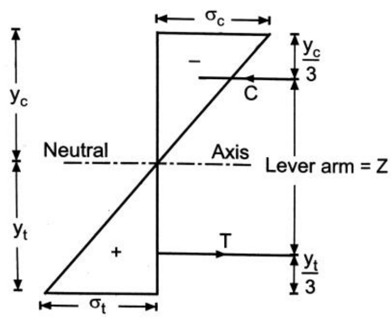
Model Answer: Winter-2018

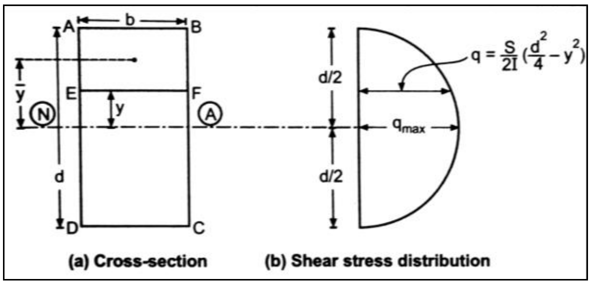
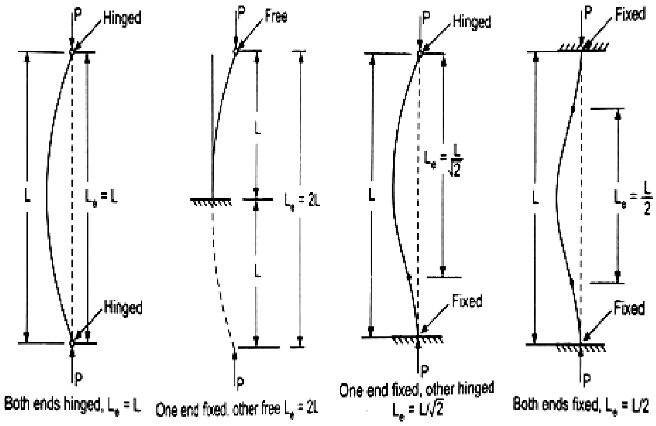
Subject: Mechanics of Structure **Sub. Code: 17311**

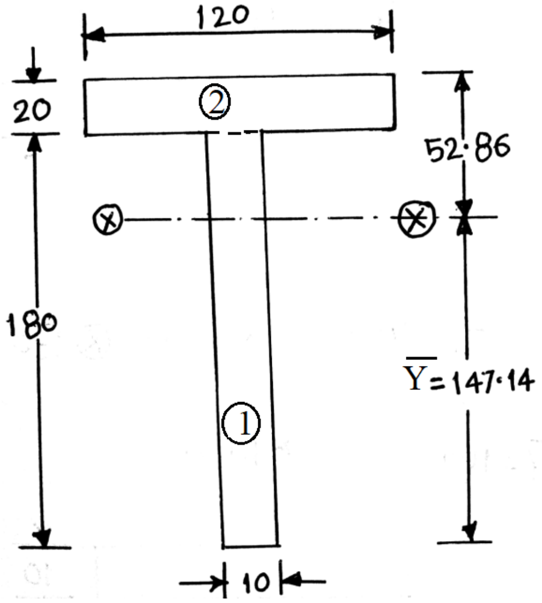
Important Instructions to examiners:

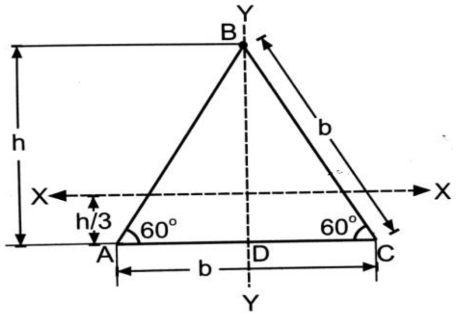
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and Communication Skills.)
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by the candidate and those in the model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and the model answer.
6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

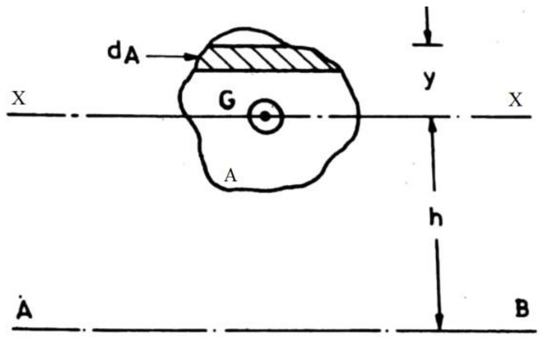
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1	A)	**Solve any six**		(12)
	a)	**State the meaning and unit of moment of inertia.**		
	Ans.	Moment of inertia of a body about any axis is equal to the product of the area of the body and square of the distance of its centroid from that axis.	1	
		OR		2
		Moment of inertia of a body about any axis is defined as the sum of second moment of all elementary areas about that axis.		
		Unit- mm^4, cm^4, m^4	1	
	b)	**Determine the radius of gyration of a square of side 'a'.**		
	Ans.	For a square section of side a		
		$$K_{xx} = K_{yy} = \sqrt{\frac{I_{xx} \text{ or } I_{yy}}{A}} = \sqrt{\frac{\frac{a^4}{12}}{a^2}} = \sqrt{\frac{a^2}{12}} = \frac{a}{2\sqrt{3}}$$	2	2
	c)	**State Hook's law.**		
	Ans.	It states, when a material is loaded within its elastic limit, the stress produced is directly proportional to the strain.	2	2
	d)	**State the meaning of composite section.**		
	Ans.	If two or more members of different materials are connected together and are subjected to the loads such a section is called as composite section.	2	2

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1	e) Ans.	**Define the slenderness ratio.** Slenderness ratio is defined as the ratio of effective length of a column and its minimum radius of gyration.	2	2
	f) Ans.	**A column, 4 m long is fixed at one end and is hinged at other. Calculate the effective length.** For one end fixed and other end is hinged $l_e = \frac{L}{\sqrt{2}} = \frac{4}{\sqrt{2}} = 2.83m$	2	2
	g) Ans.	**State the meaning of strain energy and resilience.** Strain energy or resilience: It is the recoverable internal energy stored or absorbed in a body or material, when strained within the elastic limit is called as strain energy or resilience.	2	2
	h) Ans.	**Define modulus of resilience and give its unit.** Modulus of resilience is the proof resilience per unit volume. **OR** It is the maximum strain energy stored in body per unit volume is called modulus of resilience. Unit: J/m^3 or $N\text{-}m/m^3$ or $N\text{-}mm/mm^3$	1 1	2
	B) a) Ans.	**Solve any two:** **Define moment of resistance. How does it differ from the bending moment?** **Moment of resistance**: Moment of resistance is developed by the internal stresses (bending stresses) set in the beam. The moment of couple formed by the total compressive force acting at the c.g. of the compressive stress diagram and the total tensile force acting at the c.g. of the tensile stress diagram is called moment of resistance. Bending moment is moment formed due to external load acting on the beam in transverse direction while moment of resistance is resistance developed to balance the bending moment. It resists the external bending moment.  	2 1 1	(8) 4

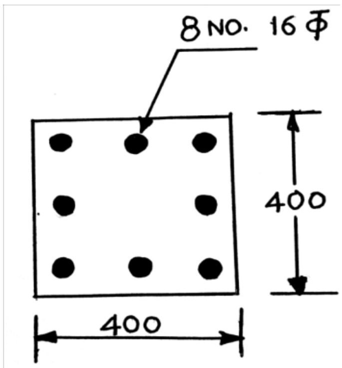
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1	b)	**Define average shear stress. Sketch the shear distribution diagram for a rectangular section stating the relation between maximum shear stress and average shear stress.**		
		Average shear stress: It is the ratio of shear force to the cross sectional area of the beam.	1	
		$$q_{\max} = 1.5 q_{avg}$$	1	4
		 **Fig. Shear Stress Distribution Diagram**	2	
	c)	**Enlist and sketch different end conditions for long column. Show the buckled shape and effective length of each**.		
	Ans.	i. When both end of column are hinged, Le = L ii. When both end of column are fixed, Le = $\frac{L}{2}$ iii. When one end is fixed and other end is hinged, Le = $\frac{L}{\sqrt{2}}$ iv. When one end is fixed and other end is free, Le = 2L	2	4
		 **Fig. Buckled Shape and Effective Length of Columns**	2	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q. 2		**Solve any two from a), b), c):**		**(16)**
	a)	**Calculate moment of inertia about XX and YY axis of a Tee section with following dimensions. Top Flange- 120 mm x 20 mm. Web = 10 mm x 180 mm. Overall Depth of section is 200 mm.**		
	Ans.			
		$a_1=180\times10=1800mm^2 \quad y_1=\frac{180}{2}=90mm$		
		$a_2=120\times20=2400mm^2 \quad y_2=180+\frac{20}{2}=190mm$		
		$\overline{y}=\frac{a_1y_1+a_2y_2}{a_1+a_2}=\frac{1800\times90+2400\times190}{1800+2400}=147.14mm$ from the base	1	
		$I_{xx}=I_{xx_1}+I_{xx_2}=(IG+ah^2)_1+(IG+ah^2)_2=\left(\frac{bd^3}{12}+ah^2\right)_1+\left(\frac{bd^3}{12}+ah^2\right)_2$	1	
		$I_{xx}=\left(\frac{10\times180^3}{12}+\left(1800\times57.14^2\right)\right)_1+\left(\frac{120\times20^3}{12}+\left(2400\times42.86^2\right)\right)_2$	2	8
		$I_{xx}=\left(10736963.28\right)_1+\left(4488751.04\right)_2$	1	
		$I_{xx}=15.226\times10^6mm^4$		
		$I_{YY}=I_{YY_1}+I_{YY_2}=\left(\frac{db^3}{12}\right)_1+\left(\frac{db^3}{12}\right)_2=\left(\frac{180\times10^3}{12}\right)_1+\left(\frac{20\times120^3}{12}\right)_2$	2	
		$I_{YY}=\left(15000\right)_1+\left(2880000\right)_2$	1	
		$I_{YY}=2.895\times10^6\ mm^4$		

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2	b) Ans.	**For an equilateral triangular section of side b show that $I_{xx} = I_{yy}$.**  	1	
		Calculate h: $\tan 60^0 = \frac{h}{\left(\frac{b}{2}\right)}$ $\sqrt{3} = \frac{h}{\left(\frac{b}{2}\right)}$ $h = \frac{b\sqrt{3}}{2}$	1	
		$I_{xx} = \frac{bh^3}{36}$ $I_{xx} = \frac{b\left(\frac{b\sqrt{3}}{2}\right)^3}{36}$ $I_{xx} = \frac{b^4\sqrt{3}}{96}$	3	8
		$I_{yy} = 2I_{BD}$ $I_{yy} = 2\left(\frac{bh^3}{12}\right)$ $I_{yy} = \frac{b\left(\frac{b\sqrt{3}}{2}\right)^3}{6}$ $I_{yy} = \frac{b^4\sqrt{3}}{96}$ $\boxed{I_{xx} = I_{yy}}$	3	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2	c)	**i) With the help of a neat sketch, state the parallel axis theorem of moment of inertia.** **ii) How percentage elongation and percentage reduction in c/s area are calculated in tension test on MS bar? State the property of material of bar assessed using them.**		
	Ans.	**i)** **Parallel axis theorem:** It states, the moment of inertia of a plane section about any axis parallel to the centroidal axis is equal to the moment of inertia of the section about the centroidal axis plus the product of the area of the section and the square of the distance between the two axes.	2	
		 **Fig: Parallel Axis Theorem**	1	
		$$I_{AB} = I_{XX} + Ah^2$$ Where, I_{AB} =MI about axis AB which is parallel to XX axis. I_{xx} = MI about horizontal centroidal axis. A= Area of the section. h = Distance between the two axes AB and XX .	1	8
		ii) In tension test on MS bar carried out on UTM, the increased length is measured using measuring scale. Due to increase in length c/s area will reduce. Reduced c/s area can be calculated by measuring reduced diameter of MS bar.	1	
		The percentage of elongation of MS bar is calculated by using following formula. $$\%\ \text{Elogation} = \left(\frac{\text{Final length - Initial length}}{\text{Initial length}} \right) \times 100$$	1	
		The percentage of reduction in area of MS bar is calculated by using following formula. $$\%\ \text{Reduction in Area} = \left(\frac{\text{Original area - Final area}}{\text{Original area}} \right) \times 100$$	1	
		The % elongation and % reduction in area up to fracture is useful to measure ductility property of material.	1	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3		**Solve any two:**		(16)
	a)	**A MS flat 25 mm wide and 6 mm thick is 2 m long. It has to transmit a pull P . Evaluate P if the stress is limited to 120 MPa and the elongation is limited to 0.8 mm. Take E = 210 GPa.**		
	Ans.	**Data:** b=25mm, t=6mm, L=2m, σ=120MPa, δL=0.8mm, E=210Gpa.		
		$\delta L = \frac{PL}{AE}$	1	
		$P = \frac{\delta L \times A \times E}{L}$	1	
		$P = \frac{0.8 \times 25 \times 6 \times 210 \times 10^3}{2000}$	1	
		$P = 12600\text{N}$	1	8
		Check for, $\sigma_{\max}$		
		$\sigma_{\max} = \frac{P}{A} = \frac{12600}{25 \times 6} = 84\text{N/mm}^2 \langle\ 120\text{N/mm}^2$	3	
		P=12.6kN	1	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q. 3	b)	**A square RCC column of side 400 mm is reinforced with 8 bars of 16 mm diameter. Calculate the safe load on the column if the permissible stresses in concrete and steel are 5 MPa and 128 MPa respectively. Take m = 18.**		
	Ans.	**Data:** σ_c = 5 MPa, σ_s = 128 MPa m = 18 **Find:** P_{safe} = ? 		
		$\sigma_s = m\,\sigma_c$ $\sigma_s = 18 \times 5 = 90$ N/mm^2 < 128 N/mm^2	1	
		For safe load, σ_s should be less than that of 90 N/mm^2 $A_g = 400 \times 400 = 160000 mm^2$	1	
		$A_s = 8 \times \left(\frac{\pi d^2}{4}\right) = 8 \times \left(\frac{\pi \times 16^2}{4}\right) = 1608.49 mm^2$	1	
		$A_c = A_g - A_s = 160000 - 1608.49 = 158391.51 mm^2$	1	8
		$P_{safe} = \sigma_s A_s + \sigma_c A_c$	1	
		$P_{safe} = (90 \times 1608.49) + (5 \times 158391.51)$	1	
		$P_{safe} = 936721.65 N$	1	
		$P_{safe} = 9.367 \times 10^3 kN$	1	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q. 3	c)	**A metal bar of diameter 20 mm and length 2 m is axially pulled by a force of 30 kN. Determine linear strain, change in length, change in diameter and change in volume of the bar if E = 80 GPa and μ= 0.24**		
	Ans.	**Data:** D=20mm L= 2m P = 30kN E= 80 GPa μ = 0.24		
		To find: e = ? δL = ? δd = ? δv = ?		
		1. **Calculate δL**		
		$\delta L = \frac{PL}{AE}$		
		$\delta L = \frac{30\times 10^3 \times 2000}{\frac{\pi}{4}\times 20^2 \times 80\times 10^3}$		
		$\delta L = 2.387\text{mm}$	1	
		2. **Calculate δd**		
		$\mu = \frac{\text{Lateral strain}}{\text{Linear strain}}$	1	
		$0.24 = \frac{\left(\frac{\delta d}{d}\right)}{\left(\frac{\delta L}{L}\right)} = \frac{\left(\frac{\delta d}{20}\right)}{\left(\frac{2.387}{2000}\right)}$	1	
		$\delta d = 0.00573 \text{ mm}$	1	8
		3. **Calculate e**		
		$e = \frac{\delta L}{L} = \frac{2.387}{2000} = 1.193\times 10^{-3}$	1	
		4. **Calculate δv**		
		$e_v = \frac{\sigma_x}{E}(1-2\mu)$	1	
		$\frac{\delta v}{v} = e(1-2\mu)$		
		$\delta v = (1-2\mu)AL$		
		$\delta v = 1.1935\times 10^{-3}(1-2\times 0.24)\times \frac{\pi}{4}\times 20^2 \times 2000$	1	
		$\delta v = 390\text{mm}^3$	1	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4		**Solve any two:**		**(16)**
	a)	**For a biaxial stress system shown in Figure (1) find the change in AB and change in BC if E = 200 GPa and μ = 0.24.**		

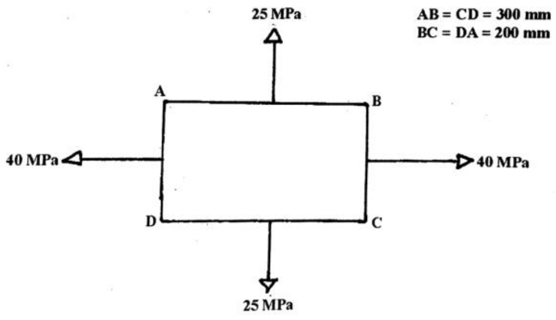
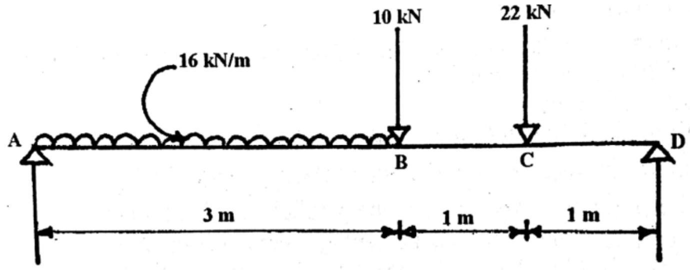
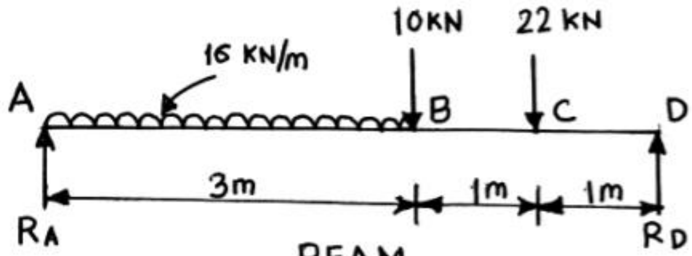
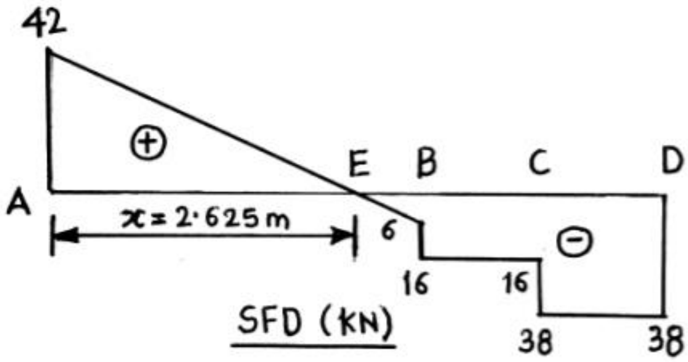
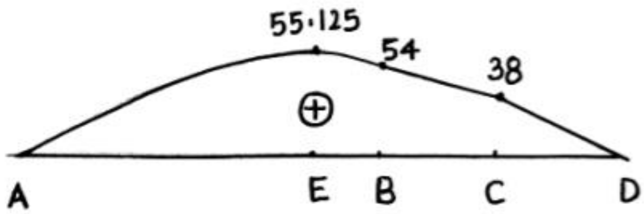


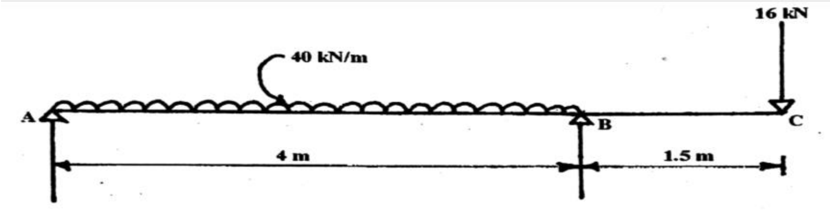
Figure 1

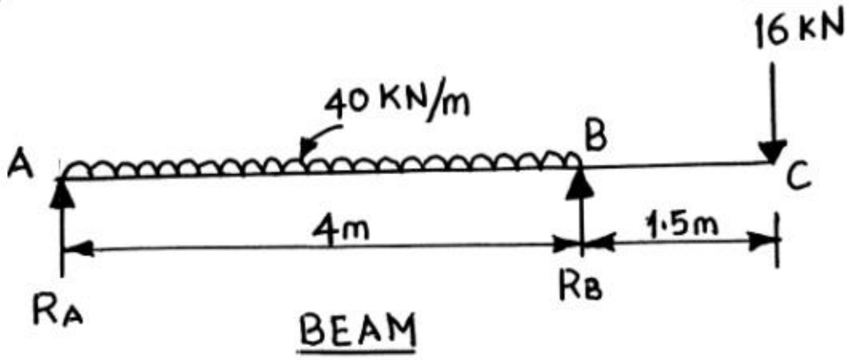
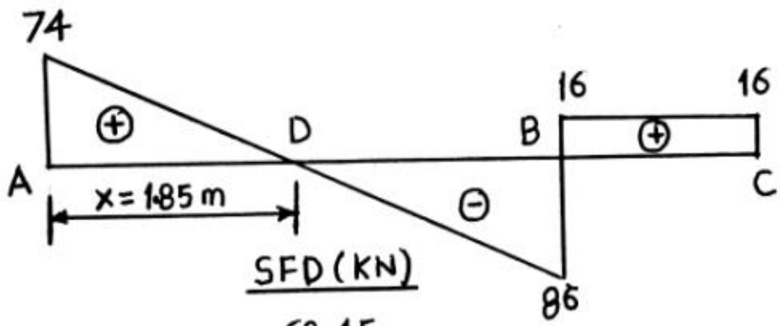
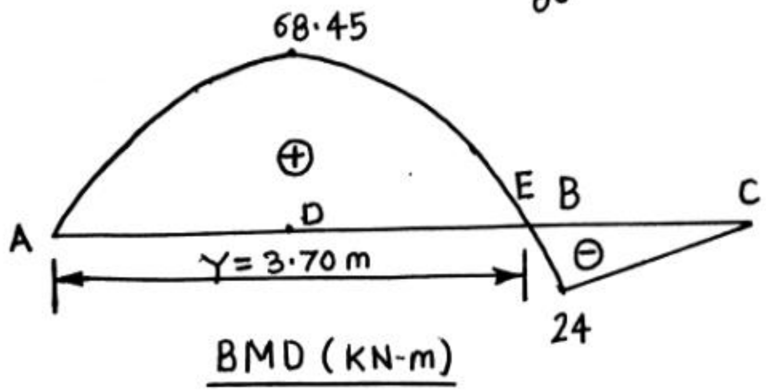
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
	Ans.	**Data:** AB=CD=300mm, BC=DA=200mm, E=200GPa, μ=0.24		
		Find: δL_{AB} = ? δL_{BC} = ?		
		$e_x = \frac{\sigma_x}{E} - \mu\frac{\sigma_y}{E} = \frac{\sigma_x - \mu\sigma_y}{E}$	**1**	
		$e_x = \frac{40-(0.3\times25)}{200\times10^3} = 1.625\times10^{-4}$	**1**	
		$e_y = \frac{\sigma_y}{E} - \mu\frac{\sigma_x}{E} = \frac{\sigma_y - \mu\sigma_x}{E}$	**1**	
		$e_y = \frac{25-(0.3\times40)}{200\times10^3} = 6.5\times10^{-5}$	**1**	**8**
		$e_x = \frac{\delta L_{AB}}{L_{AB}}$	**1**	
		$\delta L_{AB} = e_x L_{AB} = 1.625\times10^{-4}\times300$ =0.04875 mm	**1**	
		$e_y = \frac{\delta L_{BC}}{L_{BC}}$	**1**	
		$\delta L_{BC} = e_y L_{BC} = 6.5\times10^{-5}\times200 = 0.013$ mm	**1**	

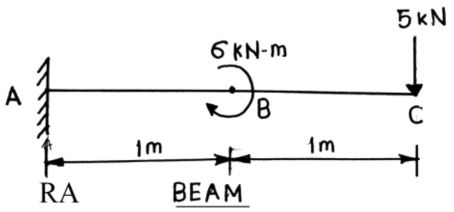
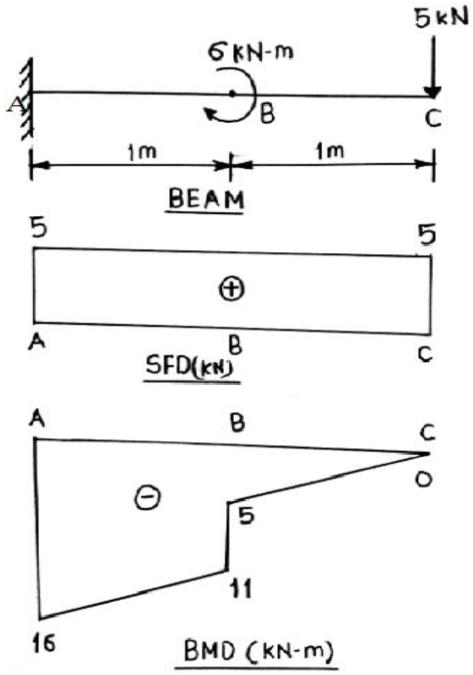
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4	b)	**An axial pull of 150 kN was applied on a bar of 20 mm diameter. The extension over a gauge length of 200 mm was observed to be 0.48 mm and the diameter was reduced by 0.012 mm. Calculate Poisson's ratio and three modulli.**		
	Ans.	**Data:** P = 150 kN d= 20 mm L = 200 mm δL = 0.48 mm δd = 0.012 mm **Find:** μ = ? E = ? G = ? K= ?		
		I. <u>Calculate E:</u>		
		$E=\frac{PL}{A\delta L}$	1	
		$E=\frac{150\times10^3\times200}{\frac{\pi}{4}\times20^2\times0.48}$		
		$E=198.943\times10^3 N/mm^2$	1	
		II. <u>Calculate μ:</u>		
		$\mu=\frac{\text{Lateral Strain}}{\text{Linaer Strain}}=\frac{\left(\frac{\delta d}{d}\right)}{\left(\frac{\delta L}{L}\right)}$	1	
		$\mu=\frac{\left(\frac{0.012}{20}\right)}{\left(\frac{0.48}{200}\right)}=0.25$	1	8
		III. <u>Calculate G:</u>		
		$E=2G(1+\mu)$	1	
		$198.943\times10^3=2G(1+0.25)$		
		$G=79.577\times10^3 N/mm^2$	1	
		IV. <u>Calculate K:</u>		
		$E=3K(1-2\mu)$	1	
		$198.943\times10^3=3K(1-2\times0.25)$		
		$K=132.628\times10^3 N/mm^2$	1	

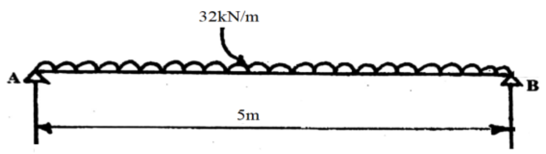
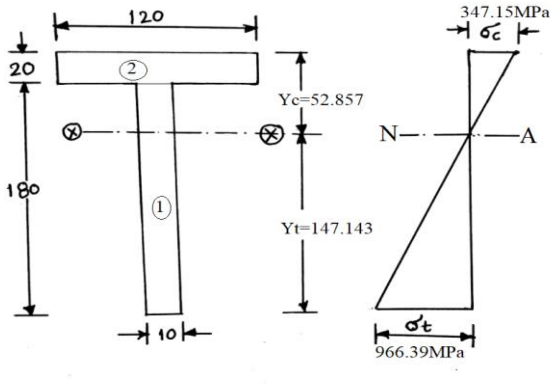
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4	c)	**A beam is loaded and supported as shown in Figure (2). Calculate magnitude and position of maximum BM. Draw SF diagram and BM diagram.**  Figure 2		
	Ans.	**1. Calculation of support reactions:** $\sum M_A = 0$ $(16\times3)\times1.5+10\times3+22\times4 = R_D\times5$ $R_D = 38$ kN $\sum F_y = 0$ $R_A + R_D = (16\times3)+10+22$ $R_A + 38 = 80$ $R_A = 42$kN	½ ½	
		2. SF calculations: SF at A_L = 0 kN A_R = + 42 kN B_L = +42 -(16×3)= -6 kN B_R = -6 -10 = -16 kN C_L = -16 kN C_R = -16 -22 = -38 kN D_L = -38 kN D_R = -38+38 = 0kN ($\therefore$ ok)	2	
		3. Location of point of contra shear: Let AE = x SF at E = 0 42 – 16 x = 0 x = 2.625 m from A	1	
		4. Bending moment calculations: BM at A and D = 0 (A and D are simple supports) C = +38×1 = + 38 kN.m $B = +38\times2-22\times1 = +54$ kN.m $E = +42\times2.625-\frac{16\times2.625^2}{2} = +55.125$ kN.m	2	

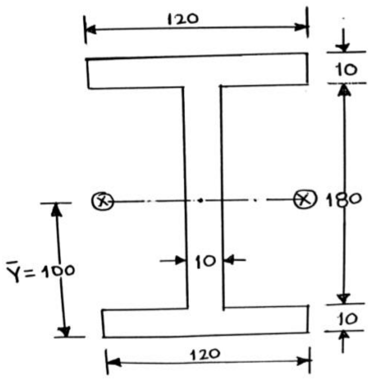
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4	c)	 BEAM  SFD (KN)  BMD (KN-m)	1 1	8

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q. 5		**Solve any two from a) , b) and c):**		(16)
	a)	**Draw SF and BM diagram for an overhanging beam loaded as shown in Figure (3). Locate the position of point of contra–flexure from A.**		
	Ans.	 Figure 3		
		1. Calculation of support reactions:		
		$\sum M_A = 0$		
		$(40\times4)\times2+16\times5.5=4R_B$		
		$R_B = 102$ kN	½	
		$\sum F_y = 0$		
		$R_A + R_B = (40\times4)+16$		
		$R_A + 102 = 176$		
		$R_A = 74$kN	½	
		2. SF calculations:		
		SF at A = +74 kN		
		B_L = +74- (40×4) = -86 kN		
		B_R = -86 +102= +16 kN	1	
		C_L = +16 kN		
		C = -16 + 16= 0 kN ($\therefore$ ok)		
		3. Bending moment calculations:		
		BM at A = 0 (Support A is simple)		
		C = 0 (C is free end)	1	
		B = -16×1.5 = - 24 kN.m		
		4. Maximum bending moment calculations:		
		Let AD = x		
		SF at D = 0		
		74 - 40x = 0	1	
		x = 1.85 m from support A		
		BM at D = + 74 $\times1.85 - 40\times\frac{(1.85)^2}{2}$ = + 68.45 kN.m	1	
		5. Location of point of contra flexure:		
		Let, E be point of contra-flexure (AE = y)		
		BM at E = 0		
		$74y - 40\frac{y^2}{2} = 0$		
		y=3.7m from support A	1	

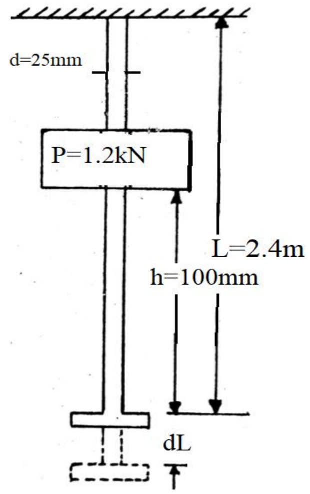
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.5	a)	 	1	8
			1	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q. 5	**b) i)**	**A 2 m long cantilever carries a vertical downward point load of 5 kN at free end. It also carries a clockwise couple of 6kN-m at 1 m from fixed end. Calculate SF and BM at free end, fixed end and 1 m from fixed end of cantilever.**		
	ii)	**Diagram Draw SF and BM diagram for cantilever in Q. 5 (b)(i)**		
	Ans.			
		1. SF calculations: SF at A = +5 kN B = +5 kN C = +5 kN	1	
		2. Bending moment calculations: BM at C = 0 $B_R = -5\times1 = -5$ kN.m $B_L = -5\times1-6 = -11$ kN.m $A = -5\times2-6 = -16$ kN.m	3	
	ii)			
	Ans.		1 3	8

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.5	c)	**The Tee section in Q. 2 (a) is used for a simply supported beam of span 5 m carrying an udl of 32 kN/m. (including self weight) on entire span. Determine the magnitude and the nature of bending stress at top and bottom fibres and sketch the bending stress distribution diagram.**		
	Ans.	**Data: L= 5m, w =32 kN/m** **Calculate: σ_c and σ_t** ***Ref Q. 2 (a)***		
		$Y_c = 52.857mm \quad Y_t = 147.143mm \quad I_{NA} = 15.226\times10^6 mm^4$	1	
				
		$M = \frac{wL^2}{8} = \frac{32\times5^2}{8} = 100kN\text{-}m = 100\times10^6 N\text{-}mm$	1	
		$\sigma_c = \left(\frac{M}{I}\right) y_c$	1	
		$\sigma_c = \left(\frac{100\times10^6}{15.226\times10^6}\right)\times52.857 = 347.15N/mm^2$	1	8
		$\sigma_t = \left(\frac{M}{I}\right) y_c$	1	
		$\sigma_t = \left(\frac{100\times10^6}{15.226\times10^6}\right)\times147.143 = 966.39N/mm^2$	1	
			2	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q. 6		**Solve any two:**		(16)
	a)	**A symmetrical I-section has two flanges each of 120 mm x 10 mm and web 10 mm x 180 mm is used as a beam. At a particular section the shear force is 80 kN. Calculate the average and maximum shear stress.**		
	Ans.	**Data:** S = 80 kN **Calculate:** q_{max} = ? q_{avg} = ?		
				
		$I_{NA} = \left(\frac{BD^3 - bd^3}{12}\right)$	1	
		$I_{NA} = \left(\frac{120 \times 200^3 - 110 \times 180^3}{12}\right) = 26540000 \text{ mm}^4$	1	
		$q_{max} = \frac{SA\overline{Y}}{bI}$	1	
		$q_{max} = \frac{80 \times 10^3 \times [(10 \times 90) \times 45] + [(120 \times 10)(90+5)]}{10 \times 26540000} = 46.571 \text{ N/mm}^2$	3	8
		$q_{avg.} = \frac{S}{A} = \frac{80 \times 10^3}{2(120 \times 10) + (10 \times 180)} = \frac{80 \times 10^3}{4200} = 19.0476 \text{N/mm}^2$	2	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q. 6	b)	**A hollow tube of external diameter 250mm and thickness 10 mm is used as a column 4.5 m long with both ends fixed. Using Euler's formula calculate the safe load the column can carry with a factor of safety of 3.**		
	Ans.	**Data:** D = 250 mm t = 10 mm L = 4.5 m FOS = 3 **Calculate**: P_{safe}		
		(Note: Assume E = 2 ×10^5 N/mm^2)		
		d = D – 2t = 250 – 2×10 = 230 mm	½	
		L_e = L/2 = 4500/2 = 2250 mm	1	
		$I_{min} = \frac{\pi}{64}\left(D^4 - d^4\right)$	1	
		$I_{min} = \frac{\pi}{64}\left(250^4 - 230^4\right)$		
		I_{min} = 54380968.83 mm^4	1	8
		$P_E = \frac{\pi^2 E I_{min}}{(L_e)^2}$	1	
		$P_E = \frac{\pi^2 \times 2\times10^5 \times 54380968.83}{(2250)^2}$	1	
		P_E = 21203699.73 N	1	
		$P_{safe} = \frac{P_E}{FOS}$	1	
		$P_{safe} = \frac{21203699.73}{3}$ = 7067899.91 N		
		$P_{safe} = 7.068\times10^3$ kN	½	
		(Note: Any appropriate value of E assumed and attempted should be considered.)		

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q. 6	**c)**	**A bar 2.4 m long and 25 mm in diameter is fixed at the top and hangs vertically. It has a collar at the lower end. A load of 1.2 kN falls onto collar from a height of 100 mm. Calculate the maximum instantaneous stress and the maximum instantaneous elongation produced if E = 205 GPa.**		
	Ans.	**Data:** L=2.4m, d=25mm, P=1.2kN, h=100mm, E=205 GPa **Calculate:** σ_{max}= ? δL = ?		
				
		$\sigma_{\max} = \left(\frac{P}{A}\right) + \sqrt{\left(\frac{P}{A}\right)^2 + \frac{2PhE}{AL}}$	**1**	
		$\sigma_{\max} = \left(\frac{1.2\times10^3}{\frac{\pi}{4}\times(25)^2}\right) + \sqrt{\left(\frac{1.2\times10^3}{\frac{\pi}{4}\times(25)^2}\right)^2 + \frac{2\times1.2\times10^3\times100\times205\times10^3}{\frac{\pi}{4}\times(25)^2\times2400}}$	**2**	
		$\sigma_{\max} = 206.8174\text{N/mm}^2$	**2**	**8**
		$\delta L = \frac{\sigma_{\max}\times L}{E}$	**1**	
		$\delta L = \frac{206.8174\times2.4\times10^3}{205\times10^3}$	**1**	
		$\delta L = 2.42$ mm	**1**	