Pinnacle DEGREE & DIPLOMA ENGINEERING

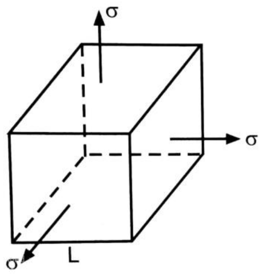
Model Answer: Summer-2019

Subject: Mechanics of Structures **Sub. Code: 22303**

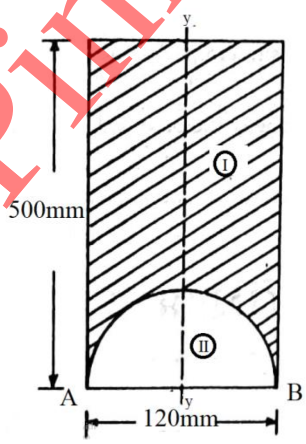
Important Instructions to examiners:

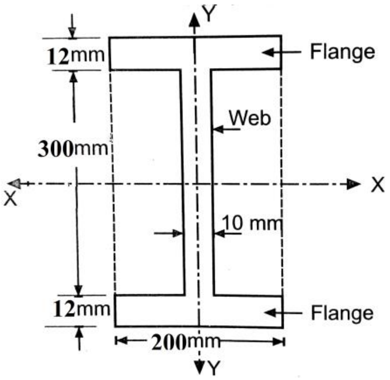
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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.

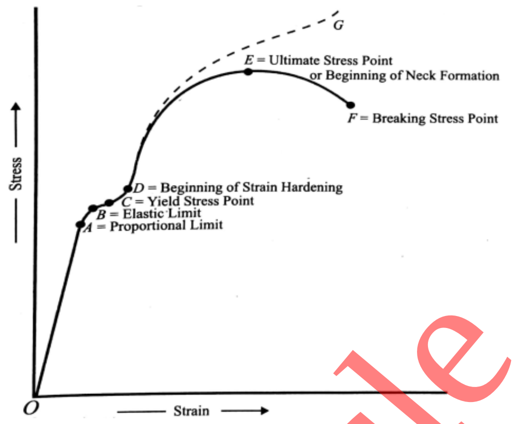
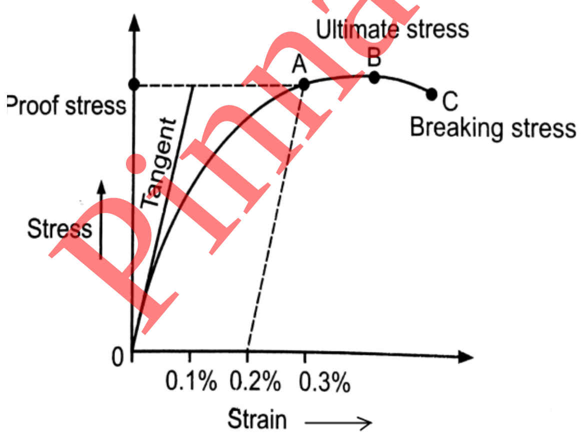
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1		**Attempt any FIVE of the following :**		(10)
	(a)	**Define ductility and plasticity.**		
	Ans.	**Ductility:** It is the property of material to undergo a considerable deformation under tension before rupture.	1	
		Plasticity: The plasticity of a material is the ability to change its shape without destruction under the action of external loads and to regain the shape given to it when the forces are removed. OR Lack of elasticity is called as plasticity.	1	2
	(b)	**Write mathematical expression of temperature stresses with meaning of each term.**		
	Ans.	$\sigma_t = \alpha \times t \times E$	1	
		Where, σ_t = Temperature Stress.(N/mm^2) α = Coefficient of linear expansion. (/^{o} C) t = Change in Temperature.(^{0}C) E = Modulus of Elasticity.(N/mm^2)	1	2
	(c)	**Calculate longitudinal stress developed in 2 cm diameter bar undergo tensile force of 120 kN.**		
	Ans.	**Data:** d = 2 cm, P = 120 kN **Find:** σ $\sigma = \frac{P}{A}$ $\sigma = \frac{120\times10^3}{\frac{\pi\times20^2}{4}}$	1	
		$\sigma = 381.97 N/mm^2$	1	2

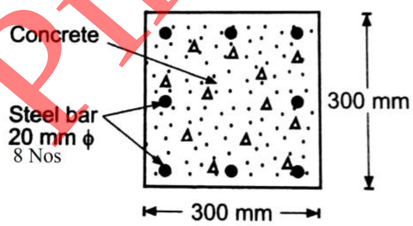
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1	(d) Ans.	**Define and explain Bulk Modulus.** **Bulk Modulus** : When a body is subjected to three mutually perpendicular like stresses of same intensity then the ratio of direct stress and the corresponding volumetric strain of the body is constant and is known as Bulk Modulus. It is denoted by K. **S.I. Unit:** N/m^2 Or Pascal.  $\text{Bulk Modulus (K)} = \dfrac{\text{Direct Stress}}{\text{Volumetric Strain}} = \dfrac{\sigma}{e_v}$	1 1	2
	(e) Ans.	**State any four types of beam.** i. Simply supported beam. ii. Cantilever beam. iii. Fixed beam. iv. Overhanging beam. v. Continuous beam	½ each (any four)	2
	(f) Ans.	**State the position of maximum shear stress and bending stress in S/S rectangular beam section carrying udl.** i. Maximum shear stress developed at the neutral axis of the rectangular section at support of simply supported beam. ii. Maximum bending stress developed at the top and bottom fibre of the rectangular section at mid span of simply supported beam.	1 1	2
	(g) Ans.	**Define effective length in column with its application.** **Effective Length:** The length of the column which bends or deflects as if it is hinged at its ends is called as effective length. It is denoted by Le. **Application:** It is used in Rankine's and Euler's formula to determine buckling load on column.	1 1	2

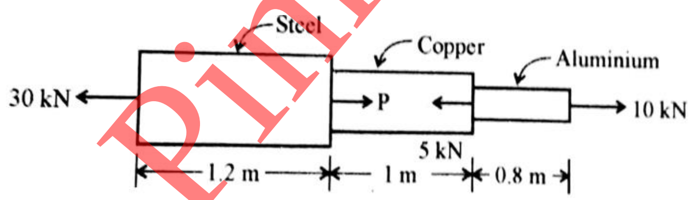
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2		**Attempt any THREE of the following :**		(12)
	(a)	**Define 'Moment of inertia' and write mathematical expression of square and quarter circle with both axis.**		
	Ans.	Moment of inertia of a body about any axis is equal to the product of the area of the body and square of the distance of its centroid from that axis.	2	
		OR		
		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		
		MI for Square = $I_{xx} = I_{yy} = \frac{bd^3}{12} = \frac{b^4}{12}$	1	
		MI for Quarter Circle = $I_{xx} = I_{yy} =$ $0.055R^4$	1	4
	(b)	**Define 'radius of gyration' and state its application. Calculate radius of gyration for circular lamina of diameter 500mm.**		
	Ans.	**Data:** d = 500mm **Calculate:** K		
		Radius of gyration (K): The radius of gyration of a given area about any axis is the distance from the given axis at which the area is assumed to be concentrated without changing the MI about the given axis.	1	
		$$K = \sqrt{\frac{I}{A}}$$ Where, I = Moment of Inertia (mm^4) A = Cross Sectional Area (mm^2) K = Radius of Gyration. (mm)		
		Application: It is used in Euler's formula to determine buckling load on long column.	1	

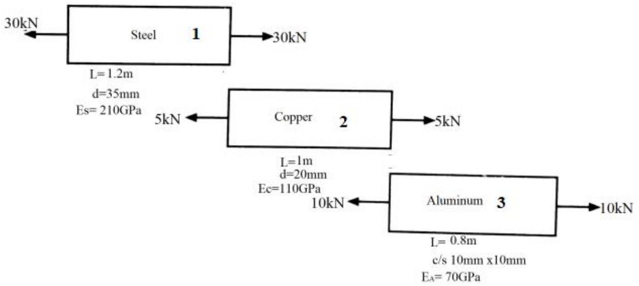
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2	(b)	$K = \sqrt{\frac{I}{A}}$ $K = \sqrt{\frac{\frac{\pi d^4}{64}}{\frac{\pi d^2}{4}}}$	1	
		$K = \sqrt{\frac{\frac{\pi \times 500^4}{64}}{\frac{\pi \times 500^2}{4}}}$ $K = \sqrt{\frac{3.068 \times 10^9}{196.35 \times 10^3}}$ $K = 125mm$	1	4
	(c)	**Calculate the moment of inertia about the base of composite lamina made up of a semicircle of 120 mm base diameter is removed from base of rectangle 120 mm X 500 mm such that lamina is symmetrical to Y- axis.**		
	Ans.		1	
		M.I. of lamina = (M.I. of rectangle about base AB) - (M.I. of semi circle about base AB) $= (I_G + Ah^2)_I - (I_G + Ah^2)_{II}$ $= \left(\frac{bd^3}{12} + (bd) \times \left(\frac{d}{2}\right)^2\right)_I - \left(0.11R^4 + \left(\frac{\pi d^2}{8}\right) \times \left(\frac{4R}{3\pi}\right)^2\right)_{II}$	1	
		$= \left(\frac{120 \times 500^3}{12} + (120 \times 500) \times \left(\frac{500}{2}\right)^2\right)_I - \left(0.11 \times 60^4 + \left(\frac{\pi \times 120^2}{8}\right) \times \left(\frac{4 \times 60}{3\pi}\right)^2\right)_{II}$	1	
		$= (5 \times 10^9)_I + (5.09 \times 10^6)_{II}$ $= 4.99 \times 10^9 mm^4$	1	4

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2	(d)	**Find centroidal moment of inertia about X-X axis of 'symmetrical I' section with flanges 200mm x 12 mm and web 10 mm x 300 mm.**		
	Ans.		1	
		$I_{xx}=\frac{BD^3-bd^3}{12}$	1	
		$I_{xx}=\frac{200\times324^3-190\times300^3}{12}$	1	
		$I_{xx}=139.37\times10^6 mm^4$	1	
		OR	OR	4
		$I_{XX}=\left(2(I_G+Ah^2)\right)_{flange}+\left(\frac{bd^3}{12}\right)_{web}$	1	
		$I_{XX}=2(\frac{200\times12^3}{12}+(200\times12)\times156^2)+\left(\frac{10\times300^3}{12}\right)$	1	
		$I_{XX}=139.37\times10^6 mm^4$	1	

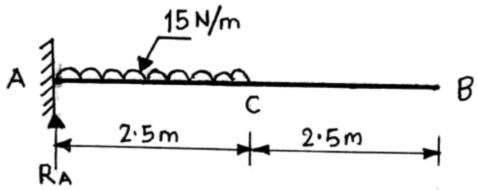
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3		**Attempt any THREE of the following :**		(12)
	(a)	**Sketch the standard stress-strain curve for mild steel and tor steel bar under axial tension and show important points on it.**		
	Ans.	 **Stress- strain curve for Mild steel**	2	
		 **Stress- strain curve for Tor steel**	2	4
	(b)	**A steel rod is subjected to an axial pull of 25 kN. Find maximum diameter if the stress is not exceed 100N/mm^2. The length of rod is 2000mm and take E= 2.1x10^5 N/mm^2**		
	Ans.	**Data:** P = 25kN, $\sigma = 110 N/mm^2$, E= 2.1x10^5 N/mm^2 **Find:** d_{min} $\sigma = \frac{p}{A} = \frac{P}{\left(\frac{\pi d^2}{4}\right)}$	1	

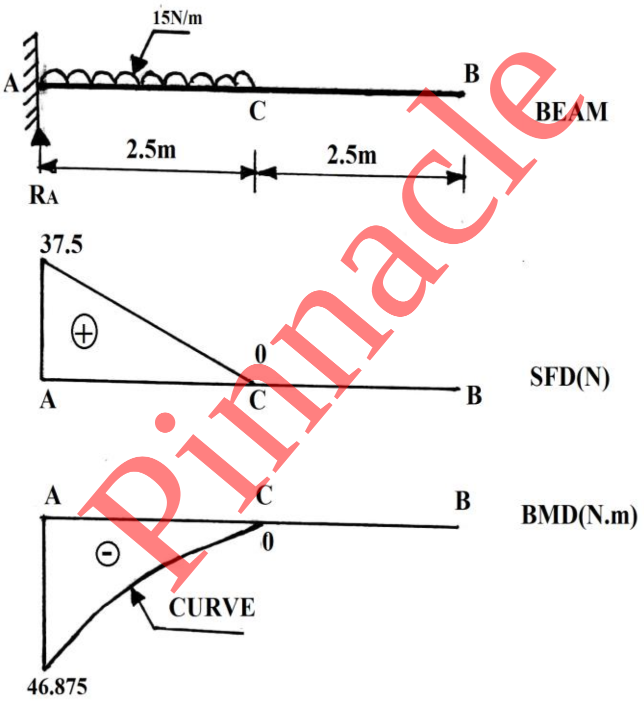
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3	(b)	$d^2 = \dfrac{P}{\left(\dfrac{\pi\sigma}{4}\right)}$	1	
		$d = \sqrt{\dfrac{P}{\left(\dfrac{\pi\sigma}{4}\right)}}$	1	
		$d = \sqrt{\dfrac{25\times10^3}{\left(\dfrac{\pi\times100}{4}\right)}}$ $d = 17.84mm$	1	4
	(c)	**A square R.C.C. column of 300mm X 300 mm in section with 8 steel bars of 20 mm diameter carries a load of 360 kN. Find the stresses induced in steel and concrete. Take modular ratio = 15.**		
	Ans.	Data: $A = 300\times300\ mm^2$, $d = 20\ mm\phi$ No. of steel bar = 8, $P = 360kN$, $m = 15$ Find: σ_c, σ_s,		
				
		$A_s = n\times\frac{\pi}{4}d^2 = 8\times\frac{\pi}{4}20^2 = 2513.27mm^2$		
		$A_c = A_g - A_s$ $A_c = 300\times300 - 2513.27$ $A_c = 87486.72mm^2$	1	
		$\dfrac{\sigma_s}{\sigma_c} = m$ $\sigma_s = m\times\sigma_c$ $\sigma_s = 15\sigma_c$		

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3	(c)	$P = P_s + P_c$ $P = \sigma_s A_s + \sigma_c A_c$	1	
		$360 \times 10^3 = (15\sigma_c)2513.27 + \sigma_c 87486.72$ $360 \times 10^3 = (37699.11 + 87486.72)\sigma_c$ $\boxed{\sigma_c = 2.876 N/mm^2}$	1	
		$\sigma_s = 15\sigma_c$ $\sigma_s = 15 \times 2.876$ $\boxed{\sigma_s = 43.136 N/mm^2}$	1	4
	(d)	**A Compound bar having steel rod of dia. 35 mm and solid copper rod of dia. 20mm and aluminum square rod of 10 mm is as shown in following figure. Find change in length of bar. Take modulus of elasticity Es = 210 kN/mm², Ec = 110 GPa and Eal = 70GPa.**  		
	Ans.	**Data:** Es= 210 kN/mm², Ec= 110 GPa and E_{Al} = 70 GPa **Find:** P, δL To find unknown force P, $\sum Fx = 0$ $-30 + P - 5 + 10 = 0$ $P - 25 = 0$ $P = 25 kN$	1	
		To find forces acting on individual part of compound rod.		

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3	(d)		1	
		$\delta L = \delta L_1 + \delta L_2 + \delta L_3$		
		$\delta L = \left(\frac{PL}{AE}\right)_1 + \left(\frac{PL}{AE}\right)_2 + \left(\frac{PL}{AE}\right)_3$		
		$\delta L = \left(\frac{30\times10^3\times1200}{\frac{\pi}{4}\times35^2\times210\times10^3}\right)_1 + \left(\frac{5\times10^3\times1000}{\frac{\pi}{4}\times20^2\times110\times10^3}\right)_2 + \left(\frac{10\times10^3\times800}{10\times10\times70\times10^3}\right)_3$	1	
		$\delta L = 0.1782 + 0.1447 + 1.1485$		
		$\delta L = 1.466mm$	1	4

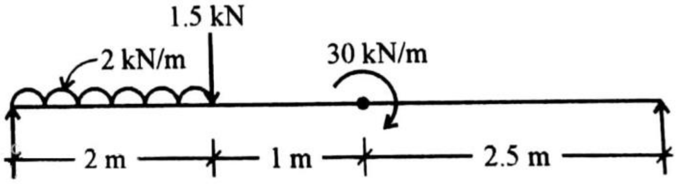
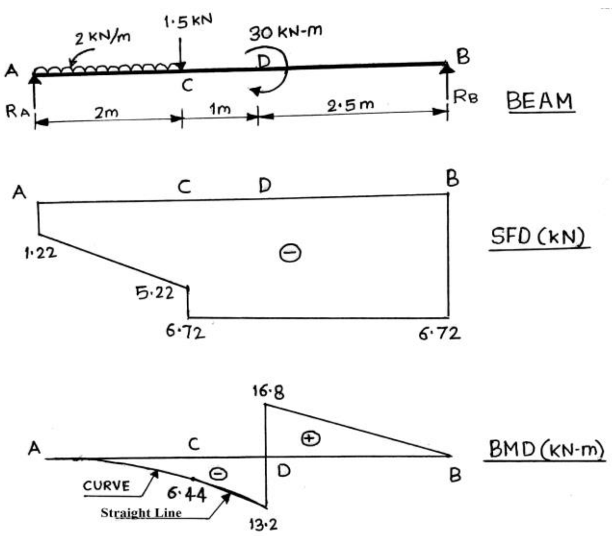
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4		**Attempt any <u>THREE</u> of the following :**		**(12)**
	(a)	**A bar of 20 mm diameter is subjected to a pull of 45 kN. The measured extension on gauge length of 200 mm is 0.05 mm and change in diameter is 0.0025mm. Calculate the Poisson's ratio and the value of modulus of rigidity.**		
	Ans.	**Data:** d= 20 mm, L=200mm, δL=0.05mm, , δb= 0.0025mm **Find:** μ , G **Calculate μ:** $\mu=\frac{Lateral\ Strain}{Linear\ Strain}$	1	
		$\mu=\frac{(\delta d/d)}{(\delta_L/L)}$ $\mu=\frac{(0.0025/20)}{(0.05/200)}$ $\mu=0.5$	1	
		Calculate E: $\delta l=\frac{PL}{AE}$ $E=\frac{PL}{A\times\delta L}=\frac{45\times10^3}{\frac{\pi}{4}\times20^2\times0.05}=572.957\times10^3\ N/mm^2$ $E=572.957\times10^3\ N/mm^2$	1	
		Calculate G: E= 2G (1+μ) $572.957 \times 10^3 = 2G(1+0.5)$ $G=190.985 \times 10^3\ N/mm^2$	1	4

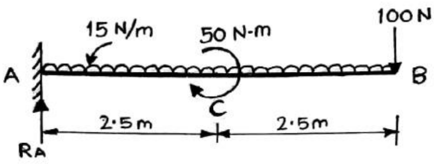
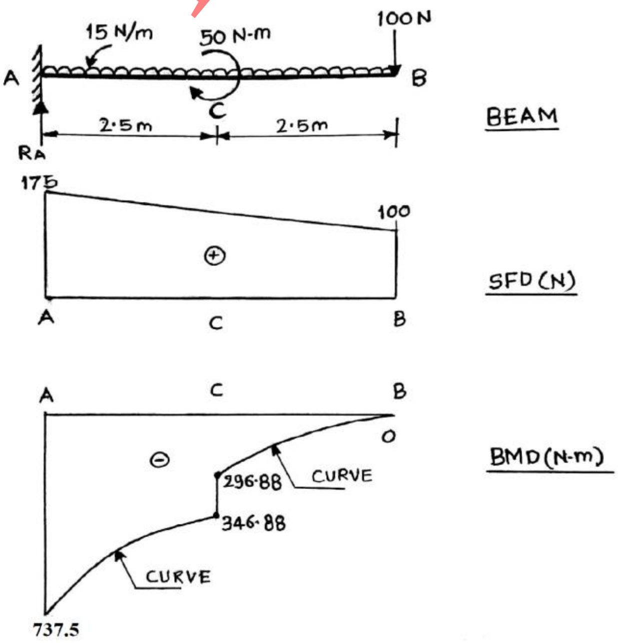
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4	(b)	**A steel flat 30 mm x 15 mm and 2.8 m long is subjected to an axial pull of 58 kN, if E = 2 x 10^5N/mm^2 and μ = 0.30. Calculate volumetric strain and change in Volume.**		
	Ans.	**Data:** b=30mm, t=15mm, L=2.8m, P=58 kN, E=2.1x10^3N/mm^2, μ=0.30		
		Find: e_v, δv		
		$\sigma = \frac{P}{A} = \frac{58\times10^3}{30\times15} = 128.88 N/mm^2$	1	
		$e_v = \frac{\sigma}{E}(1-2\mu)$	1	
		$e_v = \frac{128.88}{2.1\times10^3}\times(1-2\times0.30)$		
		$e_v = 2.454\times10^{-4}$	1	
		To find δ_v		
		$e_v = \frac{\delta_v}{V}$		
		$\delta_v = e_v \times V$		
		$\delta_v = 2.454\times10^{-4}\times2800\times30\times15$		
		$\delta_v = 309.204\ mm^3$	1	4
	(c)	**Draw shear force and bending moment diagram for cantilever beam of 5 m span subjected to udl of 15 N/m up to mid span from fixity.**		
	Ans.			
		I) Reaction Calculation:		
		$\sum Fy = 0$		
		$+R_A-(15\times 2.5)=0$		
		$R_A-37.5=0$		
		$R_A=37.5kN$		

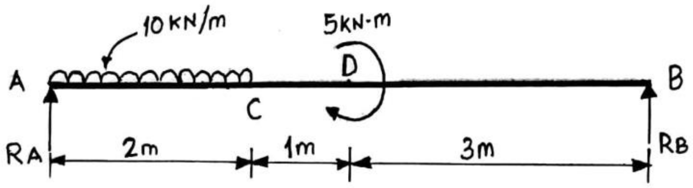
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4	(c)	**II) SF Calculation:** SF at A= +37.5kN C = +37.5-(15 × 2.5) = 0 kN B = 0 kN	1	
		III) BM Calculation: BM at B = 0 (B is free end) C = 0 (No load from B to C) A= - (15×2.5 ×1.25) = - 46.875 kN-m	1	
			1 1	4

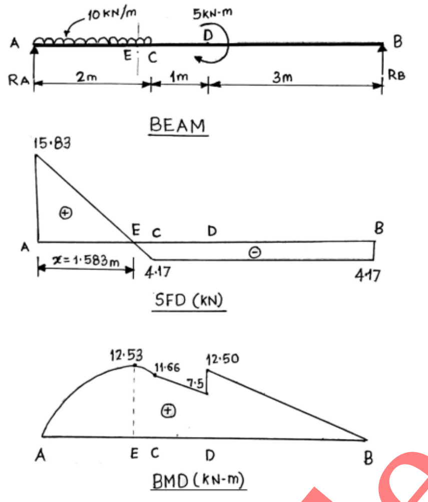
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4	(d)	**Calculate the Euler's limiting value of slenderness ratio for which it is not valid for long columns.** **Take E= $2x10^5$ MPa, & $\sigma_c = 320N/mm^2$**		
	Ans.	**Data:** E= $2x10^5$MPa, σ_c=320N/mm^2 **Find:** $\lambda_{limiting}$ For long column, Euler's formula, $P_E = \frac{\pi^2 EImin}{(L_e)^2}$	1	
		But K=$\sqrt{\frac{I}{A}}$ $K^2 = \frac{I}{A}$ I=AK^2 $P_E = \frac{\pi^2 E \times A \times K^2}{(L_e)^2}$	1	
		$\frac{P_E}{A} = \frac{\pi^2 E}{\left(\frac{Le}{K}\right)^2}$ $\sigma_c = \frac{\pi^2 E}{(\lambda)^2}$ $(\lambda)^2 = \frac{\pi^2 E}{\sigma_c}$ $\lambda = \sqrt{\frac{\pi^2 E}{\sigma_c}}$ $\lambda = \sqrt{\frac{\pi^2 \times 2\times10^5}{320}}$ for column to be safe $\sqrt{\frac{\pi^2 \times 2\times10^5}{320}} \leq \lambda$ $78.54 \leq \lambda$	1	
		Thus Euler's limiting value is 78.54. If it is less than 78.54 Euler's formula for long column is not valid.	1	4

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4	(e)	**Calculate the crippling load by Rankine's formula for a hollow circular column of 300 mm external diameter and 200 mm internal diameter. Unsupported length of the column is 4.2 m. If (a) both ends are fixed and (b) both ends are hinged. Take σc= 550 N/mm², a= (1/1600)**		
	Ans.	**Data:** L= 4.2m, a)Both ends are fixed., b) Both ends are hinged $\sigma c=550MPa, \quad a=\frac{1}{1600}$ **Find:** P_R $A=\frac{\pi}{4}(D^2-d^2)=\frac{\pi}{4}(300^2-200^2)=39269.91mm^2$ $Imin=\frac{\pi}{64}(D^4-d^4)=\frac{\pi}{64}(300^4-200^4)=319068003.9mm^4$	1	
		$K_{min}=\sqrt{\frac{Imin}{A}}=\sqrt{\frac{319068003.9}{39269.91}}=90.138mm$ OR $K_{min}=\frac{\sqrt{D^2+d^2}}{4}=\frac{\sqrt{300^2+200^2}}{4}=90.138mm$	1	
		$\lambda=\frac{Le}{K_{min}}.$ Case a) $Le=\frac{L}{2}=\frac{4200}{2}=2100mm$ Case b) Le= L = 4200mm Case a) $\lambda=\frac{2100}{90.138}=23.297$ Case b) $\lambda=\frac{4200}{90.138}=46.595$	1	
		By using Rankine's Formula, $P_R=\frac{\sigma_c A}{1+a\lambda^2}$ Case a) $P_R=\frac{550\times39269.91}{1+\left(\frac{1}{1600}\right)\times23.297^2}=16127647.85\text{ N}=16.13\times10^3kN$	1	4
		Case b) $P_R=\frac{550\times39269.91}{1+\left(\frac{1}{1600}\right)\times46.595^2}=9163741.91\text{ N}=9.16\times10^3kN$		

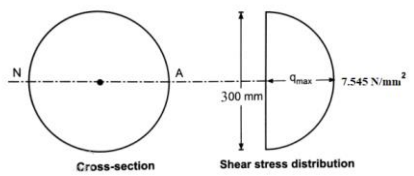
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.5		**Attempt any TWO of the following :**		(12)
	(a)	**Draw shear force and bending moment for simply supported beam as shown in Fig.** 		
	Ans.	**I) Reaction Calculation:** $\sum M_A = 0$ $R_B \times 5.5 = (2\times2)\times1+1.5\times2+30$ $R_B = 6.72kN$ $\sum Fy = 0$ $R_A+R_B = (2\times2) + 1.5$ $R_A= -1.22kN$	1	
		II) SF Calculation: SF at A = -1.22kN $C_L = -1.22-(2\times2)= -5.22kN$ $C_R = -5.22-1.5 = -6.72kN$ $B_L = -6.72kN$ $B = -6.72+6.72 = 0kN$ (∴ ok)	1	
		III) BM Calculation: BM at A and B = 0 (∵ Supports A and B are simple) $C = -1.22\times2-(2\times2)\times1 = -6.44kN\text{-}m$ $D_L = 6.72\times2.5-30= -13.2kN\text{-}m$ $D_R = 6.72\times2.5 = +16.8kN\text{-}m$	2	
			1 1	6

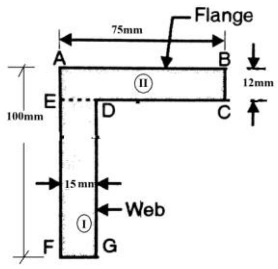
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.5	(b)	**Draw shear force and bending moment diagram for cantilever beam of 5 m span. Beam is loaded with udl of 15 N/m over entire span. Vertically downward point load of 100 N at its free and clockwise moment of 50 Nm at its mid span.**		
	Ans.			
		I) Reaction Calculation: $\sum Fy = 0$ RA = 15×5+100 = 175N		
		II) SF Calculation: SF at A = +175N B_L = +175-(15×5) = +100N B = +100-100 =0N (∴ ok)	1	
		III) BM Calculation: BM at B = 0 kN-m (∵B is Free end) C_R = -100×2.5-15×2.5×1.25 = -296.875 N-m C_L = -100×2.5-15×2.5×1.25-50 = -346.875N-m A = -100×5-15×5×2.5-50 = -737.5N-m	2	
			1 2	 6

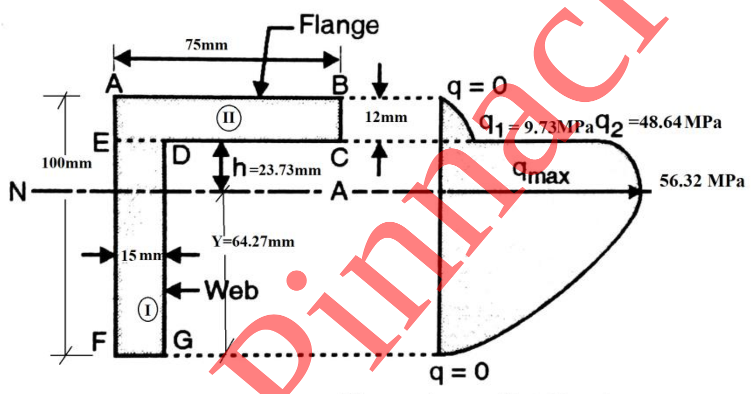
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.5	(c)	**A simple supported beam of span 6 m carries udl of 10 kN/m upto 2 m and couple of 5 kNm (clockwise) at 3 m respectively from left side support. Draw SFD and BMD with appropriate calculation.**		
	Ans.			
		I) Reaction Calculation: $\sum M_A = 0$ $R_B \times 6 = (10\times2)\times1+5 \quad \therefore R_B = 4.17kN$ $\sum Fy = 0$ $R_A + R_B = 10\times2$ $R_A + 4.17 = 20kN \quad \therefore R_A = 15.83kN$	1	
		II) SF Calculation: SF at A = +15.83kN C = +15.83 - (10×2) = - 4.17kN B_L = -4.17kN B = -4.17+4.17 = 0kN (∴ ok)	1	
		III) BM Calculation: BM at A and B = 0 (∵Support A and B is simple) C = +15.83×2-(10×2) ×1= +11.66 kN-m D_L = +15.83×3-(10×2) ×2 = +7.5kN-m D_R = +15.83×3-(10×2) ×2+5 = +12.5kN-m	1	
		IV) Maximum BM Calculation: SF at E = 0 15.83 - 10 x = 0 ∴ x = 1.583m from support A BM_{max}=+15.83×1.583–(10×1.583)×0.7915=+12.53kN-m	1	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.5	(c)		1 1	6

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.6		**Attempt any TWO of the following :**		(12)
	(a)	**A simple supported beam of span 6 m carries two point loads 18 kN with 2 m spacing and symmetrical to span. Design square beam for bending if maximum bending stresses in beam is 10 N/mm².**		
	Ans.	**Data:** L=6m, W_1=18kN, W_2=18kN, σ_b= 10N/mm^2 , b = d **Find:** b, d RA=RB=18kN (Due to symmetry) $M_{max} = M_C = M_D = 18\times2 = 36$ kN-m $= 36\times10^6$ N-mm	1	
		$I=\frac{bd^3}{12}=\frac{b^4}{12}$	1	
		$Y=\frac{d}{2}=\frac{b}{2}$		
		$\frac{M}{I}=\frac{\sigma}{Y}$	1	
		$\sigma=\frac{M}{I}\times Y$		
		$10=\frac{(36\times10^6)}{\frac{b^4}{12}}\times\frac{b}{2}$	1	
		$10=\frac{(36\times10^6)}{\frac{b^3}{6}}$		
		$b^3=\frac{(36\times10^6)}{10}\times6$	1	
		$b^3=216\times10^5$		
		b=278.495mm		
		d=278.495mm	1	6

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.6	(b)	**Draw shear stress distribution along cross-section of circular beam for 300 mm diameter carrying 400 kN shear force. Also determine the ratio of maximum shear stress to average stress.**		
	Ans.	Data- d = 300mm, S=400kN		
		Find- $\frac{q_{max}}{q_{avg}}$ =?		
		$R=\frac{d}{2}=\frac{300}{2}=150mm$		
		$A=\frac{\pi}{8}\times d^2=\frac{\pi}{8}\times(300)^2=35342.92mm^2$		
		$\bar{Y}=\frac{4R}{3\pi}=\frac{4\times150}{3\times\pi}=63.662mm$	½	
		b=d=300mm		
		$I=\frac{\pi d^4}{64}=\frac{\pi\times(300)^4}{64}=397607820.2mm^4$	1	
		$q_{max}=\frac{SA\bar{Y}}{bI}$	1	
		$q_{max}=\frac{400\times10^3\times35342.92\times63.662}{300\times397607820.2}=7.545N/mm^2$	1	
		$q_{avg}=\frac{S}{A}=\frac{400\times10^3}{\frac{\pi}{4}\times(300)^2}=5.66N/mm^2$	1	
		Ratio= $\frac{q_{max}}{q_{avg}}=\frac{7.545}{5.66}=1.33$	½	
			1	6

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.6	(c)	**Draw shear stress distribution along of beam for L section with 75 x 12mm in flange and 100 x 15 mm in web carrying 60kN shear force.**		
	Ans.	**Data:** W= 60kN, Flange: 75mm x 12mm, Web; 100mm x 15mm.		
				
		$a_1 = 15\times88 = 1320mm^2$ $a_2 = 72\times12 = 900mm^2$ $a_1 + a_2 = 1320+900 = 2220mm^2$ $y_1 = \frac{88}{2} = 44mm$ $y_2 = 88+\frac{12}{2} = 94mm$		
		$\bar{Y}_{base} = \frac{a_1y_1 + a_2y_2}{a_1 + a_2} = \frac{(1320\times44)+(900\times94)}{2220} = 64.27mm$ from base	1	
		$h_1 = 64.27-\frac{88}{2} = 20.27mm$ $h_2 = 23.73+\frac{12}{2} = 29.73mm$ $I_{NA} = (MI)_I + (MI)_{II}$ $I_{NA} = (I_G + Ah^2)_I + (I_G + Ah^2)_{II}$ $I_{NA} = \left(\frac{bd^3}{12} + (b\times d)\times h^2\right)_I + \left(\frac{bd^3}{12} + (b\times d)\times h^2\right)_{II}$ $I_{NA} = \left(\frac{15\times88^3}{12} + (1320)\times(20.27)^2\right)_I + \left(\frac{75\times12^3}{12} + (900)\times(29.73)^2\right)_{II}$ $I_{NA} = (1394192.228)_I + (806285.67)_{II}$ $I_{NA} = 2200477.838mm^4$	1	
		$q_0 = 0$ At top and bottom of section. $q = \frac{SA\bar{Y}}{bI}$		

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.6	(c)	$q_1 = \dfrac{60\times10^3\times75\times12\times29.73}{75\times2200477.838} = 9.73\ \text{N/mm}^2$	1	
		$q_2 = \dfrac{60\times10^3\times75\times12\times29.73}{15\times2200477.838} = 48.64\ \text{N/mm}^2$	1	
		$q_{(\max)} = \dfrac{60\times10^3\times\left(75\times12\times29.73+15\times23.73\times11.815\right)}{15\times2200477.838} = 56.32\text{N/mm}^2$		
		OR		
		$q_{(\max)} = \dfrac{60\times10^3\times15\times\left(64.27\times32.135\right)}{15\times2200477.838} = 56.32\text{N/mm}^2$	1	
		 Shear stress distribution diagram	1	6