

The figures in the margin indicate full marks

Assume reasonable values for any missing data.

USE SEPARATE SCRIPTS FOR EACH SECTION

**SECTION – A**

There are **FOUR** questions in this section. Answer **Q. No. 1** and any **TWO** from the rest.

**Question No. 1 is COMPULSORY.**

1. (a) Explain the functions of the mineral constituents ( $C_3A$ ,  $C_3S$ ,  $C_2S$ , and  $C_4AF$ ) of Portland Cement. Show neat sketches to demonstrate hydration rate of these constituents and their role in development of compressive strength. (10)
- (b) From mix design, the amount of water, coarse aggregate and fine aggregate required to cast  $1 \text{ m}^3$  concrete are obtained. The ingredients are cement:  $690 \text{ kg/m}^3$ , water:  $340 \text{ kg/m}^3$ , Fine Aggregate (OD):  $820 \text{ kg/m}^3$ , and Coarse Aggregate (OD):  $1300 \text{ kg/m}^3$ . Given that, moisture content and absorption capacity of coarse aggregate are 1.4% and 2.1%, and moisture content and absorption capacity of fine aggregate are 3.4% and 2.9%. (10)
  - (i) Adjust the weight of the aggregates and the mixing water based on the field moisture content of the aggregates.
  - (ii) Find the amount of ingredients required to cast a 40 ft. long pile (16 in. diameter).
- (c) Briefly describe the process that leads to corrosion of the reinforcement in concrete. (10)  
In designing a pile section, size of the main reinforcement is found to be 25 mm. It is suggested to add sacrificial thickness to avoid corrosion in the reinforcement. Find the diameter of the reinforcement to be provided if the design life is (i) 10 years, and (ii) 50 years. Comment on the obtained results. Consider the rate of corrosion to be 0.025 mm/yrs.
- (d) Briefly describe shakes, knots, and rind gall defects in timber. (5)
2. (a) Briefly explain the structural development in cement paste during the hydration process. How does this process impact the hardening of cement? (10)
- (b) What are the applications of Fiber Reinforced Polymer (FRP) in civil engineering constructions? What do you understand by macroscopic and microscopic composites? Explain with appropriate example(s). (10)
- (c) Briefly explain the characteristics of good clay brick. Describe the field test methods to identify good clay bricks. (10)
- (d) Write down the properties of rubber. (5)

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3. (a) Briefly describe the harmful effect of lime, iron pyrites, and alkali in clay bricks. Describe problems that are associated with brick manufacturing in Bangladesh. (10)
- (b) Differentiate between the wet process and dry process of mixing raw materials for cement manufacturing. Briefly describe the clinkering reactions during the burning process of cement manufacturing. (10)
- (c) What are the advantages of ferrocement? Describe the procedure of repairing spalling of concrete using ferrocement. Show neat sketches. (10)
- (d) List the requirements of a good sound insulating materials. (5)
4. (a) Explain the four moisture conditions of aggregate (over dry, air dry, saturated surface dry (SSD) and moist or wet) using a schematic diagram. Why do we need to blend aggregate from multiple sources? (10)
- (b) Briefly describe the relative advantages and disadvantages of water seasoning and air seasoning of timber. What are the factors that affect the selection of preservatives for timber? (10)
- (c) Describe the functions of the base, vehicle, drier, thinner, and pigment of paint. (10)
- (d) Differentiate between hydraulic lime and non-hydraulic lime. (5)

**SECTION – B**

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

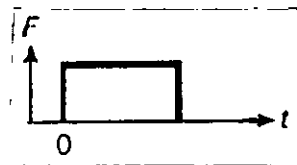
5. (a) How would you differentiate between the field test and laboratory test of material? Elaborate with the example of 'presence of silt and clay' test for sand. (5+7=12)
- (b) What do you understand by bulking of sand? Compare the bulking of fine and coarse sand using appropriate qualitative diagram(s). (5+6=11)
- (c) A sand sample fills up 250 mm height of a cylinder. When the sand is completely inundated with water the height of the sand in the same cylinder is reduced to 180 mm. What amount of this sand sample would you use to cast 50 cft concrete at a mix ratio of 1:1.25:2.5 (volume basis)? (12)
6. (a) How would you differentiate segregation from bleeding of concrete? What are some of the measures for preventing segregation in concrete? (6+6=12)
- (b) What do you understand by curing of concrete? How does curing affect the strength of concrete? Explain with an appropriate qualitative diagram. Name a couple of widely used curing methods for Bangladesh. (4+7+4=15)
- (c) How does the water cement ratio affect the strength and stiffness of concrete? Explain with appropriate stress-strain diagram(s). (8)

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7. (a) Determine the weight of ingredients for 1 cubic meter concrete for casting beams (design strength 36 MPa) with the following material specification as per ACI 211.11 mix design method. Please consider the use of a water reducing admixture which can reduce water requirement by 12% while maintaining similar workability. Please allow a slump value of at least 3 inches. Also, assume maximum size of aggregate available in your locality to be 1 inch. (24)

<b>Material Specification:</b>	
<i>Cement:</i>	<i>Admixture:</i>
Type: Ordinary Portland cement	Recommended dose: 10 gm per kg of cement
Specific gravity: 3.02	Specific gravity: 1.15
<i>Coarse aggregate:</i>	<i>Fine Aggregate:</i>
Bulk specific gravity (OD): 2.75	Bulk specific gravity (OD): 2.65
Unit weight (dry-rodded): 1560 kg per m <sup>3</sup>	Fineness modulus: 2.9

- (b) How does the engineering stress-strain diagram differ from the true stress-strain diagram. Explain with appropriate diagram(s). (6)
- (b) How does the tensile strength of steel vary with the change in the constituent carbon percentages? Explain with appropriate stress-strain diagram(s). (5)
8. (a) Draw the stress-strain diagram for a typical material and clearly identify the proportional limit, elastic limit, yield point, ultimate strength and point of rupture. How would you go about calculating the modulus of toughness and modulus of resilience from this curve? (7+4+4=15)
- (b) How are the elements of a Maxwell model connected with each other? Explain with an appropriate diagram. Write down the deformation equation of the Maxwell model as a function of time,  $t$ , force  $F$ , and constants. Draw the deformation time curve of the Maxwell model under the following loading condition. (4+4+4=12)



- (c) What do you understand by isochronous stress-strain diagram? Two elasto-plastic materials of cross-section  $A$  are subjected to constant loads  $P_1$  and  $P_2$  respectively ( $P_2 > P_1$ ). Draw the load versus time and the deformation(strain) versus time plots of these two materials. (3+2+3=8)

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**Tables for Question No. 5(a) 7(a)**

**Table 1:** Required average compressive strength when data are not available to establish a standard deviation

Specified compressive strength, $f'_c$ , MPa	Required average compressive strength, $f'_{cr}$ , MPa
Less than 21	$f'_c + 7.0$
21 to 35	$f'_c + 8.5$
Over 35	$1.10f'_c + 5.0$

Adapted from ACI 318.

**Table 2:** Relationship between water to cement ratio and compressive strength of concrete

Compressive strength at 28 days, MPa	Water-cementitious materials ratio by mass	
	Non-air-entrained concrete	Air-entrained concrete
45	0.38	0.30
40	0.42	0.34
35	0.47	0.39
30	0.54	0.45
25	0.61	0.52
20	0.69	0.60
15	0.79	0.70

Strength is based on cylinders moist-cured 28 days in accordance with ASTM C 31 (AASHTO T 23). Relationship assumes nominal maximum size aggregate of about 19 to 25 mm.

Adapted from ACI 211.1 and ACI 211.3.

**Table 3:** Recommended slumps for various types of construction

Concrete construction	Slump, mm (in.)	
	Maximum*	Minimum
Reinforced foundation walls and footings	75 (3)	25 (1)
Plain footings, caissons, and substructure walls	75 (3)	25 (1)
Beams and reinforced walls	100 (4)	25 (1)
Building columns	100 (4)	25 (1)
Pavements and slabs	75 (3)	25 (1)
Mass concrete	75 (3)	25 (1)

\*May be increased 25 mm (1 in.) for consolidation by hand methods, such as rodding and spading.

Plasticizers can safely provide higher slumps.

**Table 4:** Approximate mixing water and target air content requirements for different slumps and nominal maximum sizes of aggregates

Slump, mm	Water, kilograms per cubic meter of concrete, for indicated sizes of aggregate*							
	9.5 mm	12.5 mm	19 mm	25 mm	37.5 mm	50 mm**	75 mm**	150 mm**
<b>Non-air-entrained concrete</b>								
25 to 50	207	199	190	179	166	154	130	113
75 to 100	228	216	205	193	181	169	145	124
150 to 175	243	228	216	202	190	178	160	—
Approximate amount of entrapped air in non-air-entrained concrete, percent	3	2.5	2	1.5	1	0.5	0.3	0.2
<b>Air-entrained concrete</b>								
25 to 50	181	175	168	160	150	142	122	107
75 to 100	202	193	184	175	165	157	133	119
150 to 175	216	205	197	184	174	166	154	—
Recommended average total air content, percent, for level of exposure:†								
Mild exposure	4.5	4.0	3.5	3.0	2.5	2.0	1.5	1.0
Moderate exposure	6.0	5.5	5.0	4.5	4.5	4.0	3.5	3.0
Severe exposure	7.5	7.0	6.0	6.0	5.5	5.0	4.5	4.0

\* These quantities of mixing water are for use in computing cementitious material contents for trial batches. They are maximums for reasonably well-shaped angular coarse aggregates graded within limits of accepted specifications.

\*\* The slump values for concrete containing aggregates larger than 37.5 mm are based on slump tests made after removal of particles larger than 37.5 mm by wet screening.

† The air content in job specifications should be specified to be delivered within -1 to +2 percentage points of the table target value for moderate and severe exposures.

Adapted from ACI 211.1 and ACI 318. Hovler (1995) presents this information in graphical form.

**Table 5:** Bulk volume of coarse aggregate per unit volume of concrete

Nominal maximum size of aggregate, mm (in.)	Bulk volume of dry-rodded coarse aggregate per unit volume of concrete for different fineness moduli of fine aggregate*			
	2.40	2.60	2.80	3.00
9.5 (3/8)	0.50	0.48	0.46	0.44
12.5 (1/2)	0.59	0.57	0.55	0.53
19 (3/4)	0.66	0.64	0.62	0.60
25 (1)	0.71	0.69	0.67	0.65
37.5 (1 1/2)	0.75	0.73	0.71	0.69
50 (2)	0.78	0.76	0.74	0.72
75 (3)	0.82	0.80	0.78	0.76
150 (6)	0.87	0.85	0.83	0.81

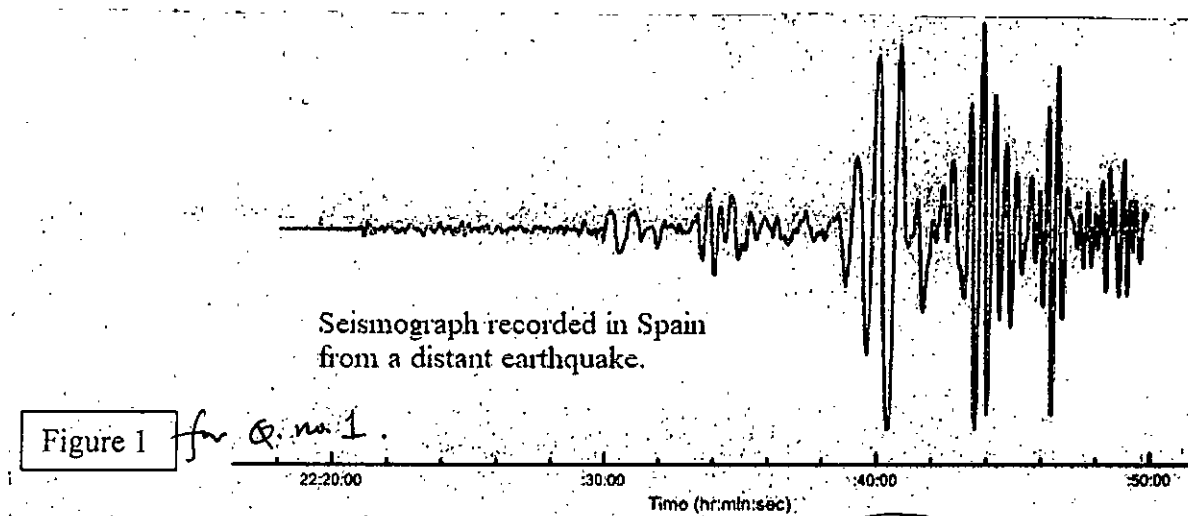
\*Bulk volumes are based on aggregates in a dry-rodded condition as described in ASTM C 29 (AASHTO T 19). Adapted from ACI 211.1.

**SECTION – A**

There are **FOUR** questions in this section. Answer **Q. No. 1** and any **TWO** from the rest.

**Question No. 1 is COMPULSORY.**

1. On 6 February 2023, an  $M_w$  7.8 ( $M_L$  7.2) earthquake struck southern and central Turkey and northern and western Syria. Figure 1 shows the seismograph recorded in a city in Spain for this earthquake producing MMI intensity VI in that city. (15+20)
- (a) Write short notes on the magnitude scales mentioned above. With a proper example, explain the difference between the magnitude values.
- (b) The Young's modulus and the shear modulus of the earth is 51.70 GPa and 25 GPa respectively. The average density of the earth is  $5.51 \text{ g/cm}^3$ . Calculate the distance (in kilometers) of the earthquake from the seismograph. Assume, Poisson's ratio to be 0.25 for the earth's body. Briefly, describe the effect of intensity VI in that city.



2. The Dawki fault is a major fault along the southern boundary of the Shillong Plateau where plate movement is not exactly parallel to the fault plane causing a potential seismic hazard for Bangladesh. This fault zone forms a sharp escarpment along the plateau's southern edge. The striking geological feature of this fault system is the low to medium mountain ranges along the plate boundary. (10+10+15)
- (a) Identify the fault system found in Dawki. Draw a neat diagram of this fault system, accurately showing the foot and hang wall.
- (b) What is an escarpment? From a lithological point of view, how do you identify the fault system in Dawki?
- (c) What tectonic plate boundary type caused the abovementioned mountains' formation? Differentiate between boundary types concerning plate and tectonic movement in a tabular format.

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3. On August 24, '79, Mount Vesuvius erupted, destroying the ancient Roman cities of Pompeii and Herculaneum. The last eruption of Mount Vesuvius took place in 1944. Vesuvius, a composite volcano, was formed as a result of the collision of two tectonic plates. (10+10+15)
- (a) Explain the following volcanic hazards that are associated with Vesuvius:
- (i) Pyroclastic flow
  - (ii) Lahar
  - (iii) Tephra
  - (iv) Phreatic explosions
  - (v) Seismicity
- (b) Which factors may cause the upward movement of magma in Vesuvius? Explain briefly.
- (c) What is an inverted relief fold system? Draw a neat diagram of this folding system showing syncline and anticline accurately. Explain the importance of folds from a civil engineering perspective.
4. (a) Failure to appreciate the geologic context and mismatch between geology and infrastructure leads to catastrophic failure and loss of life and property— Explain the statement mentioning at least one such event. (10+12+13)
- (b) Why mineralogy is important to understand the nature of earth's crust. Among color, luster, and streak which one presents a mineral uniquely? Describe briefly with the example of 'Quartz'.
- (c) Describe the sequence of how the landform shown in Figure 2 is created, stating the principles of geological formation.

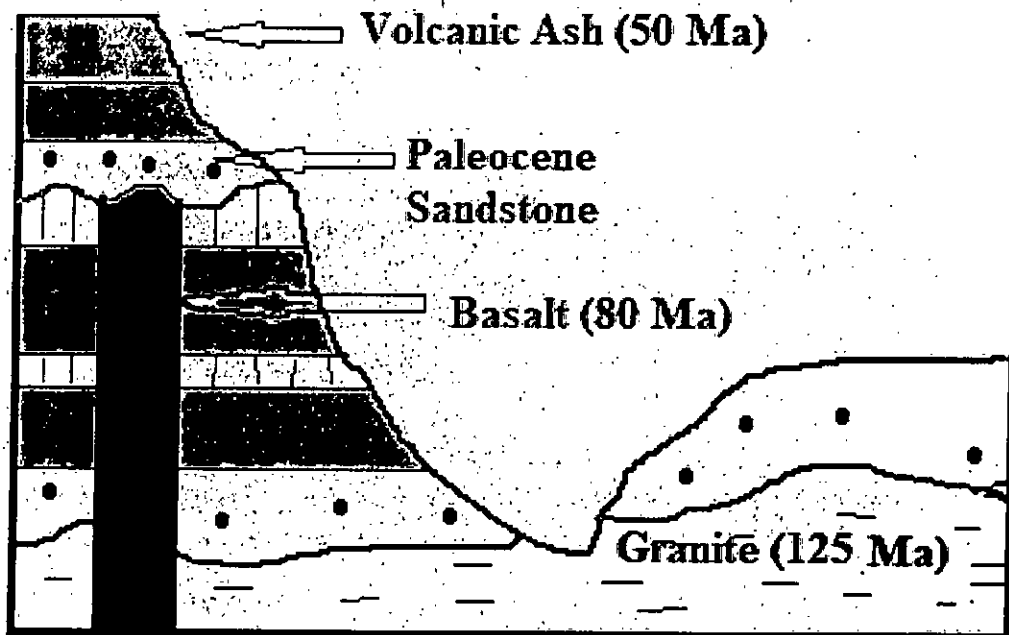


Figure 2 for ques. no. 4(c)

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**SECTION – B**

There are **FOUR** questions in this section. Answer **Q. No. 5** and any **TWO** from the rest.

**Question No. 5 is COMPULSORY.**

5. (a) Briefly explain 'Rock Cycle' with neat sketch. Write short notes on following rocks: (10)  
(i) Shale (ii) Basalt (iii) Marble
- (b) What is Lithification? Explain the formation of asymmetrical ripples and cross bedding with neat sketch. (10)
- (c) What is 'Braided river'? What are the methods of sea erosion and their affecting factors (Mention only name)? Describe the formation of Ganges-Brahmaputra Delta. (15)
6. (a) Explain the following terms with respect to an alluvial land formation: (11)  
(i) meandering River, (ii) Oxbow Lake, (iii) cutoff, (iv) natural levee
- (b) Write short notes on (i) Rectangular, (ii) Trellis, (iii) Radial types of drainage patterns with diagrams. (12)
- (c) What is geomorphic process? What is geomorphic agent? Explain with examples in the context of Bangladesh. (12)
7. (a) Explain the following terms: (i) Drainage Density and (ii) Stream Frequency. With Bangladesh context, explain (with diagram) how these parameters can vary among the different regions. (15)
- (b) What is river transportation? What are the factors affecting the transportation power of a river? What do you understand by "Capacity" and "Competence" in river transportation? (20)
8. (a) What is longitudinal bed profile of a stream? What information does it give? Show schematically the differences between a theoretical profile and an actual one for a natural river. Derive the equation of longitudinal bed profile of a stream. (17)
- (b) Write short notes on Form factor and compactness coefficient. How the differences of these parameters make difference in the drainage system? (18)
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**SECTION – A**

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

Symbols bear their usual meanings.

1. (a) A wooden I beam is made up with a narrow lower flange because of space limitations, as shown in the Figure-1. The lower flange is fastened to the web with nails spaced longitudinally 7 in apart, and the vertical boards in the lower flange are glued in place. Determine the force carried by each nail in the nailed joint if the beam is subjected to a vertical shear of 600 lb. The moment of inertia for the whole section around the neutral axis is  $2640 \text{ in}^4$ . (15)
- (b) A beam cross section shown in Figure-2 carries a vertical shear of 100 kN, determine the shears stresses at the levels indicated and hence draw the shear stress distribution diagram. Neglect the weight of the beam. (20)
2. (a) A helical valve spring, having total eight (08) numbers of turns with an outside diameter of 2" is made with 0.25" diameter steel wire. In operation the compression force applied to this spring varies from 25 lb minimum to 90 lb maximum. Stress-concentration factors for helical round-wire springs in compression or tension are shown in Figure-3. Given that  $G=11.6 \times 10^6 \text{ psi}$ . Calculate: (i) value of lift and (ii) maximum shear stress developed in the spring. (15)
- (b) A small steel T beam shown in Figure-4 is used in an inverted position to span 400 mm. If, due to the application of the three forces shown in the figure, the longitudinal gage at A resisters a compressive strain of  $55 \times 10^{-5} \text{ mm/mm}$ , what is the applied force, P? Given that  $E = 200 \text{ GPa}$ . (20)
3. (a) For the planar structure shown in the Figure-5, find the reactions and determine the axial force P, the shear V, and the bending moment M caused by the applied loads at section a-a. Show the magnitude and sense of calculated quantities on separate free-body diagrams. For simplicity, assume that members can be represented by lines. (15)
- (b) Using methods of section draw shear and moment diagrams for the beam shown in Figure-6. (20)



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4. (a) A beam ABCD is supported by a roller at 'A' and a hinge at 'D'. It is subjected to the loads shown in Figure-7, which act at the ends of the vertical members BE and CF. These vertical members are rigidly attached to the beam at B and C. Draw shear and moment diagrams for the beam ABCD only. (15)
- (b) Draw the shear force and bending moment diagrams for the beam with loads shown in Figure-8 (Ignore the vertical stiffeners shown at the location of concentrated load plus supports 'B' and 'D', also note that the concentration at 'C' represents an internal hinge). (20)

**SECTION – B**

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

5. (a) Determine the largest intensity  $w$  of the uniform loading that can be applied to the frame without causing either the average normal stress or the average shear stress at section A-A to exceed  $\sigma = 20$  MPa and  $\tau = 15$  MPa, respectively. Member BC has a square cross section of 30 mm on each side. (Figure 9(a)) (18)
- (b) If the gap between C and rigid wall at D is initially 0.14 mm, determine the support reactions at A and D when the force  $P = 250$  kN is applied. The assembly is made of solid steel cylinders.  $E_{st} = 200$  GPa. (Figure 9(b)) (17)
6. (a) The beam is supported by two rods AB and CD that have cross-sectional areas of  $15 \text{ mm}^2$  and  $10 \text{ mm}^2$ , respectively. Determine the position  $d$  of the 10 kN load so that the average normal stress in each rod is the same. (Figure 10(a)) (17)
- (b) The center post B of the assembly has an original length of 124.7 mm, where as posts A and C have a length of 125 mm. If the caps on the top and bottom can be considered rigid, determine the average normal stress in each post. The posts are made of Aluminium and have a cross-sectional area of  $400 \text{ mm}^2$ .  $E_{al} = 70$  GPa. (Figure 10(b)) (18)
7. (a) Determine the plastic torque for the 5-ft long tube, which is made of elastic-perfectly plastic material. What is the residual stress distribution in the tube if the plastic torque is removed just after the tube becomes fully plastic? (Figure 11(a)) (20)
- (b) The tube is subjected to a torque of 750 N.m. Determine the average shear stress in the tube at points A and B. (Figure 11(b)) (15)
8. (a) Determine the location of the shear center, point O, for the thin-walled member. (Figure 12(a)) (17)
- (b) If the beam is subjected to an internal moment of  $M = 5$  kip. ft, determine the maximum tensile and compressive stress in the beam. Also, sketch the bending stress distribution on the cross-section. (18)
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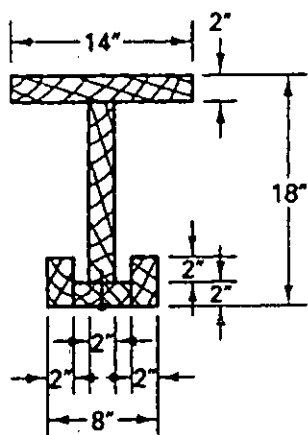


Figure -1

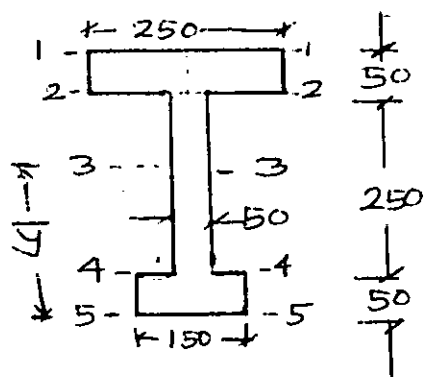


Figure -2

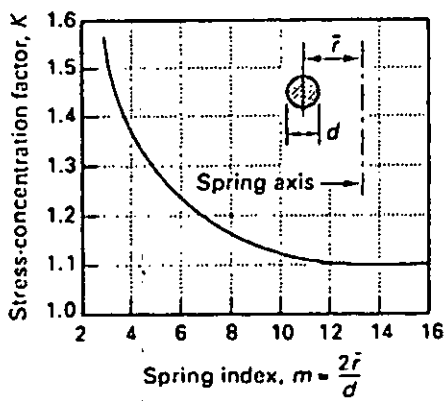


Figure-3

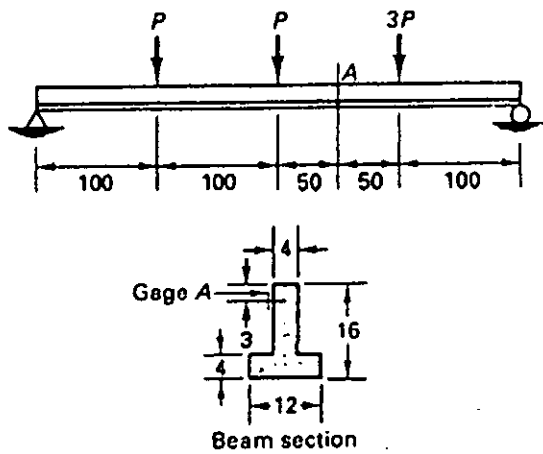


Figure -4

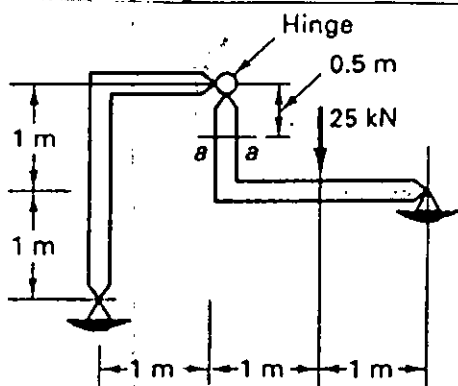


Figure -5

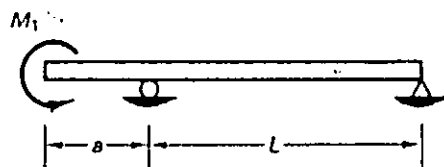


Figure -6

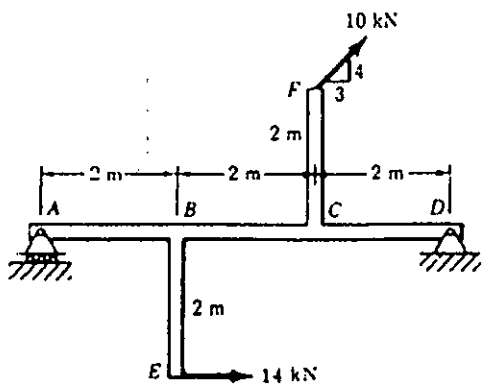


Figure -7

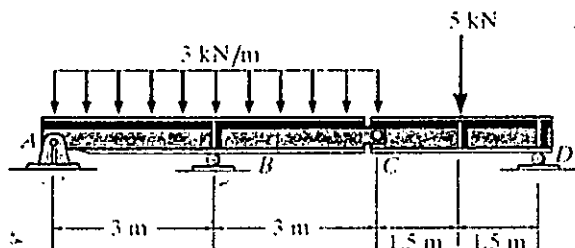
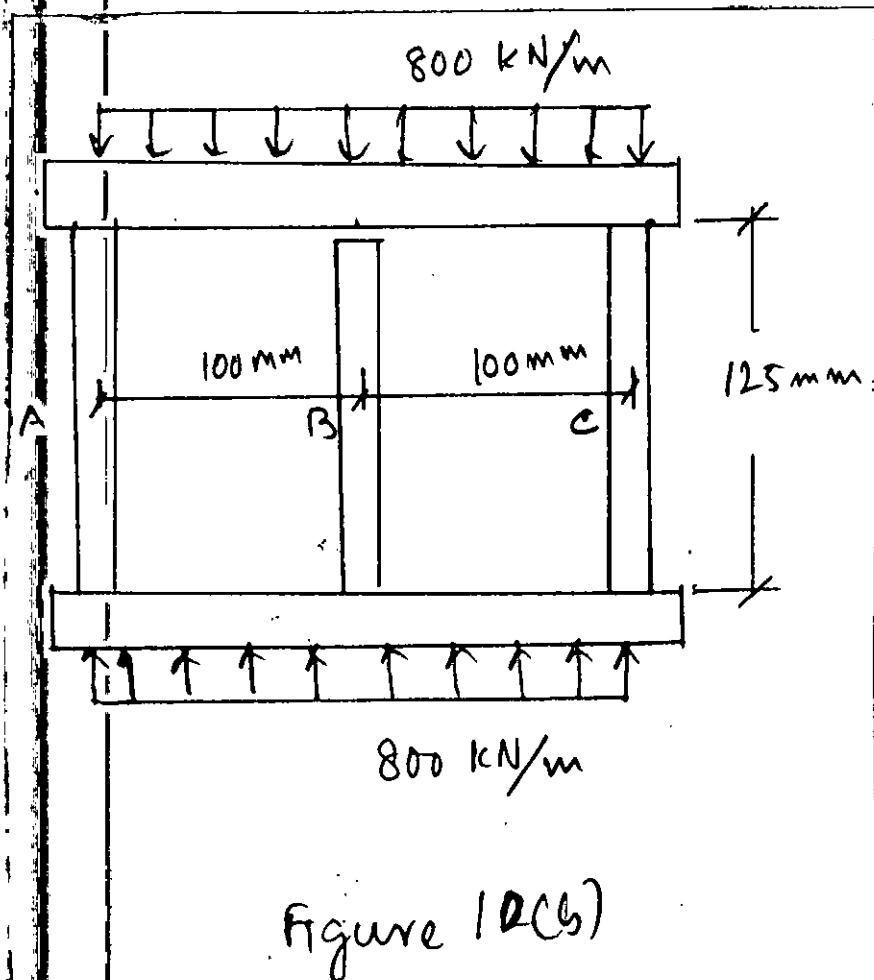
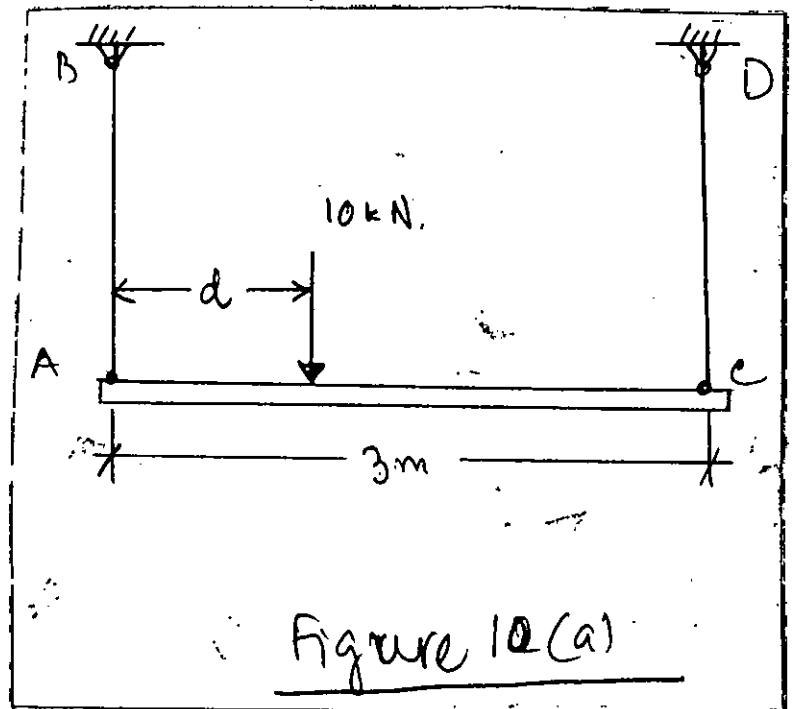
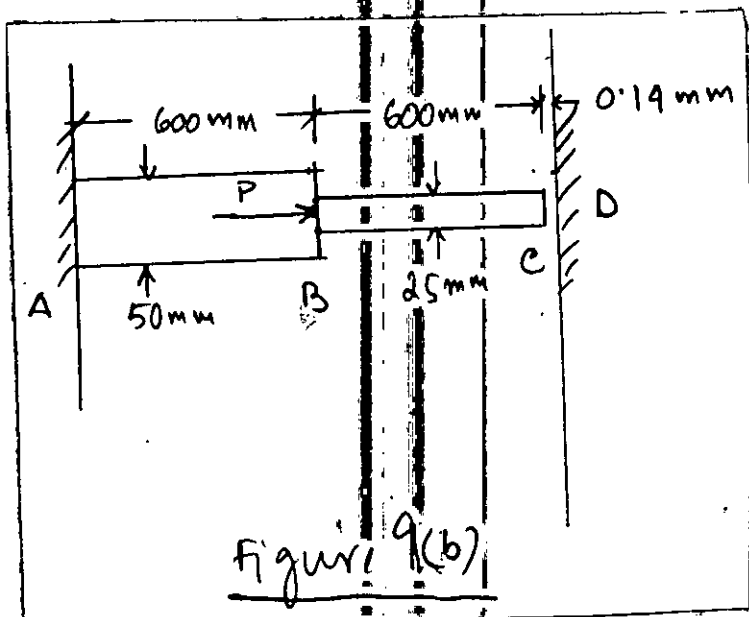
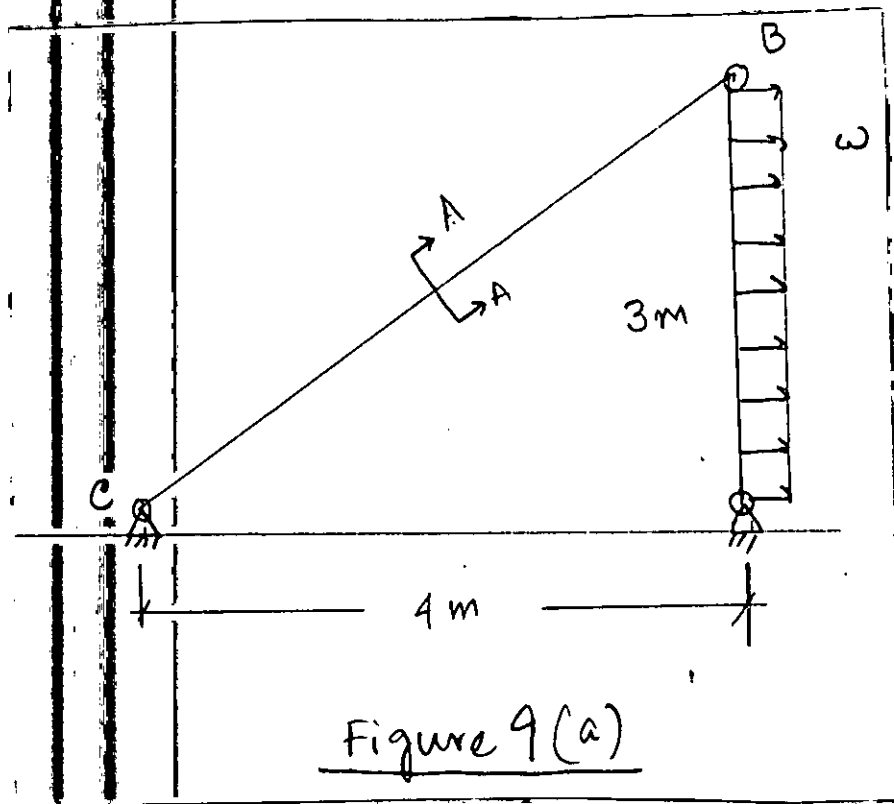


Figure -8

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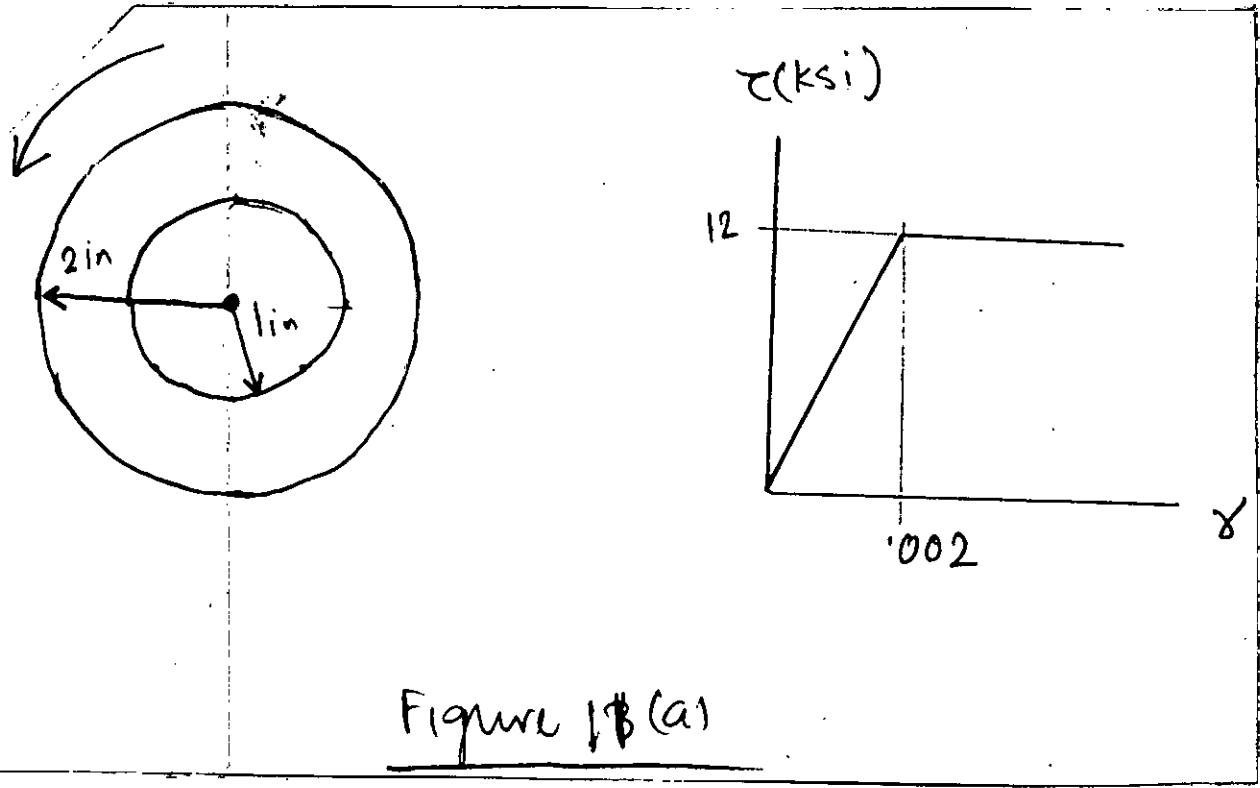


Figure 18(a)

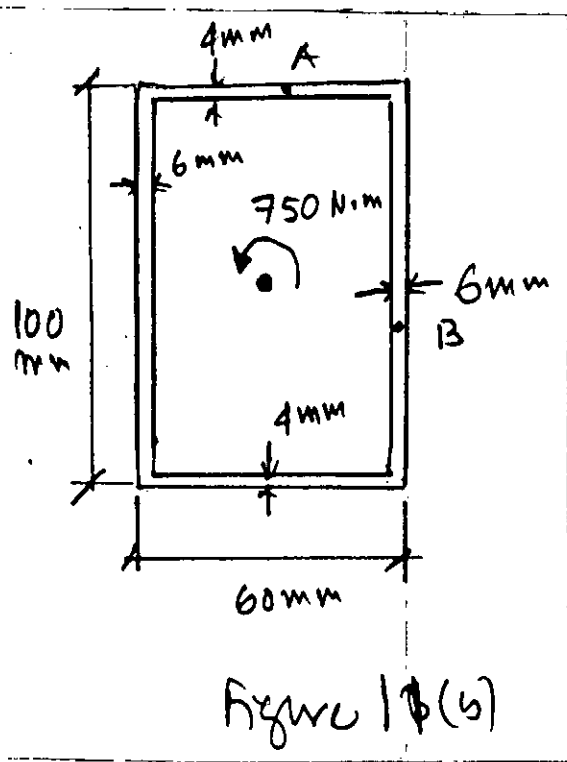


Figure 18(b)

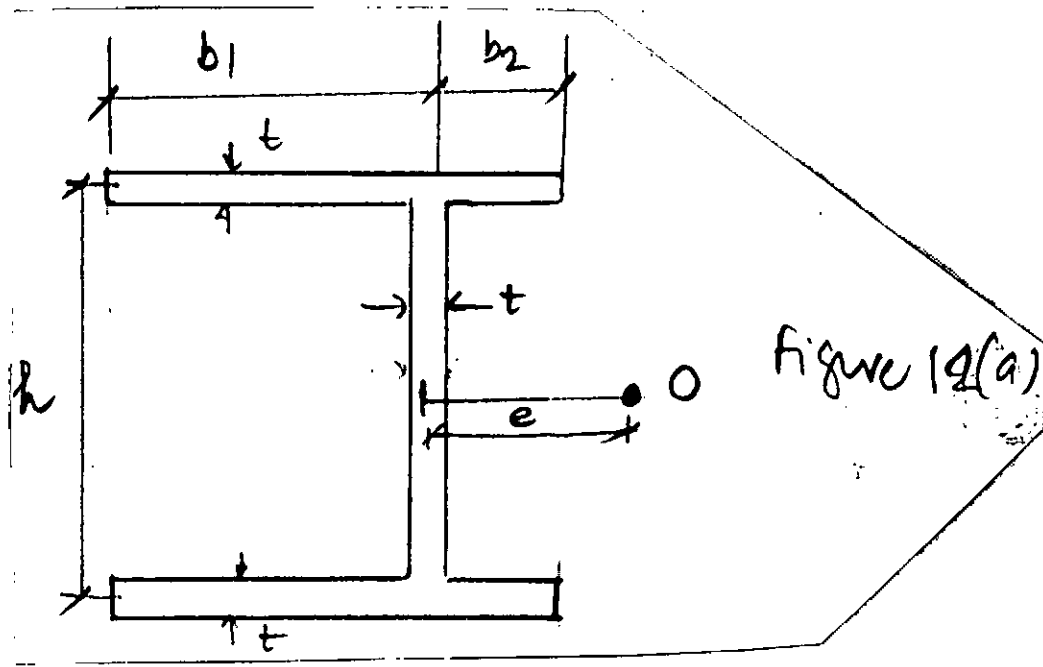


Figure 19(a)

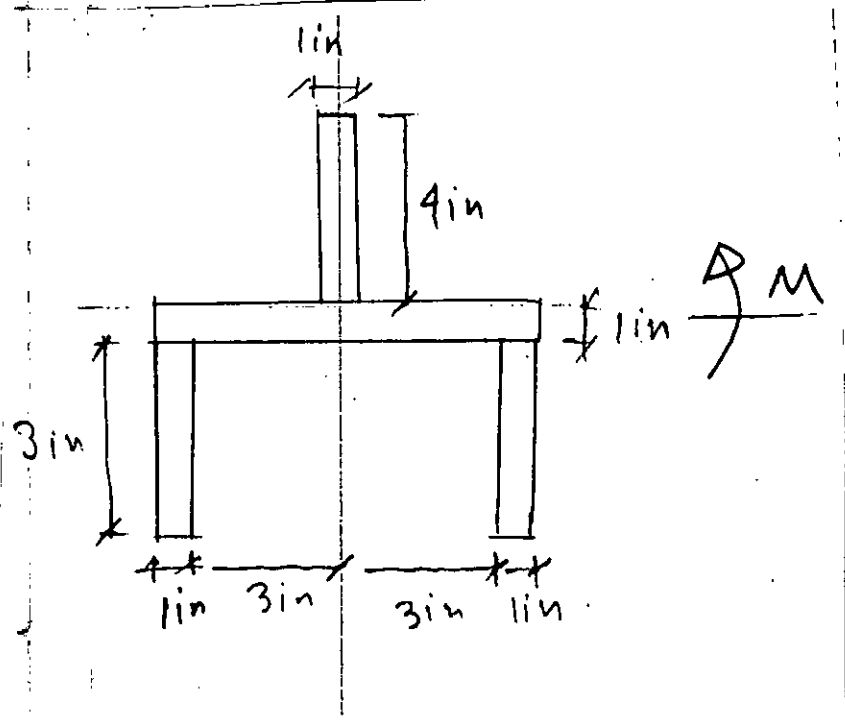


Figure 19(b)

**SECTION – A**

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

1. (a) Prove vectorially that the line joining the mid-points of any two sides of a triangle is parallel to the third and half of it. (15)
- (b) Find the volume of a parallelepiped having edges  $(\mathbf{A} \times \mathbf{B})$ ,  $(\mathbf{B} \times \mathbf{C})$ , and  $(\mathbf{C} \times \mathbf{A})$ . (10)
- (c) Find a set of vectors reciprocal to the set  $2\mathbf{i} - 3\mathbf{j} + \mathbf{k}$ ,  $\mathbf{i} - \mathbf{j} + 2\mathbf{k}$ ,  $-\mathbf{i} + 3\mathbf{j} - 2\mathbf{k}$  (10)
  
2. (a) Given points  $P(2, 1, 3)$ ,  $Q(1, 2, 1)$ ,  $R(-1, -2, -2)$  and  $S(1, -4, 0)$ , find the shortest distance between lines  $PQ$  and  $RS$ . (10)
- (b) Show that the acceleration of a particle moving along a curve is a vector in the plane of the tangent and the normal with  $\frac{dv}{dt}$  and  $v^2\mathbf{k}$  as its tangential and normal components respectively. (15)
- (c) Define Osculating plane and Rectifying plane. Find the equation of the Osculating plane and Rectifying plane for the helix  $\mathbf{r} = (a \cos t, a \sin t, bt)$  at any point  $t$ . (10)
  
3. (a) Is the vector field  $\mathbf{F} = (x^3z - 2xyz)\mathbf{i} + (xy - 3x^2yz)\mathbf{j} + (yz^2 - xz)\mathbf{k}$  solenoidal? If so, find a vector function  $\mathbf{V}$  such that  $\mathbf{F} = \nabla \times \mathbf{V}$ . (15)
- (b) Show that  $\nabla(\mathbf{A} \cdot \mathbf{B}) = \mathbf{A} \times (\nabla \times \mathbf{B}) + \mathbf{B}(\nabla \times \mathbf{A}) + (\mathbf{A} \cdot \nabla)\mathbf{B} + (\mathbf{B} \cdot \nabla)\mathbf{A}$  (10)
- (c) Find the values of  $a$  and  $b$  so that  $\mathbf{F} = (xyz)^b(x^a\mathbf{i} + y^a\mathbf{j} + z^a\mathbf{k})$  becomes an irrotational vector. (10)
  
4. (a) Show that the gradient of a scalar function  $f$  is a vector along the normal to the level surface  $f(x, y, z) = k$  at  $(x, y, z)$  in the direction of increasing  $f$  whose magnitude is the greatest rate of change of  $f$ . (10)
- (b) Determine whether the vector field  $\mathbf{F}(x, y, z) = (x^3 - x)\mathbf{i} + (y^3 - 3y)\mathbf{j} + (z^3 - 5z)\mathbf{k}$  is free of sources and sinks. If it is not, locate them. (10)
- (c) Evaluate  $\iint_S \mathbf{F} \cdot \mathbf{n} \, dS$  where  $\mathbf{F} = z\mathbf{i} + x\mathbf{j} - 3y^2z\mathbf{k}$  and  $S$  is the part of the surface of the sphere  $x^2 + y^2 + z^2 = 4$  which lies above  $xy$  plane. (15)

**MATH 237/CE****SECTION - B**

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

5. (a) Apply Green's theorem to compute the area of the loop of Descartes's Folium  $x^3 + y^3 = 3axy$   $a > 0$ . (5)

(b) Use the Gauss's divergence theorem to find the outward flux of the vector field  $\vec{F} = 4x\hat{i} + y\hat{j} + 4z\hat{k}$  with D the region of a unit cube. (15)

(c) Find  $\int_C \vec{F} \cdot d\vec{r}$  using Stokes' theorem, where  $\vec{F}(x, y, z) = -3y\hat{i} - 2z\hat{j} + 3x\hat{k}$ , C is the triangle in the plane  $y = \frac{z}{2}$  with vertices (2, 0, 0), (0, 2, 1) and (0, 0, 0) with counterclockwise orientation. (15)

6. (a) Define Laplace transform of a function. Find the Laplace transform of  $f(t) = \begin{cases} \cos t, & 0 < t < 2\pi \\ 0, & t > 2\pi \end{cases}$  by using definition. (11)

(b) Use  $L\{f'(t)\} = sF(s) - f(0)$ , where  $L\{f(t)\} = F(s)$  to compute  $L\left\{\frac{\cos \sqrt{t}}{\sqrt{t}}\right\}$ . (12)

(c) Define Error function and complementary error function. Hence calculate  $L\{erf \sqrt{t}\}$ . (12)

7. (a) Find the value of  $L^{-1}\{F(s)\}$ , if  $F(s) = \frac{2s-3}{s^2+16} + \frac{3s+10}{s^2-9}$ . (11)

(b) Describe Convolution theorem for inverse Laplace transform. Apply the theorem to find  $L^{-1}\left\{\frac{1}{(s-2)(s+2)^2}\right\}$ . (12)

(c) Explain Heaviside expansion method for inverse Laplace transform. Hence use the method to find  $L^{-1}\left\{\frac{s-1}{(s+3)(s^2+2s+2)}\right\}$ . (12)

8. (a) Solve the initial value problem using Laplace Transform (10)

$$\frac{d^2 y}{dt^2} - 2 \frac{dy}{dt} - 8y = 0; \quad y(0) = 3, \quad y'(0) = 6$$

(b) Apply Laplace Transform to find solution of the initial value problem with variable coefficients  $t \frac{d^2 y}{dt^2} + \frac{dy}{dt} + ty = 0; \quad y(0) = 1, \quad y'(0) = 0$ . (10)

(c) Use Laplace Transform to solve the following heat conduction equation (15)

$$\frac{\partial}{\partial t} u(x, t) = a \frac{\partial^2 u(x, t)}{\partial x^2}, \quad x > 0, \quad t > 0$$

where  $u(x, 0) = 0, u(0, t) = u_0$  and  $|u(x, t)| < M$  for all  $x$  and  $t$ .

**SECTION – A**

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

1. Hasim Company had the following transactions on May 2021. (23 1/3)

- May-1: The owner Investment Tk. 10,00,000 cash.  
 May-2: Advertise on account Tk. 5,000.  
 May-5: Purchase supplies for cash Tk. 6,000.  
 May-10: Purchase office equipment for Tk. 2,50,000, paying Tk. 50,000 in cash and remaining on the account.  
 May-12: Service provided on account Tk. 3,00,000.  
 May-15: Withdraw cash for personal use Tk. 10,000.  
 May-18: Salary for the month paid in cash Tk. 25,000.  
 May-20: Paid balance due for advertisement.  
 May-22: Cash received from the customer for May 12 transaction.  
 May-24: Provide services for cash Tk. 20,000.

**Required:**

- (i) Prepare necessary journal entries for May 2021.  
 (ii) Prepare the ledger accounts that are necessary to measure the total asset value of Hasim Company.
2. (a) Kareem Company has the following comparative balance sheet data. (16)

KAREEM COMPANY Balance Sheets December 31		
	2021	2020
Cash	\$ 15,000	\$ 30,000
Receivables (net)	70,000	60,000
Inventories	60,000	50,000
Plant assets (net)	<u>200,000</u>	<u>180,000</u>
Total	<u>\$345,000</u>	<u>\$320,000</u>
Accounts payable	\$50,000	\$60,000
Mortgage payable (15%)	100,000	100,000
Common stock, \$10 par	140,000	120,000
Retained earnings	<u>55,000</u>	<u>40,000</u>
Total	<u>345,000</u>	<u>320,000</u>

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**Contd.... for Q. No. 2(a)**

Additional information for 2021

- Net income was \$25,000.
- Sales on account were \$410,000. Sales returns and allowances were \$20,000.
- Cost of goods sold was \$198,000.
- The allowance for doubtful accounts was \$2,500 on December 31, 2021, and \$2,000 on December 31, 2020.

**Required:**

Compute the following ratios at December 31, 2021 and comment about Kareem Company's performance

- (i) Current
- (ii) Acid-test
- (iii) Receivable turnover
- (iv) Inventory turnover
- (v) Profit margin
- (vi) Debt to asset
- (vi) Return on equity
- (vii) Asset turnover

(b) Following is the balance sheet of Ereen Company

(7 1/3)

Ereen Company Balance Sheet As on December 31, 2021		
Particulars	2021	2020
Current Assets	\$ 74,000	\$80,000
Property, plant, and equipment	99,000	90,000
Intangibles	<u>27,000</u>	<u>40,000</u>
Total Assets	<u>\$200,000</u>	<u>210,000</u>
Current liabilities	\$42,000	\$48,000
Long-term liabilities	143,000	150,000
Stockholders' equity'	<u>15,000</u>	<u>12,000</u>
Total liabilities and stockholders' equity	<u>\$200,000</u>	<u>\$210,000</u>

**Required:**

- (i) Prepare a horizontal analysis of the balance sheet data for 2021 of Ereen Company using 2020 as a base.
- (ii) Prepare a vertical analysis of the balance sheet data for Ereen Company in columnar form for 2021.

Have Ereen Company performed well? Comment on your analysis.



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3. The trial balance of Fariz Company on January 31, 2020, is given below:

(23 1/3)

Fariz Electronics Trial Balance January 31, 2020		
Account Title	Debit (tk.)	Credit (tk.)
Cash	12,800	
Supplies	2,500	
Prepaid Insurance	3,000	
Office Equipment	5,000	
Note Payable		5,000
Account Payable		2,500
Unearned Revenue		1,200
Capital		10,000
Drawings	500	
Service Revenue		10,000
Salary Expense	4,000	
Utility Expense	900	
Total	<u>28,700</u>	<u>28,700</u>

Analysis reveals the following additional data:

- Supplies on hand on January 31, Tk. 1,200.
- Insurance policy is for two years.
- Depreciation Tk. 200 for each month.
- Unearned revenue is still unearned Tk. 800.
- Interest accrued at January Tk. 200.
- Service provided but not received Tk. 1,200.

Required:

- Prepare adjusting entries for January 31<sup>st</sup>, 2020.
- Prepare adjusted trial balance as on January 31<sup>st</sup>, 2020.

4. (a) The following is the trial balance of Wacom Company as of December 31<sup>st</sup>, 2021.

(23 1/3)

Wacom Company Trial Balance December 31 <sup>st</sup> 2021		
Account Title	Debit (tk.)	Credit (tk.)
Sales Revenue		50,000
Merchandise Inventory (01.01.21)	6,000	
Purchase	24,000	
Purchase Return		1,000
Sales discounts	2,500	
Accounts Receivable	20,000	
Accounts Payable		14,000
Capital		40,000
Drawings	10,000	
Salaries	8,000	
Supplies	3,000	
Delivery Van	20,000	
Cash	9,300	
Prepaid Insurance	2,200	
Total	<u>1,05,000</u>	<u>1,05,000</u>

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**Contd.... for Q. No. 4(a)**

Other Information:

- Supplies used Tk. 1,200.
- Depreciation on the delivery van is Tk. 2,000.
- Merchandise Inventory (31.12.21) was Tk. 5,500.
- Tk. 2,500 accounts receivable were uncollectible.
- Salaries were accrued Tk. 4,000.
- Insurance expense was Tk. 2,000.

Required:

- Prepare a classified Income Statement and Owners Equity Statement for the year ended December 2021.
- Prepare a classified Balance Sheet as on 31<sup>st</sup> December 2021.

**SECTION – B**

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

5. (a) Three of your friends of non-accounting discipline are discussing the nature of cost. The first friend says that a variable cost is one that varies per unit and a fixed cost is one that remains fixed per unit. The second friend says that a variable cost is one that varies in total but a fixed cost is one that remains fixed per unit. The third friend says that a variable cost is one that varies both per unit and in total but a fixed cost is one that remains fixed in total. They cannot agree to a point. They come to you. Discuss clearly to them the nature of variable cost and fixed cost with an appropriate example of each. (8 1/3)
- (b) The accounting department of Barilgaon Company provided the following data for January 2023: (15)

Sales	Tk. 720,000	Marketing expenses	Tk. 36,000
Purchases	Tk. 360,000	Administrative expenses	Tk. 7,200
Direct labor	Tk. 150,000	Other expenses	Tk. 3,600
Factory overhead	Tk. 100,000		
<b>Inventories:</b>		<u>Beginning</u>	<u>Ending</u>
	Finished goods	Tk. 70,000	Tk. 102,000
	Work-in-process	80,000	150,000
	Materials	80,000	85,000

Required: Prepare the

- cost of goods sold statement, and
- income statement.

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6. (a) Explain the concept of break-even point with an example. The Fashion Shoe Company operates a chain of women's shoe shops that carry many styles of shoes that are all sold at the same price. Sales personnel in the shops are paid a sales commission on each pair of shoes sold plus a small base salary.

(23 1/3)

The following data pertains to Shop 48 and is typical of the company's many outlets:

	Per pair of Shoes
Selling price	Tk. 1,500
Variable expenses:	
Invoice cost	Tk. 675
Sales commission	Tk. 225
Total variable expenses	Tk. 900
<b>Fixed expenses:</b>	
Advertising	Tk. 1,500,000
Rent	Tk. 1,000,000
Salaries	Tk. 5,000,000
Total fixed expenses	Tk. 7,500,000

**Required:**

- (i) What is Shop 48's annual break-even point in unit sales and Taka sales?
- (ii) If 12,000 pairs of shoes are sold in a year, what would be Shop 48's net operating income (loss)?
- (iii) The company is considering paying the Shop 48 store manager an incentive commission of Tk. 37.5 per pair of shoes (in addition to the salesperson's commission). If this change is made, what will be the new break-even point in unit sales and Taka sales?
- (iv) Refer to the original data. As an alternative to (iii) above, the company is considering paying the Shop 48 store manager Tk. 25 commission on each pair of shoes sold in excess of the break-even point. If this change is made, what will be Shop 48's net operating income (loss) if 15,000 pairs of shoes are sold?
- (v) Refer to the original data. The company is considering eliminating sales commissions entirely in its shops and increasing fixed salaries by Tk. 1,575,000 annually. If this change is made, what will be Shop 48's new break-even point in unit sales and Taka sales? Would you recommend that the change be made? Explain.

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7. (a) Barilgaon Company uses job-order costing. It starts a job. The job requires direct materials of Tk. 750,000. It applies overhead cost to jobs on the basis of direct labor cost. For the current year, the company estimates that it will incur Tk. 300,000 in direct labor cost and Tk. 150,000 of manufacturing overhead. During the year, Tk. 350,000 of direct labor costs was incurred.

(8 1/3)

Required: Compute-

- (i) the company's predetermined overhead rate, and
  - (ii) the cost of the job.
- (b) Kalatia Company manufactures and sells a single product. The following costs were incurred during the company's first year of operations:

(15)

Variable costs per unit:		
Manufacturing:		
	Direct materials	Tk. 20
	Direct labor	Tk. 12
	Variable manufacturing overhead	Tk. 4
	Variable selling and administrative expense	Tk. 2
Fixed costs per year:		
	Fixed manufacturing overhead	Tk. 960,000
	Fixed selling and administrative expenses	Tk. 240,000

During the year, the company produced 25,000 units and sold 20,000 units. The selling price of the company's product is 58 per unit.

Required:

Prepare an income statement for year under variable and absorption costing.

8. What is meant by capital budgeting? Discuss the techniques of capital budgeting. Consider the following projects.

(23 1/3)

Year	Project A (Tk.)	Project B (Tk.)	Project C (Tk.)
0	(1,000,000)	(1,000,000)	(1,000,000)
1	300,000	100,000	500,000
2	300,000	200,000	400,000
3	300,000	300,000	300,000
4	300,000	400,000	200,000
5	300,000	500,000	100,000

Required: Rank the three projects based on the following methods:

- (i) Payback period,
- (ii) Net present value at 10% discount rate, and
- (iii) Profitability index at 10% discount rate.

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