L-3/T-1/ME

13/05/2024

Date : ~~25/04/2024~~

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2022-2023

Sub : **ME 321** (Fluid Mechanics-I)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer all questions.

Assume any reasonable values for missing data.

1. **Answer 1(a,b) or 1(c,d)**

(a) Show that the pressure at a point in a fluid has the same magnitude in all directions. **(10)**

(b) As shown in Fig. for Q. 1(b), The pipe and connection B are full of oil of sp.gr. 0.9 under pressure. If the U-tube contains mercury, find the elevation of point A in meters. **(15)**

Or

(c) For a gage pressure at A of −11 kPa, find the specific gravity of the manometric liquid B as shown in Fig. for Q. No. 1(c). The elevations are in meters. **(14)**

(d) If atmospheric pressure at ground is 101.3 kPa and temperature is 15°C, calculate the pressure 8.0 km above the ground, assuming (i) isothermal variation of density with pressure, and (ii) adiabatic variation of density with pressure. **(12)**

Answer 2(a, b) or 2(c, d)

2. (a) Obtain an equation for the hydrostatic force on an inclined submerged plane surface. **(10)**

(b) Calculate W×l and the exact position of the pointer as shown in Fig. for Q. 2(b) to hold the triangular gate in equilibrium. **(16)**

Or

(c) Define and explain Metacentre and Metacentric height. Analytically show how the Metacentric height determine stable, unstable and neutral equilibrium of floating bodies. **(10)**

(d) A block of wood having a sp.gr. of 0.8, floats in water as shown in Fig. for Q. 2(d). Find the metacentric height if the size of the block is 1.2 m × 0.6 m × 0.5 m. **(16)**

3. (a) Prove that in case of forced vortex, the rise of liquid level at the ends is equal to the fall of liquid level at the axis of rotation. **(12)**

(b) Find the location of the vertical axis of rotation and the speed of rotation of the U-tube as shown in Fig. for Q. 3(b) so that the pressure of liquid at the midpoint B of the U-tube and at A are both zero. What is the pressure at point C during the rotation? **(14)**

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4. (a) Derive the Bernoulli's equation and show the Energy, Head and Pressure form of it. **(10)**

(b) Water in a large tank is under a pressure of 35 kPa gage at the free surface as shown in Fig. for Q. 4(b). It is pumped through a pipe and issues out a nozzle to form a free jet. Calculate the power required by the pump if its efficiency is 70%. **(17)**

SECTION - B

There are **FOUR** questions in this section. Answer **All** questions.

5. **Answer Questions 5(a) or 5(b)**

(a) (i) Explain in the context of fluid mechanics how a fluid behaves differently from a solid. **(5)**

(ii) A clean glass tube of 0.5 mm × 0.5 mm square cross section is vertically inserted in water. Determine the height that the water will climb up the tube. The water makes a contact angle of 0° with the clean glass. Take, surface tension of water = 0.072 N/m. **(10)**

(iii) For the fluid in the annular gap between two 0.2-m-long rotating concentric cylinders, the velocity distribution is given by u(r) = 0.4/r – 1000r m/s. The diameters of the cylinders are 2 cm and 3 cm, respectively. Calculate the fluid viscosity if the torque on the inner cylinder is 0.0026 N-m. **(12)**

Or

5. (b) (i) What is Continuum? What is its relevance in the study of fluid mechanics? **(5)**

(ii) Show that the internal pressure in a bubble is twice as large as that in a droplet of the same size. **(10)**

(iii) A velocity field is given by $V = (\frac{V_0}{l})(-x\hat{\imath} + y\hat{\jmath})$ where V_0 and l are constants. Determine the streamlines and the acceleration field for this flow. **(12)**

6. **Answer Question 6(a) or 6(b).**

(a) A 1.5 m high, 1 m diameter cylindrical water tank whose top is open to the atmosphere is initially filled with water. There is a discharge plug near the bottom of the tank. If the plug is pulled out a water jet of diameter 0.01 m streams out (Fig. for Q 6(a). The average velocity of the jet is given by: **(18)**

$$V_{jet} = \sqrt{2gh} \quad \text{(m/s)}$$

where h is the height of water in the tank measured from the center of the hole and g is the gravitational acceleration. Determine

- How long it will take for the water level in the tank to drop to 0.75 m from the bottom
- How long it will take to empty the tank

How do you interpret the results?

Contd P/3

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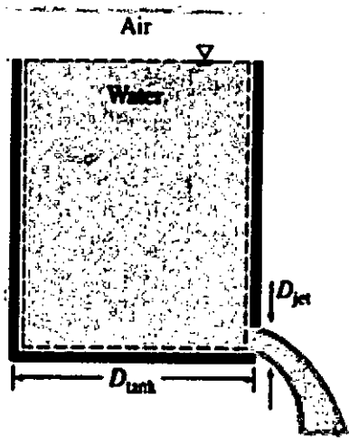

Fig. for Q 6.a

(ii) The velocity of a fluid particle is given by **(8)**

$$\vec{V} = V(x, y, z, t)$$

Determine the acceleration field. Identify its local and convective components. How do you interpret the local and convective accelerations?

Or

(b) (i) A stream function is given as follows- $\psi = y^2 - x$

- Draw the streamlines for $\psi_1(x,y) = 0$, $\psi_2(x,y) = 2$ m^2/s, and $\psi_3(x,y) = 4$ m^2/s.
- What is the velocity of a fluid particle at y = 1 m on the streamline $\psi_2(x,y) = 2$ m^2/s?

(18)

(ii) Show that the streamlines and potential lines are everywhere mutually orthogonal except at a stagnation point. **(8)**

7. (i) Determine the magnitude and direction of the anchoring force needed to hold the horizontal elbow and nozzle combination shown in Fig. for Q7 in place. Atmospheric pressure is 100 kPa (abs). The gage pressure at section (1) is 100 kPa. At section (2), the water exits to the atmosphere. **(18)**

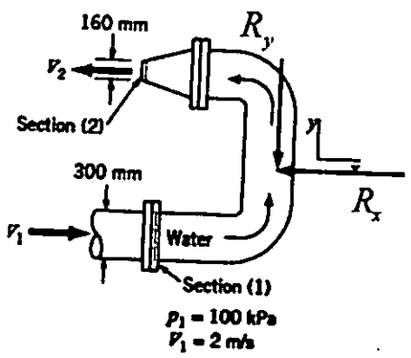

Fig. for Q7

(ii) With a neat sketch show the details of a Pitot-static tube and derive the equation for calculating the velocity of a flow using the readings of Pitot-static tube. **(8)**

8. (i) Derive the stream function for (a) doublet and (b) circulation. **(8)**

(ii) Show that a uniform flow in the positive x direction combined with a doublet can be used to represent flow around a circular cylinder. **(14)**

(iii) What is d'Alembert's paradox? **(4)**

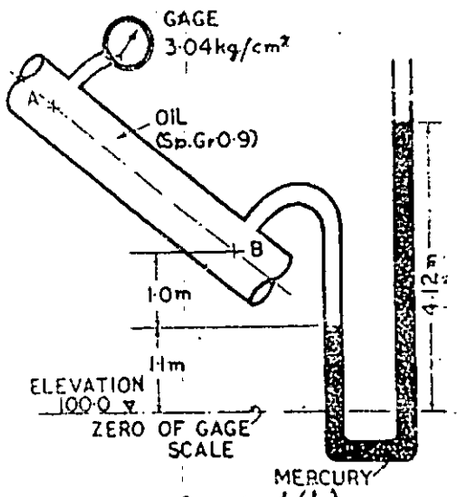

Fig. for Q. 1(b)

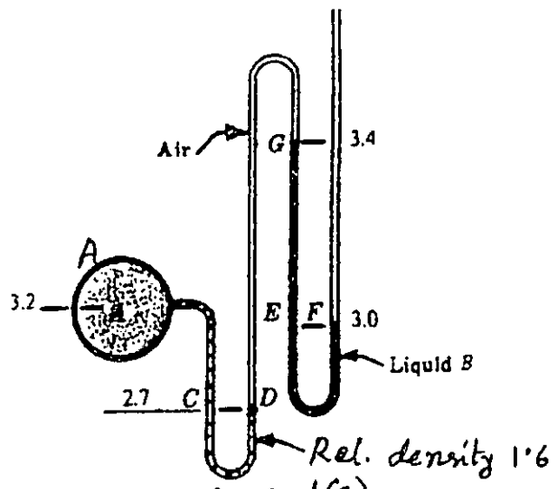

Fig. for Q. 1(c)

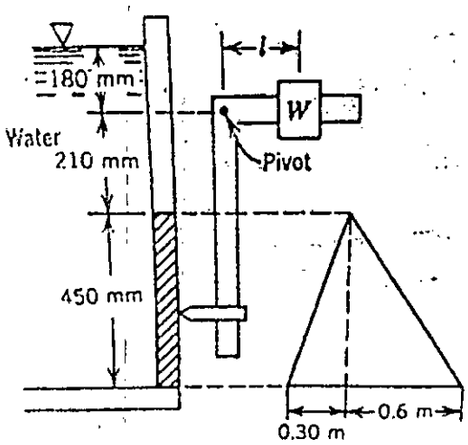

Fig. for Q. 2(b)

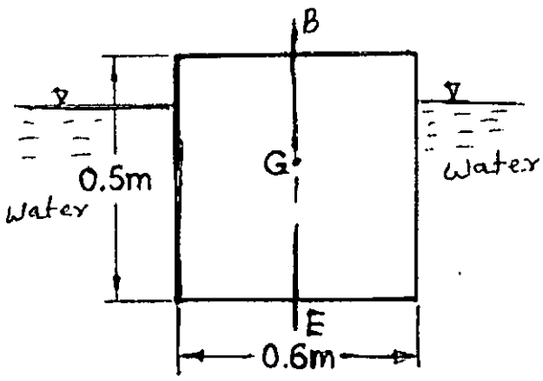

Fig. for Q. 2(d)

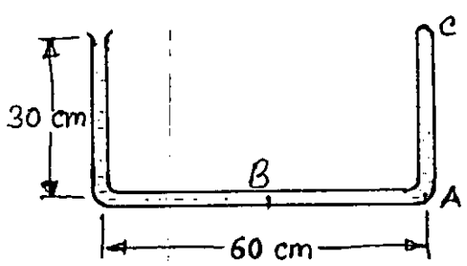

Fig. for Q. 3(b)

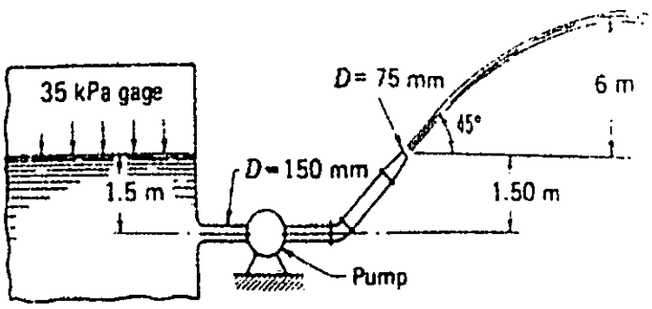

Fig. for Q. 4(b)

L-3/T-1/ME Date: ~~30/04/2024~~ 20/05/2024

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2022-2023

Sub: **ME 361** (Instrumentation and Measurement)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **ALL** questions.

1. Answer either (a) or (b)

(a) (i) Design and describe in detail an experiment to determine the time constant of a first-order system. In the analysis, demonstrate how your designed system addresses the problem of deviation from ideal first-order behavior, which is common in real systems. **(10)**

(ii) The amplitude spectrum of the time-varying displacement signal from a vibrating U-shaped tube used in a Coriolis mass flow meter is expected to have a spike at each of 85, 147, 220, and 452 Hz. Each spike is related to an important vibrational mode of the tube. Displacement transducers available for this application have a range of natural frequencies from 500 to 1000 Hz, with a fixed damping ratio of about 0.5. The transducer output is to be monitored on a spectrum analyzer that has a frequency bandwidth extending from 0.1 Hz to 100 kHz. Within the stated range of availability, select a suitable transducer for this measurement. **(16)**

OR

(b) (i) Describe an experiment to determine the natural frequency and damping ratio of a second-order system. **(10)**

(ii) The displacement of a solid body is to be monitored by a transducer (second-order system) with signal output displayed on a recorder (second-order system). The displacement is expected to vary sinusoidally between 2 and 5 mm at a rate of 85 Hz. Select appropriate design specifications for the measurement system for no more than 5% dynamic error (i. e., specify an acceptable range for natural frequency and damping ratio for each device). **(16)**

2. Answer either (a) or (b)

(a) (i) Write a short note on loading error. Discuss loading error in the context of high spatial resolution temperature measurement using a thermocouple. **(9)**

(ii) A 1-kHz sine wave is sampled at 5 kHz. What is the Nyquist frequency of the sampling system in this case? Will there be aliases in the digitally recorded signal? Will there be aliases if the original analog signal included both even and odd harmonics of its primary frequency (i. e., 2, 3, 5 kHz, etc.)? What would be the highest harmonic that will be faithfully represented in the discrete-time version of the analog signal? **(9)**

(iii) Using a comparator, draw a circuit that could be used to turn on an LED when an input voltage exceeds 5 V. How would you modify your design for noisy signals? **(8)**

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Contd ... Q. No. 2

OR

(b) (i) Suppose you have a signal in the range of ±10 V. What is the minimum number of bits needed in an A/D converter such that the signal is sampled with at least 0.005 V resolution? **(7)**

(ii) What are the two main controlling parameters during the reconstruction of a measured waveform from a discrete signal? Outline their significance. **(7)**

(iii) The voltage output from a J-type thermocouple referenced to 0°C is to be used to measure temperatures from 50 to 70°C. The output voltages vary linearly over this range from 2.585 to 3.649 mV. If the thermocouple voltage is input to an 8-bit A/D converter having a ±10V range, estimate the percent quantization error in the digital value. If the analog signal can be first passed through an amplifier circuit, compute the amplifier gain required to reduce the quantization error to 7% or less. If the ratio of signal-to-noise level (SNR) in the analog signal is 40 dB, compute the magnitude of the noise after amplification. **(12)**

3. **Answer all the following questions.**

(a) What are the main elements in a measurement system and what are their functions? **(9)**

(b) Explain the difference between accuracy and precision, using sketches as appropriate to illustrate the differences. **(6)**

(c) Explain the key differences between static and dynamic calibration. Give examples. **(11)**

4. **Answer all the following questions.**

(a) What are the advantages of using virtual instrumentation? Discuss. **(10)**

(b) Discuss signal conditioning in the context of optical diagnostics and image processing. **(10)**

(c) "The type of connecting wires used between electrical devices can have a significant impact on the noise level of the signal"- discuss some practical ways to keep this noise level low. **(7)**

SECTION – B

There are **FOUR** questions in this section. Answer any **ALL** questions.

5. **Answer either a and b, OR c and d**

(a) What do you understand by probability density function? Write down the density functions of any two standard statistical distribution and show their shapes. **(10)**

(b) A batch of plastic rivets is tested for shear strength. A sample of 20 rivets shows the following values (in MPa): **(20)**

51.9, 48.7, 51.1, 51.7, 49.9, 48.8, 52.5, 51.7, 51.3, 52.6, 49.4, 50.3, 50.3, 50.2, 50.9, 52.1, 49.3, 50.7, 50.5, 49.7.

Estimate the range of values for which you would expect 98% of all possible measured values for this operating condition to fall.

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Contd ... Q. No. 5

OR

(c) Explain the differences between the following terms used in measurement. **(12)**

(i) error vs uncertainty, (ii) repeatability vs reproductivity, (iii) random error vs systematic error.

(d) Three resistor R_1 = 100.0 ± 0.1 Ω, R_2 = 50.0 ± 0.03 Ω, and R_3 = 25 ± 0.02 Ω are connected in parallel. Calculate the uncertainty in the combined resistance for the parallel arrangement. Also calculate the uncertainty if the resistors were connected in series. **(18)**

6. Answer either a and b, OR c and d

(a) With a neat sketch, describe the working principle of an LVDT. **(12)**

(b) Describe the steps to measure a very low absolute pressure using a McLeod gage. Derive an expression for the indicated pressure. For a McLeod gage having capillary diameter 1 mm and bulb volume 100 cc, calculate the indicated pressure when it reads 3.0 cm. **(18)**

OR

(c) The mercury manometer connected between the static and stagnation pressure connections of a pitot static probe in an aircraft reads 30 mm. If the air density at the altitude of flight is 1.13 kg/m^3, what is the aircraft velocity? **(10)**

(d) With a neat sketch, describe the Schlieren technique for flow visualization. What are the distinctions between it and the Shadowgraph? **(20)**

7. Answer all the following questions.

(a) A 10 cm × 5 cm venturi meter is employed to measure the flow rate through a horizontal pipe carrying water. A mercury manometer placed between the inlet and throat of the venturi shows 10 cm deflection. If the discharge coefficient is 0.98, calculate the volumetric flow rate through the pipe. **(8)**

(b) Write down the advantages and disadvantages of rotameter. **(10)**

8. Answer all the following questions.

(a) How is the change of resistance due to temperature compensated during the measurement of strain using a resistance strain gage? **(10)**

(b) Describe the construction and operation of a bimetallic strip thermometer. **(10)**

(c) Calculate the total sound intensity resulting from three sound sources having intensities 70, 75, and 80 dB. **(7)**

Student's t Distribution

ν	t_{50}	t_{90}	t_{95}	t_{99}
1	1.000	6.314	12.706	63.657
2	0.816	2.920	4.303	9.925
3	0.765	2.353	3.182	5.841
4	0.741	2.132	2.770	4.604
5	0.727	2.015	2.571	4.032
6	0.718	1.943	2.447	3.707
7	0.711	1.895	2.365	3.499
8	0.706	1.860	2.306	3.355
9	0.703	1.833	2.262	3.250
10	0.700	1.812	2.228	3.169
11	0.697	1.796	2.201	3.106
12	0.695	1.782	2.179	3.055
13	0.694	1.771	2.160	3.012
14	0.692	1.761	2.145	2.977
15	0.691	1.753	2.131	2.947
16	0.690	1.746	2.120	2.921
17	0.689	1.740	2.110	2.898
18	0.688	1.734	2.101	2.878
19	0.688	1.729	2.093	2.861
20	0.687	1.725	2.086	2.845
21	0.686	1.721	2.080	2.831
30	0.683	1.697	2.042	2.750
40	0.681	1.684	2.021	2.704
50	0.680	1.679	2.010	2.679
60	0.679	1.671	2.000	2.660
∞	0.674	1.645	1.960	2.576

L-3/T-1/ME Date: ~~05/05/2024~~ 26/5/24

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2022-2023

Sub: **IPE 331** (Production Processes)

Full Marks: 280 Time: 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) What are some of the functions of the electrode coatings in shielded metal arc welding? Sketch and explain the various weld joints and welds used in making a joint. **(13)**

   (b) Differentiate among autogenous welding, homogenous welding and heterogeneous welding. With the help of suitable diagram describe MIG welding process. **(20)**

   (c) With a simplified diagram, describe the laser beam welding process. In comparison to the electron beam welding write down its advantages and disadvantages. **(13⅔)**

2. (a) Describe briefly the principles of operation of Submersed arc welding with necessary sketch. For what types of applications might Thermit welding be attractive? **(13)**

   (b) With the help of neat sketches, describe briefly the principles of operation and give one suitable industrial application of (i) Percussion welding and (ii) Resistance projection welding. **(20)**

   (c)Enumerate common defects encountered with welding products and suggest methods to counter these defects. Identify the factors that affect weldability. **(13⅔)**

3. (a) With the help of diagram, describe briefly (i) Split pattern, (ii) Loose-piece pattern, (iii) Cope and drag pattern and (iv) Follow board pattern. **(16)**

   (b) Discuss the requisite characteristics essential for molding sand. With neat sketches, describe briefly the permanent mold casting. **(18)**

   (c) A series of tool life tests are conducted on two work materials under identical cutting conditions, varying only speed in the test procedure. The first material, defined as the base material, yields a Taylor tool life equation $vT^{0.28} = 350$, and the other material (test material) yields a Taylor equation $vT^{0.27} = 440$, where speed is in m/min and tool life is in min. determine the machinability rating of the test material using the cutting speed that provided a 60-min tool life as the basis of comparison. The speed is denoted by v_{60}. **(12⅔)**

Contd P/2

IPE 331

4. (a) Describe briefly the investment casting with necessary sketch. List the advantages and limitations of investment casting in comparison with sand casting. **(20)**

(b) Classify and elucidate the diverse anomalies observed in casting methodologies utilizing appropriate illustrations. How could flawed castings be rectified to facilitate efficacious utilization within their designated application? **(15⅔)**

(c) With the help of suitable diagram, describe the various elements of gating system. With the help of suitable diagrams describe (i) Squeeze casting and (ii) Centrifugal Casting. **(11)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE** questions.

Make appropriate assumptions for any missing data.

5. (a) Define a single-point cutting tool and give some examples of this kind of cutting tool. **(6⅔)**

(b) A drilling operation is to be performed with a 12.7 mm diameter twist drill in a steel workpiece. The hole is a blind hole at a depth of 60 mm and the point angle is 118°. The cutting speed is 25 m/min and the feed is 0.30 mm/rev. Determine: **(15)**

(i) The cutting time to complete the drilling operation.

(ii) Metal removal rate during the operation, after the drill bit reaches full diameter.

(c) Explain the following machining processes with necessary sketches, and also mention the required direction of motion in the sketches: **(25)**

(i) Taper turning

(ii) Threading

(iii) Knurling

(iv) Boring

(v) Drilling

6. (a) Differentiate positive rake angles from negative rake angles with neat sketches. **(6⅔)**

(b) (i) Write the names of the variables that affect tool life. **(5+10=15)**

(ii) Illustrate the graph showing the general relationship between tool flank wear and machining time and briefly explain the regions usually be identified in the typical tool wear growth curve.

Contd P/3

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Contd... Q. No. 6

(c) Prove the followings by master line methods for a single-point cutting tool. **(3×6+7=25)**

i) $\tan \gamma_o = \tan \gamma_x \sin \varphi + \tan \gamma_y \cos \varphi$

ii) $\tan \lambda = -\tan \gamma_x \cos \varphi + \tan \gamma_y \sin \varphi$

iii) $\tan \gamma_m = \sqrt{\tan^2 \gamma_o + \tan^2 \lambda}$

Here, all the symbols carry their usual meaning.

Determine the value of the maximum rake angle of the turning tool whose geometry is specified as 10°, –10°, 8°, 6°, 15°, 30° and 0 (inch).

7. (a) Distinguish between up milling and down milling. **(6⅔)**

(b) Write down the main functions of using cutting fluid in machining operations. Discuss the properties of a good cutting fluid. **(15)**

(c) What is a quick return mechanism? Why is it employed in a shaper machine? Describe the mechanism of a hydraulic shaper quick return mechanism with necessary sketches. **(25)**

8. (a) What do you understand by coining? Write some applications for this process. **(6⅔)**

(b) Define the bulk deformation process. Briefly describe the four basic bulk deformation processes with the necessary diagrams. **(15)**

(c) Write two characteristics based on how you can classify forging processes. According to the characteristics, classify forging processes and explain them with appropriate diagrams. **(25)**
