BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2020-2021

Sub: **WRE 201** (Fluid Mechanics)

Full Marks: 280   Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

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

1. (a) What are the different approaches to describe fluid motion? Explain with examples. **(10)**

   (b) Derive the expressions for linear and shear strain rates and hence write down the strain rate tensor in the Cartesian coordinate. **(10)**

   (c) Define and explain different types of vorticity with sketches. **(10)**

   (d) Compute the acceleration of fluid flow at points A and B of Figure 1. **(16 $\frac{2}{3}$)**

2. (a) Describe the system approach and control volume approach of fluid flow analysis. Derive the general form of equation that connects these two approaches. **(16 $\frac{2}{3}$)**

   (b) Velocity in a uniform diameter pipe varies linearly from 1.0 m/s at center to 0.1 m/s at the wall. Compute the energy correction factor if the diameter of the pipe is 50 mm. **(10)**

   (c) Water is being pumped from an underground reservoir tank whose elevation is 4.0 m to an overhead tank on the roof of the Civil Engineering building. The elevation of the pump and the exit pipe at the tank are 5.0 m and 30.0 m respectively. The velocity at the exit should be 0.5 m/s. If the diameter of the exit pipe is 50 mm determine the power of pump required with efficiency of 90%. Consider the total head loss is 2m. **(10)**

   (d) Briefly describe the working principle of a syphon. Also draw its hydraulic grade line and energy line. **(10)**

3. (a) Derive the generalized energy equation for steady flow. Hence deduce the Bemoullis equation. **(16 $\frac{2}{3}$)**

   (b) A liquid (s = 0.86) with a vapor pressure of 26 kN/m^2 (abs) flows through a horizontal pipe as shown in Figure 2. Atmospheric pressure is 68 cm of mercury. Find the maximum theoretical discharge at which cavitation just occurs. Also calculate the force on the pipe segment. Neglect head loss. **(15)**

WRE 201
Contd... Q. No. 3

(c) Water flows through the pipe C at 4 m/s. Determine the horizontal and vertical components of force exerted by elbow D necessary to hold the pipe assembly in equilibrium (Figure 3). Neglect the size and weight of the pipe and the water within it. The pipe has a diameter of 60 mm at C, and at A and B the diameters are 20 mm. Consider the piping system is in the horizontal plane.   **(15)**

4.   (a) Briefly describe the working principle of fluid measurement using the followings devices; (i) Acoustic Doppler Velocimeter (i) Particle Image Velocimetery (iii) Sharp-crested weir.   **(15)**

(b) Water flows from a 0.6 m -diameter tank as shown in Figure 4. The jet diameter is 7.5 cm. If the static coefficient of friction between the tank and the floor is 0.56, determine the minimum value of h at which the tank will commence to move to the left. The tank itself weighs 450 N.   **(15)**

(c) A radial flow turbine has the following dimensions: r_1 =0.5 m, r_2 = 0.3 m, and β_1 = 80°. The width of the flow passage between the two sides of the turbine is 0.25 m. At 300 rpm the flow rate through the turbine is 4 m³/s. Find the blade angle β_2, such that the water exits from the turbine is the radial direction. $(16\frac{2}{3})$

SECTION – B

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

5.   (a) Define (i) Mach Number, (ii) Froud Number and (iii) Euler Number   **(6)**

(b) What is similitude? State dynamic similarity conditions for flow. $(8\frac{2}{3})$

(c) A 120 m long ship is to be tested by a model of 3 m long. If the ship travels at 56 km/h, at what speed must the model be towed for achieving dynamic similitude between model and prototype? If drag of the model is 10 N, what prototype drag is to be expected?   **(14)**

(d) Using dimensional analysis, derive an expression for small flow rates over a spillway, in the form of a function including dimensionless quantities. The parameters involved are height of spillway P, head on the spillway H, acceleration due to gravity g, viscosity of liquid μ, and density of liquid ρ.   **(18)**

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6. (a) Differentiate between: (i) Compressible and incompressible fluid (ii) Ideal and real fluid. **(6)**

(b) Define absolute pressure, vacuum pressure and gage pressure. How are they interrelated? $(9\frac{2}{3})$

(c) A manometer is attached to a tank containing three different fluids, as shown in Figure 5. What will be the difference in elevation of mercury column in the manometer. **(12)**
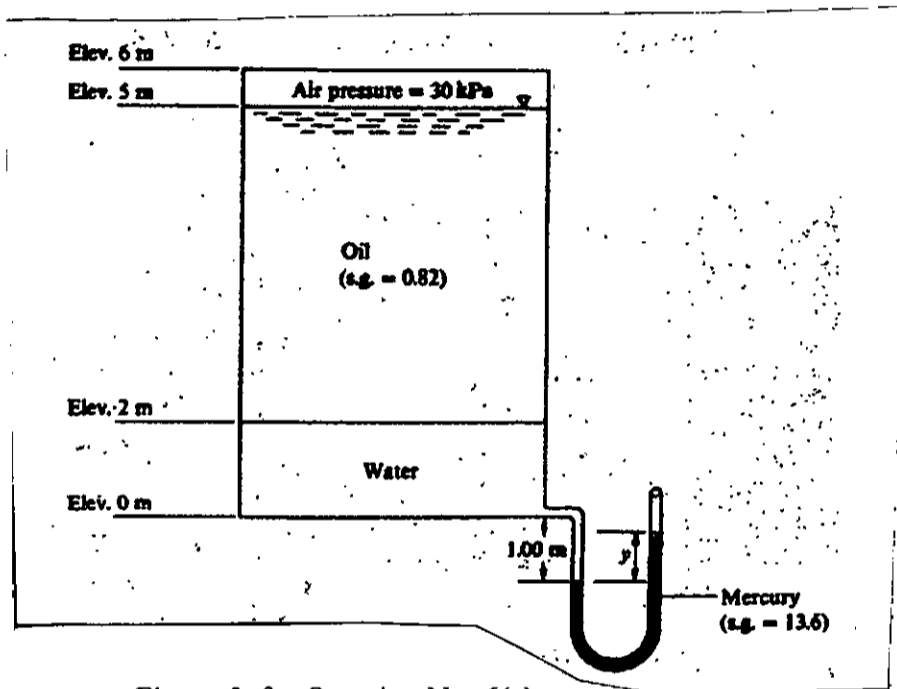
Elev. 6 m

Elev. 5 m   Air pressure = 30 kPa

Oil
(s.g. = 0.82)

Elev. 2 m

Water

Elev. 0 m

1.00 m   y

Mercury
(s.g. = 13.6)

Figure 5: for Question No. 6(c)

(d) The flows into and out of a two-loop pipe system are shown in Figure 6. Determine the flow in each pipe by Hardy - Cross method. The K values for each pipe were calculated from the pipe and minor loss characteristics are from assumed value of f. The discharges are in liter/sec (L/s). Show only one trial. **(19)**
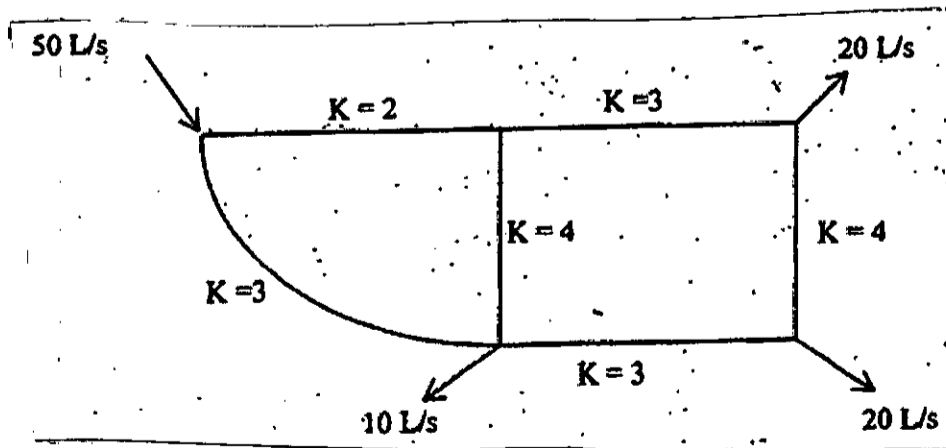
50 L/s   20 L/s

K = 2   K = 3

K = 4   K = 4

K = 3

K = 3

10 L/s   20 L/s

Figure 6: for Question No. 6(d)

WRE 201
<u>Contd... Q. No. 7</u>

7. (a) Two reservoirs with a difference in water surface elevation of 8 m are connected by a pipeline ABC which consists of two pipes AB and BC are joined in. Pipe AB has diameter of 10 cm, 20 m long and friction factor 0.021. Diameter, length and friction factor of pipe BC are 18 cm, 30 m and 0.015, respectively. The junctions with the reservoirs and between the pipes are sharp. Calculate discharge considering all minor losses. **(16)**

(b) What do you understand by (i) surface tension and (ii) Adhesion and cohesion? Explain with suitable figures. **(10)**

(c) State the Newton's law of viscosity. Derive the expression of Newton's law of viscosity. **(12)**

(d) A piston is moving through a cylinder at a speed of 19 ft/s, as shown in Figure 7. The film of oil separating the piston from the cylinder has a viscosity of 0.02 lb.s/ft^2.

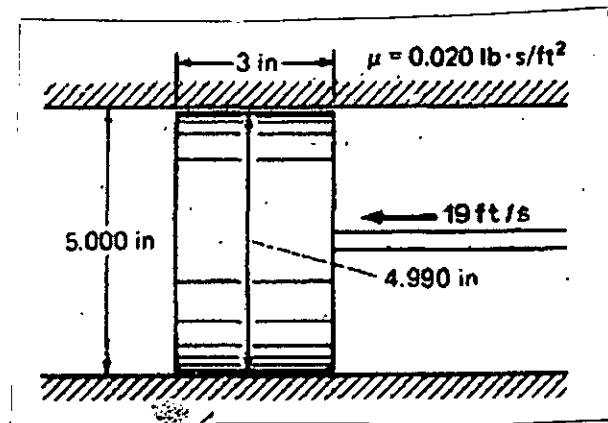What is the force required to maintain this motion? **$(8\frac{2}{3})$**

Figure 7: for Question No. 7(d)

8. (a) For the open tank, with piezometers attached on the side, containing two different immiscible liquids, as shown in Figure 8, find the (i) elevation of the liquid surface in piezometer A, (ii) elevation of the liquid surface in piezometer B, and (iii) total pressure at the bottom of the tank. **$(10\frac{2}{3})$**
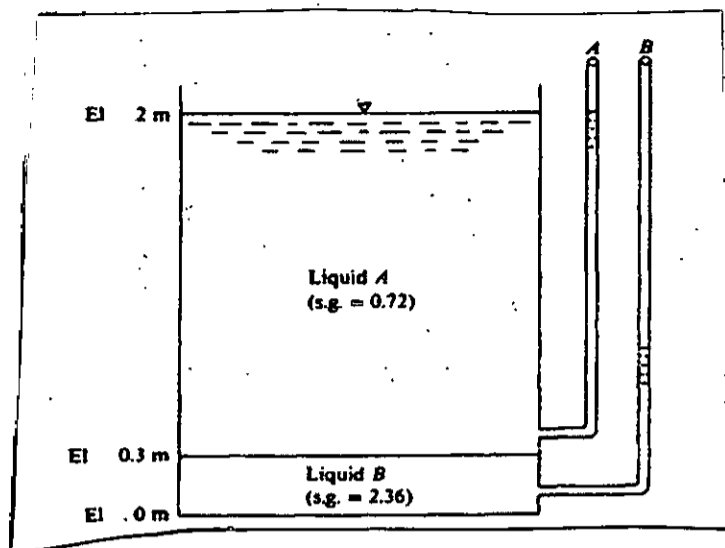
WRE 201

<u>Contd... Q. No. 8(a)</u>

Figure 8: for Question No. 8(a)

(b) The U-shaped tube shown in Figure 9 has a diameter of 10 mm and contains mercury. If 12 mL of water is poured into the right-handed leg, what are the ultimate heights in the two legs? **(15)**
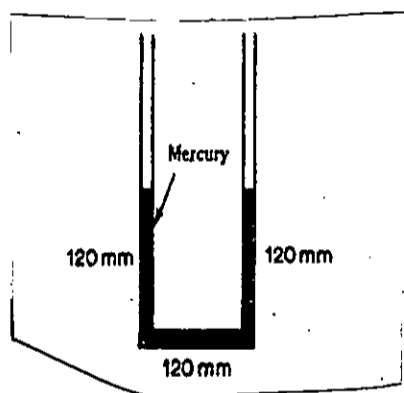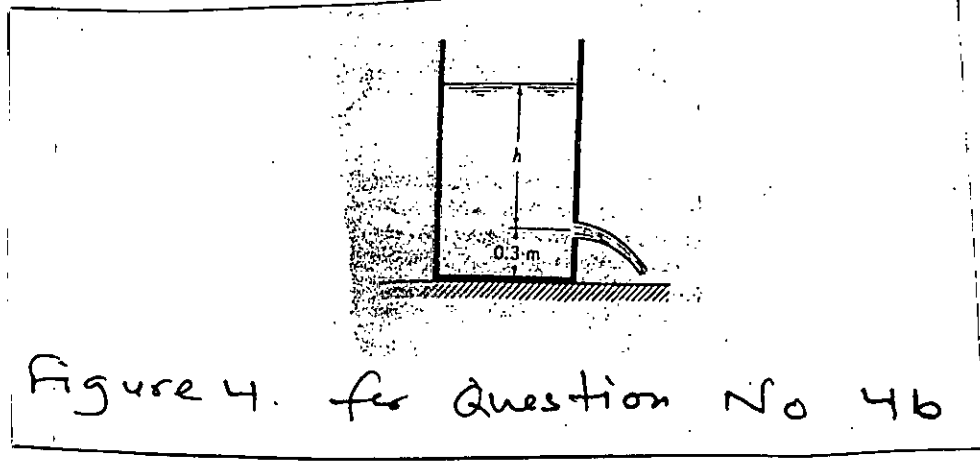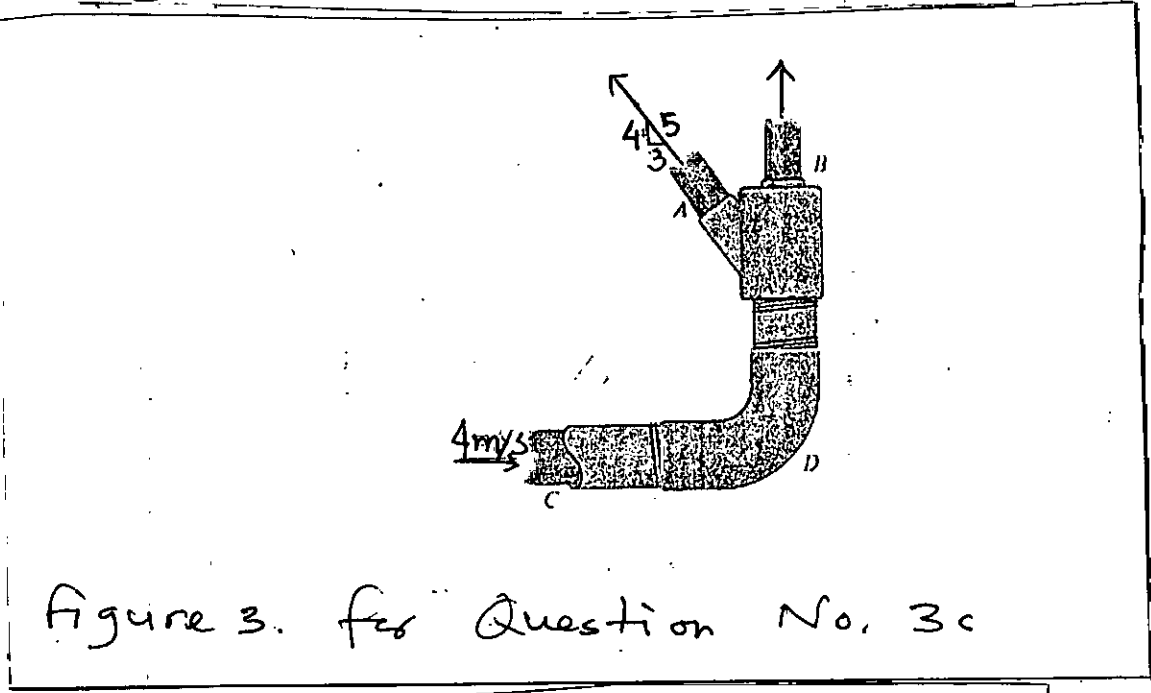

Figure 9: for Question No. 8(b)

(c) What do you understand by buoyancy? Discuss the stability of immersed and floating bodies using suitable diagrams based on your understanding of buoyancy. **(11)**

(d) Prove that the pressure at any point of a liquid is proportional to the depth of that point from the free surface. **(10)**

V=.2 m/s

A

B

Stream tube of 2 cm dia

30°

1 m radius

45°

X

V= 2 m/s

figure 1. for Question No. 1d

70 kN/m²

Q

30 cm diam

90 cm diam

figure 2. for Question No 3b

4 5
3

A

B

4m/s

C

D

figure 3. for Question No. 3c

h

0.3 m

figure 4. for Question No 4b

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2020-2021

Sub: **WRE 205** (Numerical Methods)

Full Marks: 140   Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

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

Assume any reasonable value where necessary.

1.   (a) Distinguish between numerical accuracy and numerical precision. $(3\frac{1}{3})$

(b) Find the real root of the equation f(x) = 2x - 3 sin x -5 = 0 using Reguli-Falsi

method. (Do only five iterations.)   **(10)**

(c) During an experiment in a flume at Hydraulics and River Engineering Laboratory
of BUET, discharge over a sharp crested rectangular weir with end contractions was

found 0.0175 m³/s. Discharge formula for the weir is given by,   **(10)**

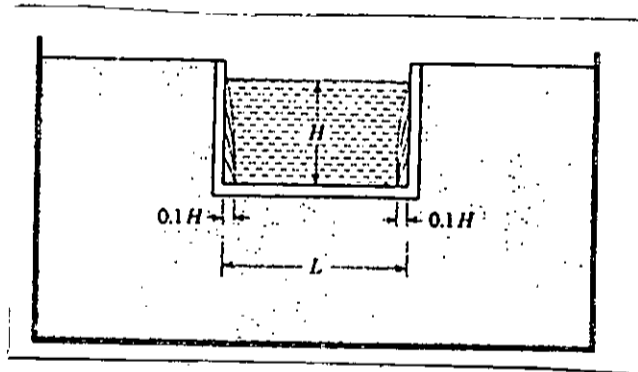$$Q = \frac{2}{3} * C_d * \sqrt{2g} * (L - 0.1 * n * H) * H^{3/2}$$

Figure 1: Weir with end contractions

Solve the above-mentioned equation to get the water depth (H) over the crest by
Newton-Raphson method. Use Coefficient of discharge, C_d = 0.55; number of end
contractions, n = 2; width of weir, L = 0.22 m. (Do only 3 iterations)

2.   (a) A numerical model can have stability issues: Explain briefly. $(3\frac{1}{3})$

(b) Solve the system of equations by Matrix Inversion method.   **(8)**

$9x_1 - 2x_2 + x_3 = 17$

$4x_1 + 5x_2 - 2x_3 = -9$

$x_1 - 3x_2 - 5x_3 = 4$

WRE 205
Contd... Q. No. 2

(c) The following system of equations is designed to determine discharge in a series of coupled flume. **(12)**

$$2q_1 - 3q_2 + 10q_3 = 3$$
$$-q_1 + 4q_2 + 2q_3 = 20$$
$$5q_1 + 2q_2 + q_3 = -12$$

Determine the flow rate in each flume i.e. the values of q_1, q_2 and q_3 using the method of LU decomposition.

3. (a) What do you mean by initial value problems and boundary value problems? **($3\frac{1}{3}$)**

(b) Solve the system of equations by the relaxation method. (Show only 3 iterations) **(10)**

$$-2x_1 + 10x_2 - x_3 - x_4 = 15$$
$$10x_1 - 2x_2 - x_3 - x_4 = 3$$
$$-x_1 - x_2 + 10x_3 - 2x_4 = 27$$
$$-x_1 - x_2 - 2x_3 - 10x_4 = -9$$

(c) Solve the following nonlinear simultaneous equations by Newton-Raphson method. Take $x_0 = 1$, $y_0 = 1$ as initial approximation. (Do only 2 iterations) **(10)**

$$x^2 + 2y^2 = 3.1$$
$$xy = 1.1$$

4. (a) Given the ordinary differential equation $\dfrac{dy}{dx} = 1 + y^2$ with $y(0) = 0$, estimate $y(0.2)$ and $y(0.4)$ when $h = 0.2$ using the fourth order Runge-Kutta Method. **(10)**

(b) Suppose, water quality in a lake is described by the following ordinary differential equation: **($10+3\frac{1}{3}$)**

$$\frac{dC}{dt} = \frac{22.5}{T} - \frac{C}{T}$$

Solve the equation for 5 days using forward finite difference scheme. Take concentration C (at $t = 0$) = 10.0 mg/l, T = 10 days, $\Delta t = 1.25$ days and $\Delta t = 2.5$ days. Compare the results qualitatively with a graph for taking different time step, Δt.

SECTION – B

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

5. (a) Fit a second degree parabola using the following data by least squares method: **($12\frac{1}{3}$)**

x	1929	1930	1931	1932	1933	1934	1935	1936	1937
y	352	356	357	358	360	361	361	360	359

(b) Find the value of f(x) for x = 301 using Lagrange interpolation formula from the following data set: **(11)**

x	300	304	305	307
f(x)	2.4771	2.4829	2.4843	2.4871

6. (a) For the data given below, find the equation of the best fitting exponential curve considering the form $y = ax^b$: **($12\frac{1}{3}$)**

x	1	2	3	4	5	6
y	1200	900	600	200	110	50

(b) Find the value of u_{14} using Newton's divided difference formula from the following data set: **(11)**

x	11	17	21	23	31
u_x	14646	83526	194486	279846	923526

7. (a) Following are the survey data of a river. Assuming the mean velocity of the flowing river water to be 1.1. m/s, find out the discharge of the river using Simpson's 1/3 rule: **($14\frac{1}{3}$)**

Chainage from left bank (m)	0	20	40	60	80	100	120	140	160	180	200
Bed Level (m)	10	5	0	-4	-15	-20	-16	-6	-2	4	10

Assume water level elevation is at 10 m.

(b) Explain forward difference formula, backward difference formula and central difference formula in brief. **(9)**

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8. (a) In the table below, distances traveled by a water particle at various time intervals during the initial running at the downstream of a spillway area given.

    $(9\frac{1}{3})$

Time, t(sec)	5	6	7	8	9
Distance, s (m)	10	14.5	19.5	25.5	32

Estimate the velocity at time t = 5 sec and 9 sec. Use any approximate Finite Difference scheme.

(b) A mathematical function is given as: $f(x) = 5 + 2x + 6x^2 + 3x^3$. (i) Using the values of the function and its derivatives at x = 5, determine the values of the function at x = 5.05 with the help of the Taylor series expansion and compare these values with the actual values of the function. (ii) Also taking $\Delta x = 0.05$, determine the % of error of forward, backward and central differences of the first derivative and of the second derivative with respect to the point where x = 5.

(14)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA
L-2/T-2   B. Sc. Engineering Examinations 2020-2021
Sub : CE 223 (Mechanics of Solids II)
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 THREE.

1. (a) Outer surface of a steel spherical pressure vessel (inner diameter = 20 inch and wall thickness = $\frac{1}{4}$ inch) is coated with paint as shown in Figure 1. Determine the internal pressure which will just create cracking on the paint if cracking strain of paint is 14×10^{-5}. What will be the decrease in wall thickness and increase in diameter of the vessel at this instant? Assume, E (steel) = 30,000 ksi and μ (steel) = 0.30.   **(8)**

   (b) Using moment-area method, determine the vertical reaction at support 'B' of the indeterminate beam loaded as shown in Figure 2. Determine angular rotation at free end 'A', angular rotation at 'B', vertical deflection at free end 'A' and vertical deflection at 'C'. Given, bending stiffness (EI) = constant.   **(27)**
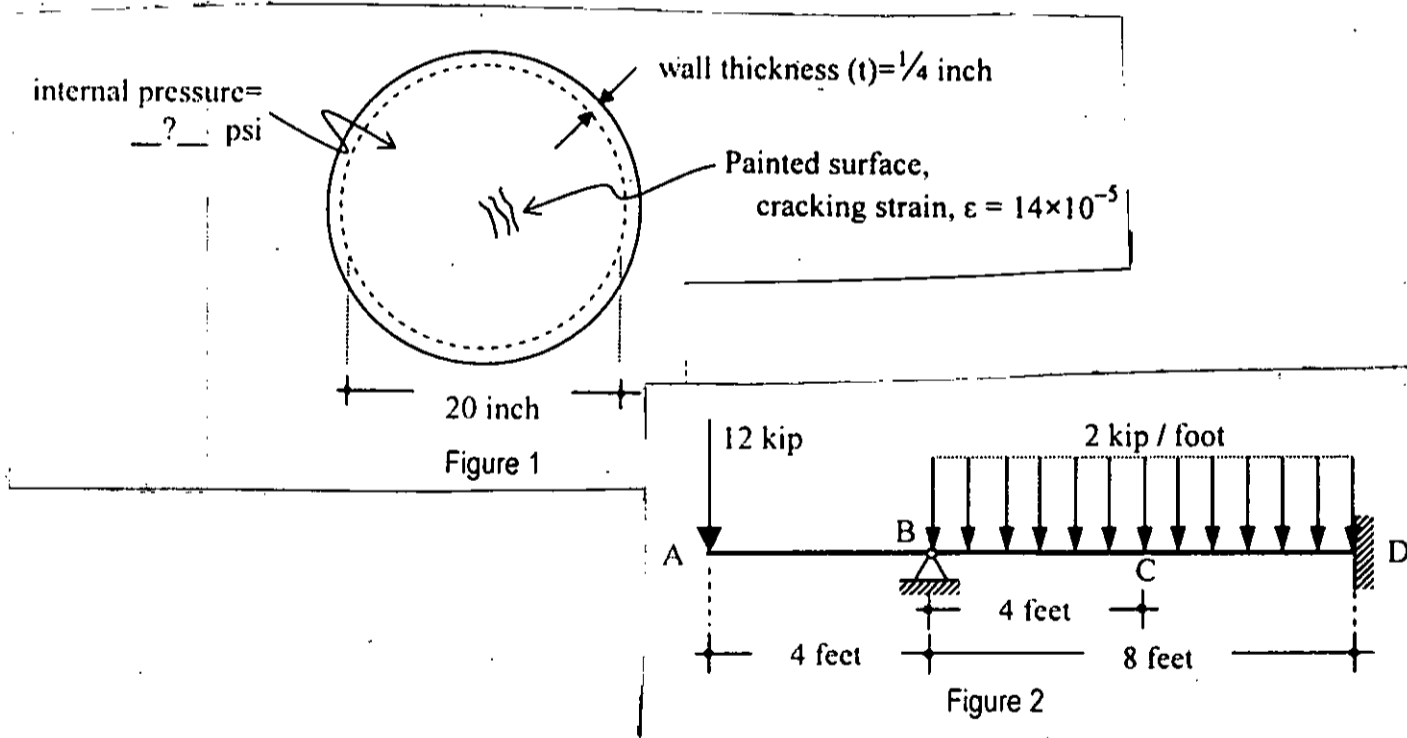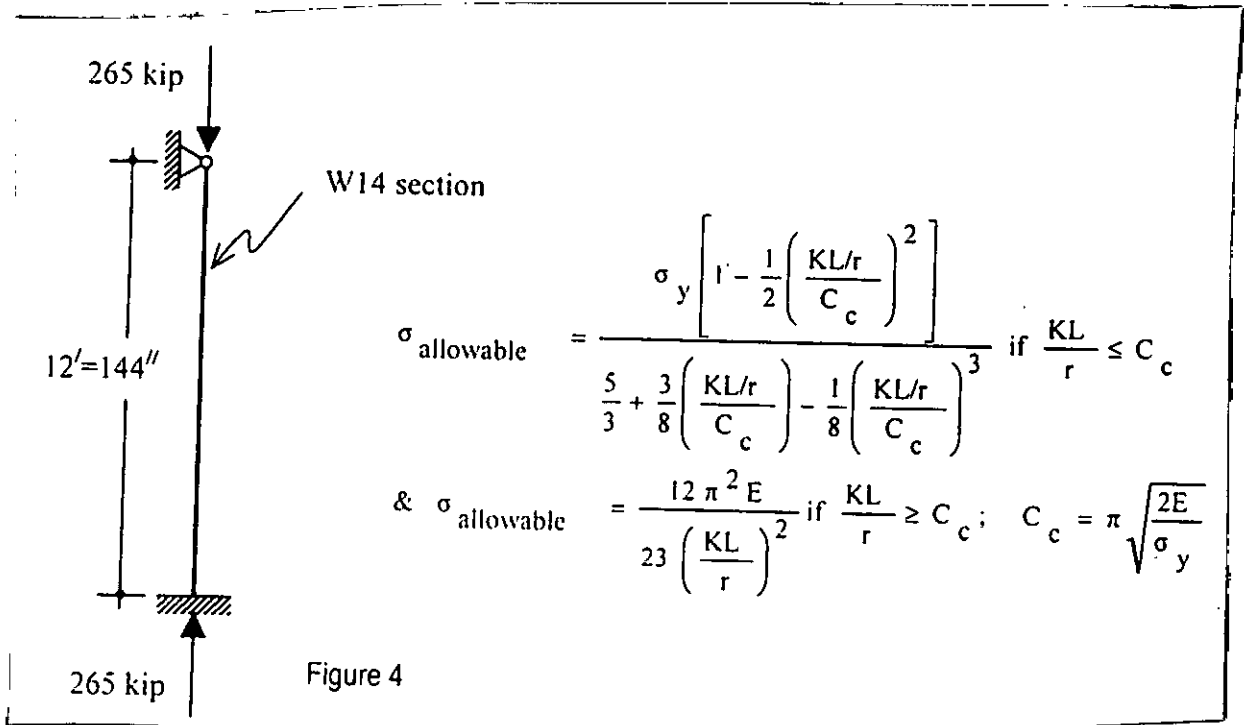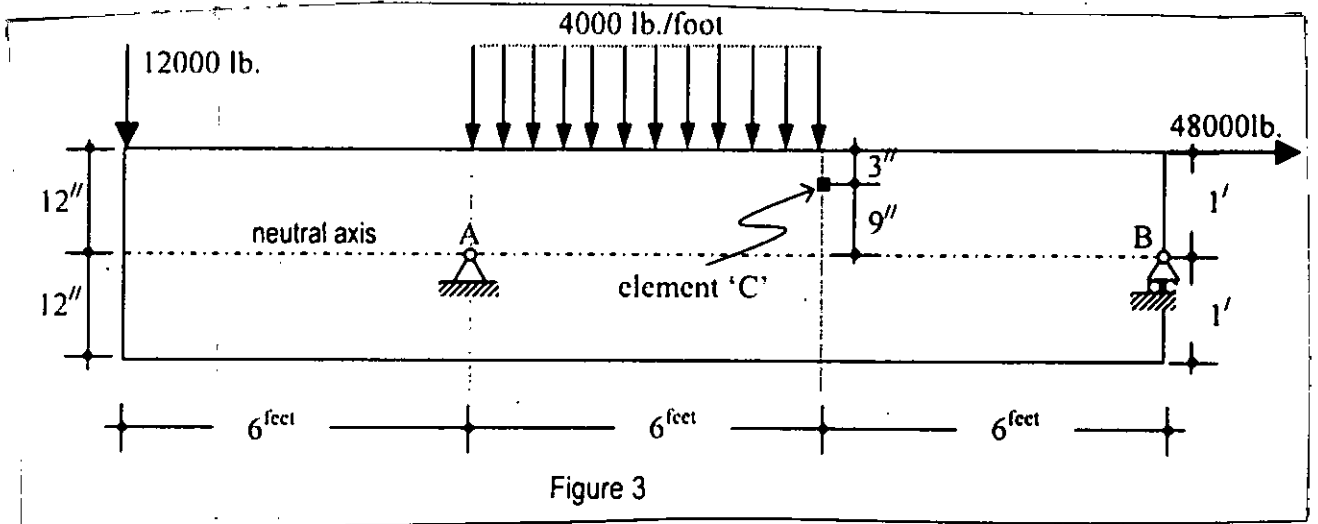

Figure 1

Figure 2

2. (a) An overhanging beam is subjected to transverse as well as axial loads as shown in Figure 3. Identify and draw state of stress at element 'C' as marked on the beam. Assume, beam cross-section (width × depth) = 12″ × 24″.   **(17)**

   (b) Select the lightest W14 section of A36 steel for a column of 12 feet length subjected to an axial compression of 265 kip as shown in Figure 4. Assume the member is fixed at the bottom and hinged at the top for bending about either principal axis. Use AISC specification. A table of W14 section properties is attached at the end. Given, E = 29000 ksi and σ_y = 36 ksi.   **(18)**

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Contd ... Q. No. 2

4000 lb./foot

12000 lb.

48000lb.

12″

neutral axis   A

element 'C'   B

12″

3″

9″

1′

1′

|← 6^{feet} →|← 6^{feet} →|← 6^{feet} →|

Figure 3

265 kip

W14 section

$$\sigma_{allowable} = \frac{\sigma_y\left[1 - \frac{1}{2}\left(\frac{KL/r}{C_c}\right)^2\right]}{\frac{5}{3} + \frac{3}{8}\left(\frac{KL/r}{C_c}\right) - \frac{1}{8}\left(\frac{KL/r}{C_c}\right)^3} \quad if \ \frac{KL}{r} \le C_c$$

12′=144″

$$\& \ \sigma_{allowable} = \frac{12\pi^2 E}{23\left(\frac{KL}{r}\right)^2} \quad if \ \frac{KL}{r} \ge C_c; \quad C_c = \pi\sqrt{\frac{2E}{\sigma_y}}$$

265 kip   Figure 4

3. (a) Determine strain energy absorbed by the cantilever beam subjected to an end moment of 30 kip-ft as shown in Figure 5. Also, compute the rotation at free end 'B'. Given, EI = 45,000 kip-foot^2. **(6)**

(b) A reinforced concrete dam of constant cross-section is built to retain the water as shown in Figure 6. Determine the maximum permissible height 'h' of the water behind the dam that will cause zero normal stress at 'A'? Given, unit weight of concrete = 150 lb./ft^3 and that of water = 62.40 lb./ft^3. **(11)**

(c) A suspension bridge (with stiffening truss) carries two concentrated loads as shown in Figure 7. Determine **(18)**

(i) horizontal component of cable tension (H), (ii) maximum cable tension (T$_{maximum}$), (iii) uniform load on the cable (w), (iv) hanger tensile force (F), (v) support reactions at 'L' and 'R' (vi) truss member force in "a" and "b".
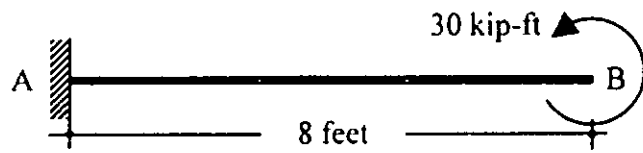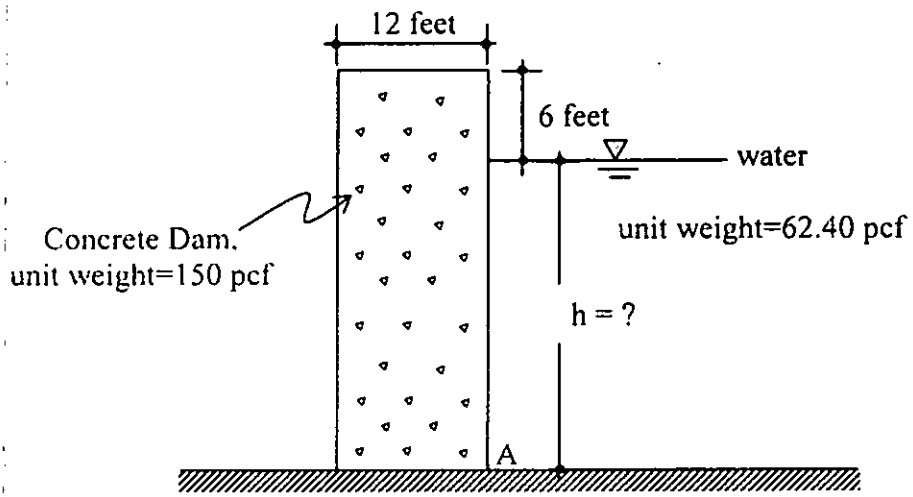
CE 223/WRE

Contd ... Q. No. 3

30 kip-ft

A   B

8 feet   Figure 5

12 feet

6 feet

water

Concrete Dam.
unit weight=150 pcf

unit weight=62.40 pcf

h = ?

A

Figure 6

cable

tower

hanger

L′   R′

16′

12′

a

8′

b

L   R
I

60 kip   40 kip
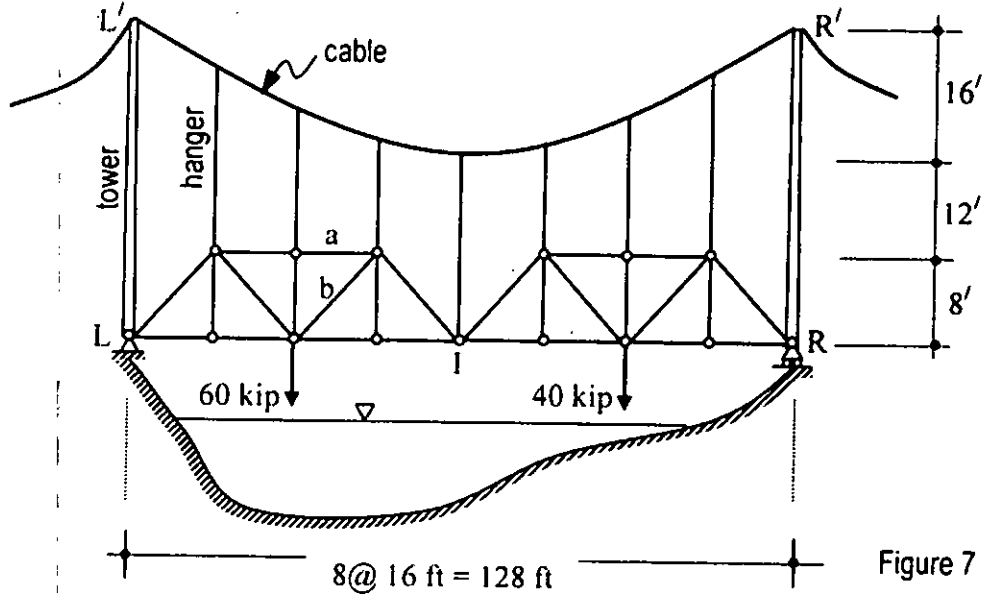
8@ 16 ft = 128 ft   Figure 7

CE 223/WRE

4. (a) A beverage can made with aluminum she·t having ultima· ? shear strengtl ($\tau_{ultimate}$) of 12 ksi is fitted with a transverse strain gauge as show n in Fi; i re 8. Upon tl. opening of the lid, what will be reading of transverse strain gau ;e assu: i ng a factor o safety = 3? What was the pressure inside the can if diam eter-to-v all thi ·ness ratio = 2)? Assume, E (aluminum) = 10,000 ksi and μ (aluminum· = 0.33. **(9)**

(b) Using direct integration method, determine the v rtical ·ection at supf rt 'B' of the indeterminate beam as shown in Figure 9. Determi e angι ι r rotation at ·ee end 'A', angular rotation at 'B' and vertical deflection at fr · end . ι. Given ben(ιg stiffness (EI) = 45,000 kip-foot². **(26)**

d_i=2r_i

d_i/t =200

t →

transverse strain gauge, ε = __?__

beverage can

Figure 8

2 kip / foot

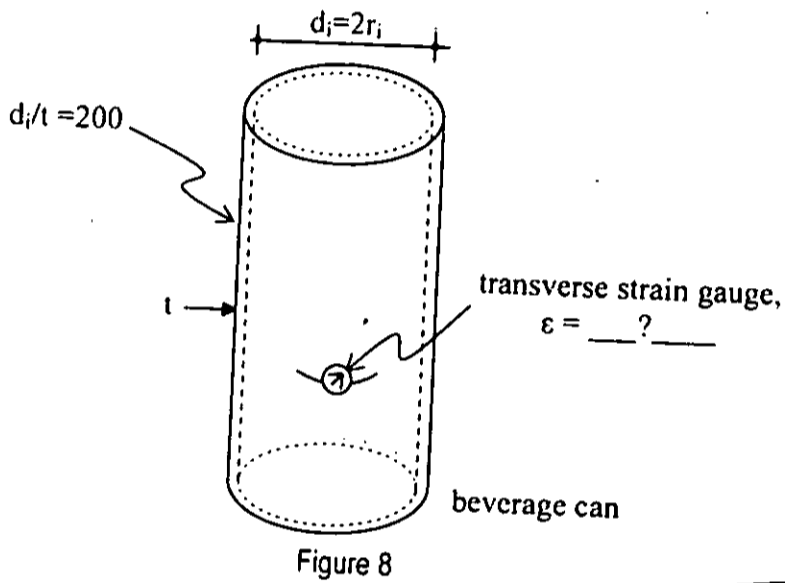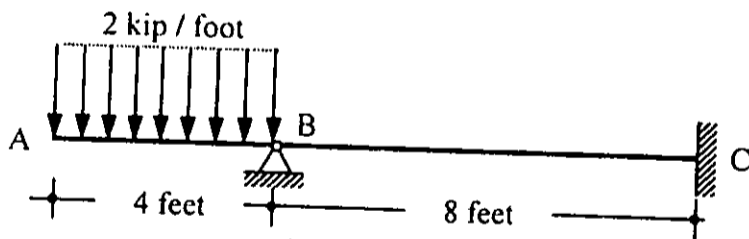A   B   C

4 feet   8 feet

Figure 9

SECTION – B

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

5. (a) The state of stress at a point is represented by the element shown in Fig. 10. Using stress transformation equations, determine the state of stress at same the point on another element oriented 30° clockwise from the position shown. **(15)**

(b) Draw Mohr's circle for the state of stress at a point as represented by the element shown in Fig. 11. Using the Mohr's circle, determine the principal stresses and show their sense on a properly oriented element. **(20)**

CE 223/WRE

6. (a) Find the **Kern** of a rectangular section (having dimensions **b** × **h**) and show the results on the section. **(15)**

    (b) The rectangular block of negligible weight in Fig. 12 is subjected to a vertical force of **40** kN, which is applied to its corner. Determine the largest normal stress acting on a section through ABCD. **(20)**

7. (a) Determine the equation of the elastic curve for the beam shown in the Fig. 13, due to the applied loading. Also determine the slope of the elastic curve at point **b**. EI is constant. **(20)**

    (b) Determine the equation of the elastic curve for the beam shown in the Fig. 14, due to the applied loading. EI is constant. **(15)**

8. (a) Using the moment-area method, determine the deflection at **C** for the beam shown in Fig. 15. Given that EI of the beam is constant. **(15)**

    (b) Using the moment-area method, determine the deflection and the slope of the elastic curve at point **A** (mid span) due to the applied load on the beam, as shown in the Fig. 16. Specify the direction of deflection and of rotation for the calculated quantities. Given that EI of the beam is constant. **(20)**

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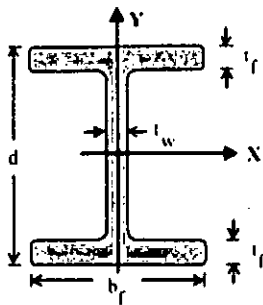
Wide Flange Section (W Shapes)
Dimensions & Properties

Table 1: Properties of W14 Sections

Designation	Area (A)	Depth (d)	Nominal weight per linear foot	Axis X-X		Axis Y-Y	
				I_{XX}	r_{XX}	I_{YY}	r_{YY}
	inch^2	inch	lb.	inch^4	inch	inch^4	inch
W 14×426	125.0	18.67	426	6600	7.26	2360	4.34
W 14×398	117.0	18.29	398	6000	7.16	2170	4.31
W 14×370	109.0	17.92	370	5440	7.07	1990	4.27
W 14×342	101.0	17.54	342	4900	6.98	1810	4.24
W 14×311	91.4	17.12	311	4330	6.88	1610	4.20
W 14×283	83.3	16.74	283	3840	6.79	1440	4.17
W 14×257	75.6	16.38	257	3400	6.71	1290	4.13
W 14×233	68.5	16.04	233	3010	6.63	1150	4.10
W 14×211	62.0	15.72	211	2660	6.55	1030	4.07
W 14×193	56.8	15.48	193	2400	6.50	931	4.05
W 14×176	51.8	15.22	176	2140	6.43	838	4.02
W 14×159	46.7	14.98	159	1900	6.38	748	4.00
W 14×145	42.7	14.78	145	1710	6.33	677	3.98
W 14×132	38.8	14.66	132	1530	6.28	548	3.76
W 14×120	35.3	14.48	120	1380	6.24	495	3.74
W 14×109	32.0	14.32	109	1240	6.22	447	3.73
W 14×99	29.1	14.16	99	1110	6.17	402	3.71
W 14×90	26.5	14.02	90	999	6.14	362	3.70
W 14×82	24.1	14.31	82	882	6.05	148	2.48
W 14×74	21.8	14.17	74	796	6.04	134	2.48
W 14×68	20.0	14.04	68	723	6.01	121	2.46
W 14×61	17.9	13.89	61	640	5.98	107	2.45
W 14×53	15.6	13.92	53	541	5.89	57.7	1.92
W 14×48	14.1	13.79	48	485	5.85	51.4	1.91
W 14×43	12.6	13.66	43	428	5.82	45.2	1.89
W 14×38	11.2	14.10	38	385	5.87	26.7	1.55
W 14×34	10.0	13.98	34	340	5.83	23.3	1.53
W 14×30	8.85	13.84	30	291	5.73	19.6	1.49
W 14×26	7.89	13.91	26	245	5.65	8.91	1.08
W 14×22	6.49	13.74	22	199	5.54	7.00	1.04

50 MPa
80 MPa
25 MPa

Fig-1 10

90 MPa
60 MPa
20 MPa

Fig-2 11

40 kN
0.8 m
0.4 m
D
C
A
B

Fig-3 12

M_b
a
b
L

Fig-4 13

w_o N/m
L

Fig-5 14

M_0
A
C
B
$\frac{L}{2}$
$\frac{L}{2}$

Fig-6 15

w_o N/m
A
a
a
a
a
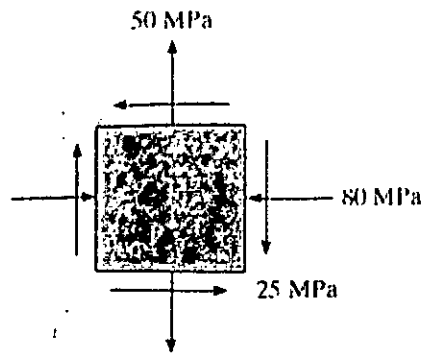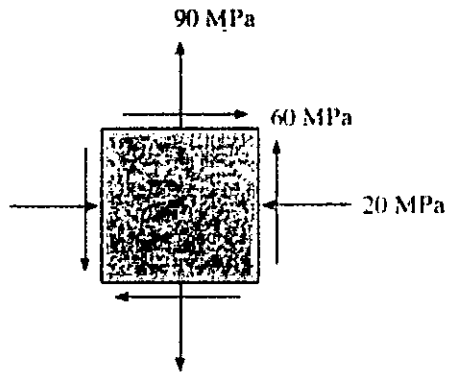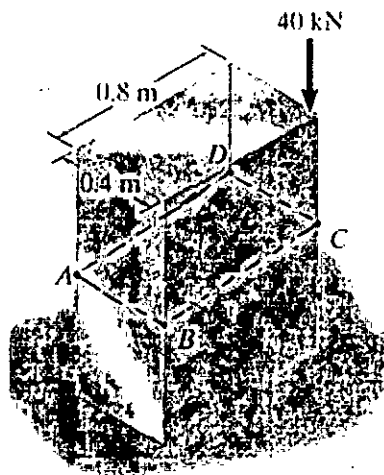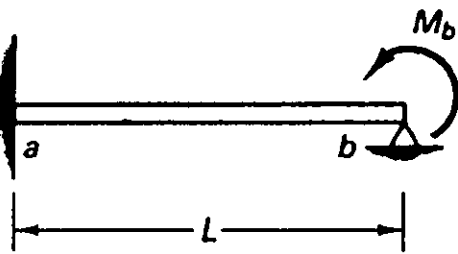
Fig-7 16

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2020-2021

Sub: **MATH 235** (Vector Analysis and Statistics)

Full Marks: 210   Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions.
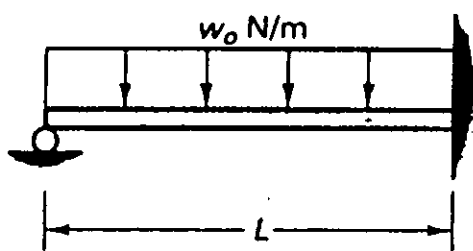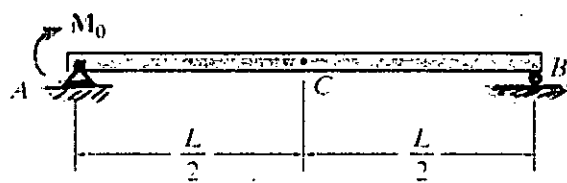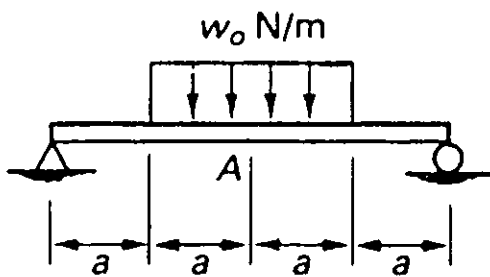
1. (a) Define linearly dependent and independent set of vectors. Examine whether the vectors $5\underline{a}+6\underline{b}+7\underline{c}$, $7\underline{a}-8\underline{b}+9\underline{c}$ and $3\underline{a}+20\underline{b}+5\underline{c}$ ($\underline{a},\underline{b},\underline{c}$ being non-coplanar vectors) are linearly independent or dependent. (11)

(b) Find the angle between the lines AB, AC where A, B, C are the three points with rectangular Cartesian coordinates $(1, 2, -1)$, $(2, 0, 3)$, $(3, -1, 2)$ respectively. (10)

(c) Establish the formula $\underline{a}\times(\underline{b}\times\underline{c})=\underline{b}(\underline{a}.\underline{c})-\underline{c}(\underline{a}.\underline{b})$ and hence show that $\underline{a}\times(\underline{b}\times\underline{c})+\underline{b}\times(\underline{a}\times\underline{c})+\underline{c}\times(\underline{a}\times\underline{b})=0$. (14)

2. (a) Let $\underline{a}=(1,1,1)$, $\underline{b}=(2,-1,3)$, $\underline{c}=(1,-1,0)$, and $\underline{d}=(6,2,3)$. Express $\underline{d}$ in terms of $\underline{a}\times\underline{b}$, $\underline{b}\times\underline{c}$, $\underline{c}\times\underline{a}$. (11)

(b) Find the equation of the plane through the point $\hat{i}+2\hat{j}-\hat{k}$ which is perpendicular to the line of intersection of the planes $\underline{r}.(3\hat{i}-\hat{j}+\hat{k})=1$ and $\underline{r}.(\hat{i}+4\hat{j}-2\hat{k})=2$. (12)

(c) Find the directional derivative of the function $f=xy+yz+zx$ in the direction of the vector $2\hat{i}+3\hat{j}+6\hat{k}$ at the point $(3, 1, 2)$. (12)

3. (a) Give the physical significance of curve of a vector point function. (9)

(b) If $\underline{F}=3xy\hat{i}-y^2\hat{j}$, then evaluate $\int_c \underline{F}.d\underline{r}$, where c is the curve in the xy - plane, $y=2x^2$, from $(0, 0)$ to $(1, 2)$. (10)

(c) Evaluate $\iint_S \underline{A}.\hat{n}ds$, where $\underline{A}=18z\hat{i}-12\hat{j}+3y\hat{k}$ and S is the part of the plane $2x+3y+6z=12$ which is located in the first Octant. (16)

4. (a) Find the volume of the region common to the intersecting cylinders $x^2+y^2=a^2$ and $x^2+z^2=a^2$. (15)

MATH 235
Contd... Q. No. 4

(b) Give the statement of Gauss' Divergence theorem. **(20)**

Verify the Gauss' Divergence theorem for the function $\underline{F} = (2x - z)\hat{i} + x^2 y\hat{j} - z^2 x\hat{k}$ over the region bounded by the surface $x = 0, x = 1; y = 0, y = 1; z = 0, z = 1$.

SECTION – B

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

5. (a) Find four moments about the value 65 of the distribution below. Also measure kurtosis and skewness and interpret. **(15)**

Weight (Kg)	60-62	63-65	66-68	69-71	72-74
No. of Students	5	18	42	27	8

(b) Following is the distribution of marks obtained by 150 students: **(20)**

Marks more than	0	10	20	30	40	50	60
No. of Students	150	136	120	101	91	35	25

Calculate the quartile marks. If 60% students pass the test, find the minimum marks obtained by a pass candidate.

6. (a) An engineering statistics class has 40 students; 60% are electrical engineering majors, 10% are industrial engineering majors, and 30% are civil engineering majors. A sample of 4 students is selected randomly without replacement for a project team. Let X and Y denote the number of industrial and civil engineering majors, respectively. Determine the following: **(15)**

    I. Joint probability distribution of random variables X and Y

    II. Marginal distribution of X and Y.

    III. Expected value of X and Y.

(b) Determine the value of "c" that makes the function $f(x, y) = c(x + y)$ a joint probability mass function over the sixteen points with $X = 1, 2, 3, 4$ and $Y = 1, 2, 3, 4$. Also calculate the followings: $P(X = 1, Y < 3)$; Variance of X and Covariance of X and Y. **(20)**

7. (a) A lot of 100 semiconductor chips contain 20 that are defective. Two are selected randomly, without replacement from the lot. What is the probability that the second one selected is defective given that the first one was defective? How does the answer change if chips selected were replaced prior to the next selection? **(11)**

(b) The life of a semiconductor laser at a constant power is normally distributed with a mean of 7000 hours and a standard deviation of 600 hours. **(12)**

    I. What is the probability that a laser fails before 5000 hours?

    II. If three lasers are used in a product and they are assumed to fail independently, what is the probability that all three are still operating after 7000 hours?

(c) A manufacturer of a consumer electronics product expects 2% of units to fail during warranty period. A sample of 500 independent units is tracked for warranty performance. **(12)**

    I. What is the probability that none fails during warranty period?

    II. What is the probability that more than two units fail during warranty period?

8.   (a) A product developer is interested in reducing the drying time of a primer paint. Two formulations of the paint are tested; formulation-1, is the standard chemistry, and formulation-2, has a new drying ingredient that should reduce the drying time. From experience, it is known that the standard deviation of drying time is 8 minutes, and this inherent variability should be unaffected by the addition of new ingredient. Ten specifications are painted with formulation-1, another ten specifications are painted with formulation-2. The two-sample average drying times are 121 minutes and 112 minutes respectively. What conclusion can the product developer draw about the effectiveness of the new ingredient, using 5% level of significance. (Give that at 5% level of significance for one tailed test, $z = \pm 1.645$) **(17)**

(b) Find the Karl Pearson's correlation coefficient between the sales and expenses from the data given below and interpret its value: **(18)**

Advertising Expenses (Lakhs)	10	12	15	23	20
Sales (Lakhs)	14	17	23	25	21

Table (continued) Areas under the Normal Curve

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998

For question 7 (b)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA
L-2/T-2   B. Sc. Engineering Examinations 2020-2021

Sub : HUM 313 (Principles of Accounting)

Full Marks : 140   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) Who are the external users of accounting information? How does financial accounting provides relevant data/information to these users? $(3\frac{1}{3})$

   (b) Mr. Ahmed started his own delivery service "Ahmed Deliveries", on July 1, 2021. The following transactions occurred during the month of July.   **(20)**

July - 1:	He invested Tk. 500,000 cash in the business.
July - 2:	Purchased Furniture for Tk. 25,000. Mr. Ahmed paid Tk. 10,000 cash and signed a note payable for Tk. 15,000.
July - 3:	Paid cash Tk. 1000 for office rent for the month.
July - 4:	Paid salary of staff for the month Tk. 2000.
July - 6:	Provide services to the customer for Tk. 100,000. Out of this amount Tk. 60,000 received in cash and balances are due.
July - 14:	Mr. Ahmed withdraw Tk. 35,000 cash from the business for his personal use.
July - 21:	Purchased advertising on account/credit Tk. 1000.
July - 25:	Took a bank loan from Sonali Bank for Tk. 7000.
July - 29:	Purchased supplies for Tk. 15,000.
July - 31:	Provide services for cash Tk. 60,000.

   Required:

   Show the effects of the above transactions in the Accounting Equation:

   Assets = Liabilities + Owners Equity

2. (a) What are the elements of financial statements? Write down the characteristics of these elements. $(3\frac{1}{3})$

   (b) Mr. Hassan has started his business "Hassan Computer Company" on April 1st 2021. The following transactions occurred during the month.   **(20)**

April - 1:	Invested cash in the business Tk. 30,000.
April - 2:	Purchased computer equipments for Tk. 20,000 from "Digital Equipment" on account.
April - 3:	Purchased computer supplies for Tk. 1,500 cash.

= 2 =

HUM 313/WRE

Contd ... Q. No. 2(b)

April - 6: Performed computer services to a construction company for Tk. 8000.

April - 8: Paid "Digital Equipment" Tk. 10,000 for previously purchased equipment.

April - 18: Performed services on credit for a customer which amount to Tk. 5,000.

April - 20: Mr. Hassan invested an additional Tk. 7000 in the business.

April - 25: Paid expenses for the month rent Tk. 1000; Salaries of employees Tk. 800 and Utilities bill Tk. 200.

April - 30: Received Tk. 5,000 from the customer who has been previously billed in April 18.

Required:

Journalise the above transactions in a good form.

3. The trial balance for Jahan Group is as follows: (23 ⅓)

Jahan Group
Trial Balance
December 31, 2019

Accounts Title	Debit (Tk.)	Credit (Tk.)
Cash	16,500	
Accounts Receivable	4,000	
Prepaid Insurance	2,400	
Supplies	1,500	
Office furniture	15,000	
Accounts payable		3,500
Unearned service revenue		6,000
Capital		30,000
Service revenue		3,900
Salaries expenses	2,000	
Rent expenses	1,000	
Drawings	1,000	
Machinery	20,000	
Equipment	18,000	
Notes payable		30,000
tax payable		8,000
Total	81,400	81,400

Other information:

* One third of the unearned service revenue has been earned during the period.

* Insurance expires at the rate of Tk. 200 per month.

Required:

Prepare (i) An Income Statement.

(ii) An Owner's Equity Statement, and

(iii) A Balance Sheet as on 31st December, 2019.

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4. (a) What is Expense Recognition principle? $(3\frac{1}{3})$

(b) Following are the balance figures from the ledger of "Eastern Housing Company" for the year ended on 31st December 2019: **(16)**

Accounts Title	Tk.	Accounts Title	Tk.
Cash	8,700	Accounts payable	2,500
Accounts Receivable	11,500	Salaries payable	725
Supplies	650	Interest payable	100
Prepaid Insurance	1,200	Unearned Rent Revenue	1,050
Equipment	18,000	Capital	22,000
Accumulated depreciation - Equipment	700	Drawings	1,600
Notes payable	10,000	Service Revenue	17,100
Rent Expenses	2,900	Rent Revenue	2,260
Depreciation expenses	700	Salaries expenses	8,725
Utilities expenses	1,510	Supplies expenses	850
		Interest expenses	100

Required:

Prepare a trial balance.

(c) Distinguish between: **(4)**

(i) Unearned service revenue and service revenue.

(ii) Prepaid rent and rent expenses.

SECTION – B

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

5. Volver Company manufactures and sells a specialized cordless telephone for high electromagnetic radiation environments. The company's contribution format income statement for the most recent year is given below: $(23\frac{1}{3})$

Sales (20,000 units @ Tk. 60 per unit)	Tk. 1,200,000
Less: Variable cost	900,000
Contribution margin	300,000
Less: Fixed cost	240,000
Net income	Tk. 60,000

HUM 313/WRE

Contd ... Q. No. 5

Required:

(i) Compute the company's CM ratio.

(ii) Compute the company's break-even point in both units and in Tk.

(iii) Assume that sales increase by Tk. 400,000 next year. If cost behavior patterns remain unchanged, by how much will the company's net income increase?

(iv) Refer to the original data. Assume that next year management wants to earn a profit of Tk. 90,000. How many units will have to be sold to earn this target profit?

(v) Refer to the original data. Compute the company's margin of safety in Tk. And in percentage form.

(vi) *Compute the company's degree of operating leverage (DOL) at the present level of sales.

* Assume that company's sales increase by 8% next year. By what percentage would you expect net income to increase? Use DOL to obtain your answer.

* Verify your answer as calculated above by preparing a new contribution format income statement showing a 8% increase in sales.

6. (a) What is the basic difference between absorption costing and variable costing methods? **(3 ⅓)**

    (b) Chuck Wagon Grills Manufacturing Company makes barbecue grill that it sells for Tk. 210. Data for the last year's operation follow: **(20)**

Units produced	20,000
Units sold	19,000
Variable cost per unit:	
Direct materials	Tk. 50
Direct labor	80
Variable manufacturing overhead	20
Variable selling and administrative overhead	10
Fixed costs:	
Fixed manufacturing overhead	Tk. 700,000
Fixed selling and administrative overhead	285,000

Required:

(i) Compute unit product cost under both absorption costing and variable costing methods.

(ii) Prepare income statements under both of the methods.

HUM 313/WRE

7. (a) What are the purposes of overhead cost allocation? (3 ⅓)

(b) The relevant data for allocating service department costs over production department are given below: (20)

	Production Department			Service Department		Total
	A	D	E	D	E	
Overhead cost before allocation (Tk.)	7,550	7,200	9,650	4,625	1,575	30,600
Service rendered by (in %):						
D	20%	30%	40%	--	10%	100%
E	40%	30%	30%	10%	--	100%

Required:

Prepare a schedule for allocating the service department costs over the production departments under each of the following methods:

(i) Direct cost allocation method

(ii) Reciprocal service method

8. (a) The data below have been taken from the cost records of Beverly Hospital. A careful study by the company's cost analyst has determined that if the number of X-rays taken is 7,000, the average operating cost is Tk. 4.14 per X-ray. If the number of X-rays taken is 3,000, the average operating cost is Tk. 5.65 per X-ray. (10)

Required:

(i) Using the high-low point method, determine the variable cost per X-ray taken and fixed cost in total.

(ii) Express the variable cost and fixed cost in the cost formula $(y = mx + c)$.

(iii) If the number of X-rays taken in a month is 4,600, what total operating X-rays costs would you expect?

(b) The following cost and inventory data are taken from the accounting records of Mason Company for the year ended 31 December 2015: (8)

Direct labor cost	Tk. 70,000
Purchase of raw materials	118,500
Indirect labor	30,000
Maintenance, factory	6,000
Advertising expenses	90,000
Insurance, factory	800

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Contd ... Q. No. 8(b)

Sales commission	35,000
Supervisor's salary	12,000
Rent, factory	30,000
Power and electricity	2,500
Fuel for factory equipment	700
Administrative manager's salary	55,000

Inventors:	Jan 1, 2015	Dec 31, 2015
Raw materials	Tk. 7,000	Tk. 15,000
Work-in process	10,000	5,000
Finished goods	20,000	35,000

Required:

Prepare a cost of goods sold statement.

(c) Listed below are a few costs typically found in an organization: (5 ⅓)

(i) Advertising by a consulting office.

(ii) Sugar used in soft drinks production.

(iii) Factory supervisor's salary.

(iv) Property taxes on the factory space.

(v) Wages of the workers assembling computers.

Required:

Classify each item as fixed, variable or mixed cost.