow

19. Prandtl's boundary-layer equation is valid for:
    a. gravity force  b. 3-D flow  c. laminar flow  d. porous flow

20. What is used to prevent the whole fluid mass from rotating in a stirred-tank mixer?
    a. impeller  b. baffle  c. shaft  d. weir

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SECTION "B"

Attempt *ALL* questions. Urgent appropriate assumptions are permissible.

1. An open tank containing water 7 m deep is placed on an elevator. Calculate the gauge pressure at the bottom of the tank: [3 × 2 = 6]
   a. when the elevator is standing still,
   b. when the elevator is accelerating upward at the rate of 6 m/s$^2$, and
   c. when the elevator is accelerating downward at the rate of 4 m/s$^2$

2. A microchip diffusion furnace having volume of 12 ft$^3$ and temperature of 68°F contains air, which may be considered an ideal gas. The vacuum pump is pumping air out prior to beginning the thermal diffusion step. During the pumpout process the heating coils in the tank hold the temperature in the tank constant at 68°F. The volumetric flow rate at the inlet of the pump, independent of pressure, is 1.6 ft$^3$/min. How long does it take the pressure to fall from 1 atm to 0.0002 atm? [6]

3. The venturi meter in Fig.1 has water flowing through it. The pressure difference $P_1$-$P_2$ is 1.6 psi. The diameter at point 1 is 1.2 ft, and that at point 2 is 0.4 ft. What is the volumetric flow rate through this meter? Take into account the experimental results summarized in Fig. 2. [6]

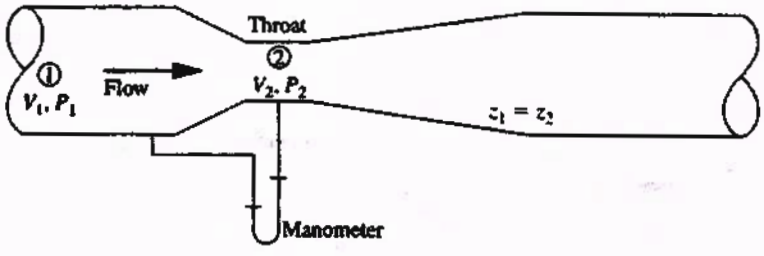


Fig. 1: Venturi meter for fluid velocity measurement.

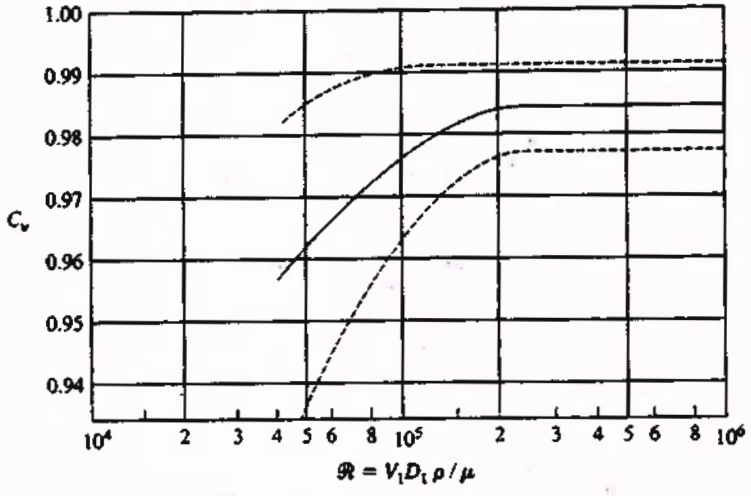


Fig. 2: Discharge coefficients for venturi meters. Here velocities and diameters, $V_1$ and $D_1$ are measured at point 1 in Fig. 1. The solid line represents the best average of the available data.

4. The tank in Fig. 3 is attached to 13 ft of 5-in pipe. The losses at the entrance from the reservoir to the pipe are negligible. What is the velocity at the exit of the pipe? Use $\varepsilon/D$=0.00036. [6]

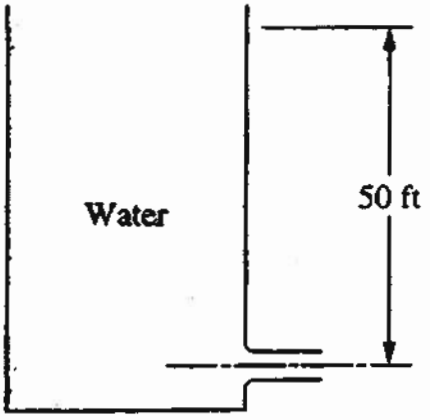


Fig. 3: Gravity draining flow with friction.

5. A multistage centrifugal compressor has an impeller diameter of about 2.2 ft, and operates at about 11,000 rpm. If the fluid in the first stage of the compressor is air at 1.1 atm, what is the estimated pressure rise in the first stage? Clearly mention the assumptions used. [6]

6. Briefly explain the following: [5 × 2=10]
   a. Use of eductors in industries
   b. Limitations of dimensional analysis
   c. Behavior of non-Newtonian fluids
   d. Assumptions used in deriving Navier-Stokes Equation
   e. Concept of boundary layer