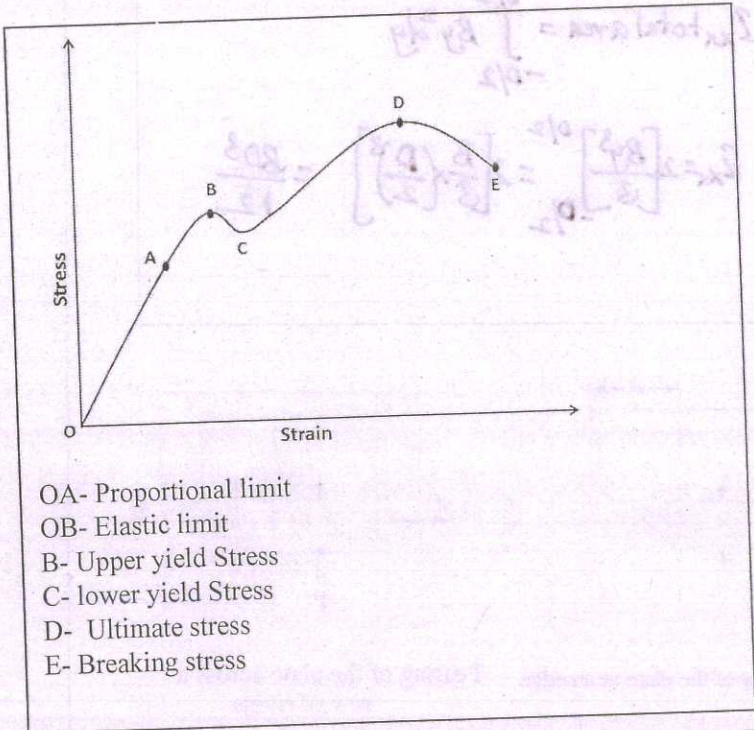


**SCHEME OF VALUATION**

Revision : 2015				
Course Title : <b>APPLIED MECHANICS AND STRENGTH OF MATERIALS</b>				
Course Code: 4021				
Q. No	Scoring Indicators	Split-up Score	Sub total	Total
<u><b>PART -A</b></u>				
I. 1.	The ratio of the lateral strain to longitudinal strain	2	2	10
2	Ratio of limiting friction to the Normal reaction	2	2	
3	Centre of gravity is the point through which the whole weight of the body acts	2	2	
4	The moment of inertia of the area about an axis perpendicular to the plane of the figure and passing through the centre of gravity.	2	2	
5	Ratio of mean diameter of coil to the wire diameter of spring	2	2	
<u><b>PART -B</b></u>				
II. 1.	 <p>OA- Proportional limit                  OB- Elastic limit                  B- Upper yield Stress                  C- lower yield Stress                  D- Ultimate stress                  E- Breaking stress</p>	Diagram 3	3	6
		½ X 6	3	

2.

$$\begin{aligned}
 d &= 25 \text{ mm} & l &= 4 \text{ m} = 4000 \text{ mm} & t_1 &= 80^\circ \text{C} \\
 t_2 &= 30^\circ \text{C} & t &= 80 - 30 = 50^\circ \text{C} & \delta &= 1.5 \text{ mm} \\
 E &= 2.1 \times 10^5 \text{ N/mm}^2 & \alpha &= 12 \times 10^{-6} / ^\circ \text{C} \\
 A &= \pi/4 \cdot 25^2 = 490.87 \text{ mm}^2
 \end{aligned}$$

$$\begin{aligned}
 \text{Thermal stress, } \sigma &= (\alpha t - \delta/l)E \\
 &= (12 \times 10^{-6} \cdot 50 - 1.5/4000) \cdot 2.1 \times 10^5 \\
 &= 47.25 \text{ N/mm}^2
 \end{aligned}$$

$$\begin{aligned}
 \text{Pull exerted, } P &= \sigma \cdot A \\
 &= 47.25 \cdot 490.87 = 23193.6 \text{ N}
 \end{aligned}$$

Eqn: 2

2

6

6

2

3.

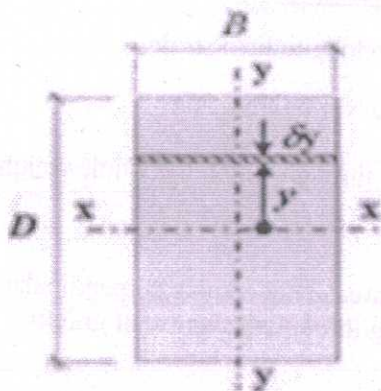


Fig. 2

$$I_{xx} \text{ for element} = dy^2 - (Bdy \cdot y^2)$$

$$I_{xx} \text{ total area} = \int_{-D/2}^{D/2} B y^2 dy$$

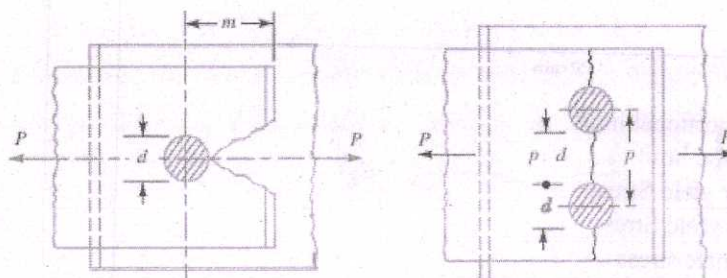
$$I_{xx} = 2 \left[ \frac{B y^3}{3} \right]_{-D/2}^{D/2} = 2 \left[ \frac{B}{3} \cdot \left( \frac{D}{2} \right)^3 \right] = \frac{BD^3}{12}$$

4

6

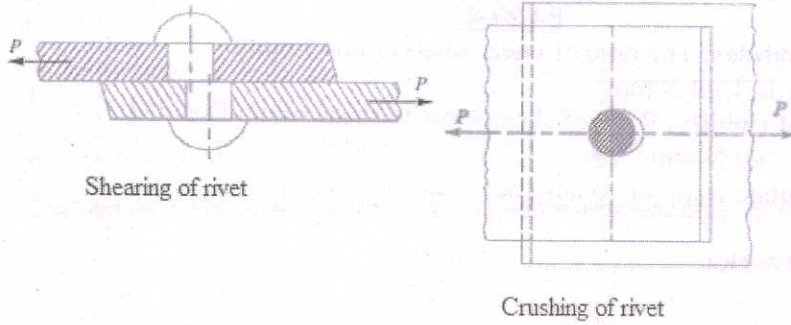
6

4



Tearing of the plate at an edge

Tearing of the plate across a row of rivets



$4 \times 1\frac{1}{2} = 6$

6

6

5

$d = 800\text{mm}$ ,  $t = 12\text{mm}$ ,  $p = 3\text{ MPa} = 3\text{ N/mm}^2$

Circumferential stress  $\sigma_c = pd/2t$

$$= (3 \times 800) / (2 \times 12)$$

$$= 100\text{ N/mm}^2 = 100\text{ MPa}$$

Longitudinal stress,  $\sigma_c = pd/4t$

$$= (3 \times 800) / (4 \times 12)$$

$$= 50\text{ N/mm}^2 = 50\text{ MPa}$$

Eqns =

2

2 marks

Calculati

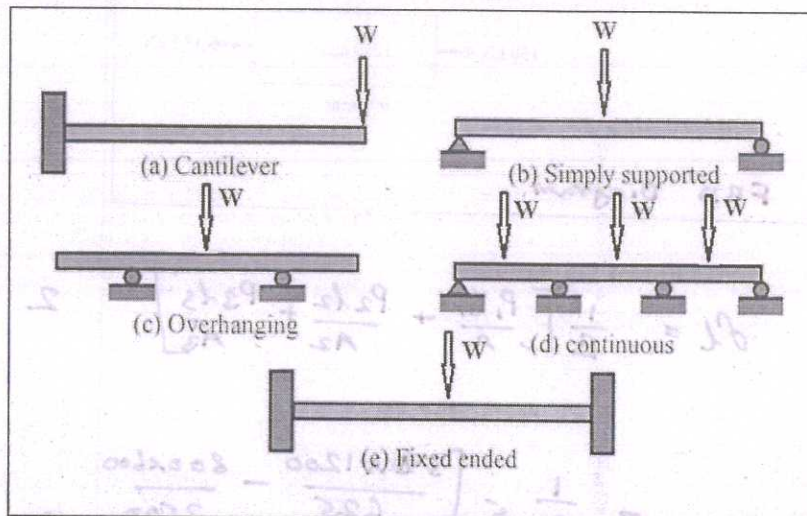
6

on =  $2 \times 2 =$

4

4 marks

6



Any 4  
 $4 \times 1.5$

6

6

7

**Buckling load:** The maximum axial compressive load which a column can take without failure.

**Slenderness ratio:** It is the ratio of the length of the column to the least radius of gyration of the cross sectional area of the column.

**Effective length:** Column with given end conditions is the length of an equivalent column of the same material and cross section with hinged ends, and having the value of the crippling load equal to that of the given column.

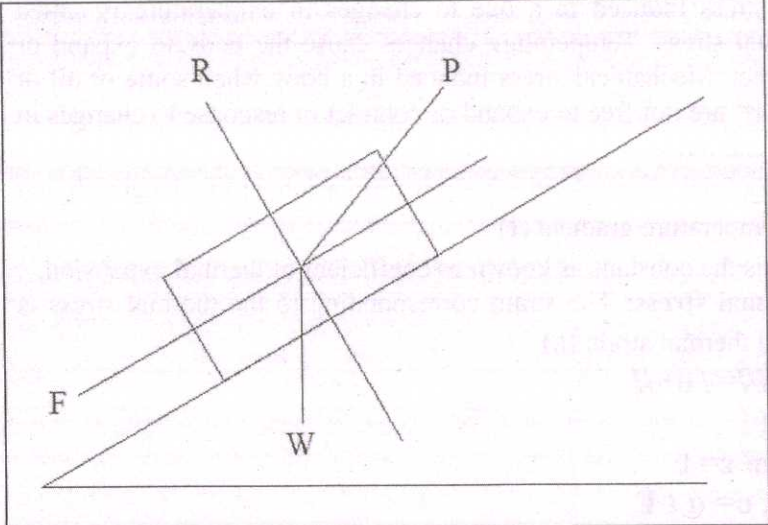
$2 \times 3$

6

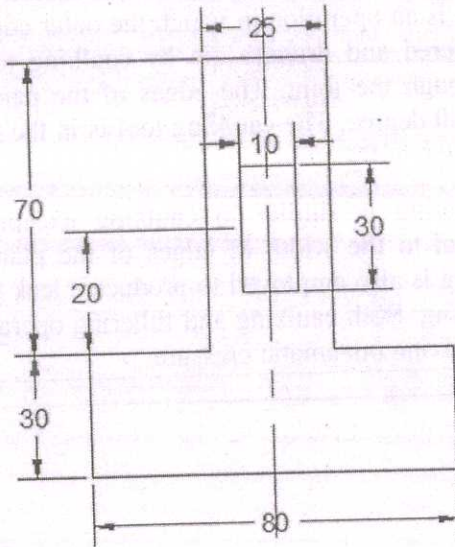
6

<p>III.(a)</p>	<p style="text-align: center;"><b>PART-C</b></p> <p><b>Youngs modulus:</b> The ratio of linear stress to linear strain. Denoted by E. Unit N/mm<sup>2</sup></p> <p><b>Modulus of rigidity:</b> Ratio of shear stress to shear strain. Denoted by C or G. Unit N/mm<sup>2</sup></p> <p><b>Bulk modulus:</b> Ratio of volumetric strain to the volumetric strain. Denoted by K. Unit N/mm<sup>2</sup></p> <p><math>E = \frac{9KG}{G+3K}</math></p>	<p>1 1 1 2</p>	<p>5</p>	<p>15</p>
<p>(b)</p>	<p><math>P_1 = 50 \text{ kN}</math>, <math>P_3 = 450 \text{ kN}</math>, <math>P_4 = 150 \text{ kN}</math></p> <p><math>P_1 + P_3 = P_2 + P_4</math></p> <p><math>P_2 = P_1 + P_3 - P_4 = 50 + 450 - 150 = 350 \text{ kN}</math></p> <div style="border: 1px solid black; padding: 10px; margin: 10px 0;"> <p style="text-align: center;">FBD Diagram</p> </div>	<p>2</p>	<p>10</p>	<p></p>
<p>b.</p>	$\delta L = \frac{1}{E} \left[ \frac{P_1 l_1}{A_1} + \frac{P_2 l_2}{A_2} + \frac{P_3 l_3}{A_3} \right]$ $= \frac{1}{2 \times 10^5} \left[ \frac{50 \times 1200}{625} + \frac{300 \times 600}{2500} + \frac{150 \times 900}{1250} \right] \times 10^3$ $= \underline{\underline{0.66 \text{ mm}}}$	<p>2 3 2</p>	<p>6</p>	<p>7</p>

IV (a)	<p><b>Thermal stress:</b> The stress induced in a due to changes in temperature is called thermal stress. Temperature changes cause the body to expand or contract. Mechanical stress induced in a body when some or all of its parts are not free to expand or contract in response to changes in temperature.</p> <p>The thermal stress (<math>\sigma</math>) in a body is proportional to its length (<math>l</math>) and the temperature gradient (<math>t</math>) let <math>\alpha</math> is the constant, is known as coefficient of thermal expansion, <b>Thermal stress:</b> The strain corresponding to the thermal stress is called thermal strain (<math>\epsilon</math>) <math>\epsilon = \delta l/l = l \alpha t/l</math> <math>= \alpha t</math> But, <math>\sigma/\epsilon = E</math> Then, <math>\sigma = \alpha t E</math></p>	2.5	5	
(b)	<p><math>l = 5m = 5000mm</math> <math>b = 50mm</math> <math>t = 30mm</math> <math>P = 4kN = 40000N</math> <math>E = 2.0 \times 10^5 N/mm^2</math> <math>\mu = 0.3</math></p> <p><math>\delta l = Pl/AE = (40000 \times 5000)/(50 \times 30 \times 2 \times 10^5)</math> <math>= 0.6667mm</math> <math>\epsilon_{linear} = \delta l/l = 0.6667/5000 = 0.00013334</math> <math>\epsilon_{lateral} = \mu \times \epsilon_{linear} = 0.3 \times 0.00013334</math> <math>= 0.00004</math> <math>\delta_b = b \times \epsilon_{lateral} = 50 \times 0.00004 = 0.002mm</math> <math>\delta_t = t \times \epsilon_{lateral} = 30 \times 0.00004 = 0.012mm</math></p>	1	10	15
V(a)	<ol style="list-style-type: none"> <li>When an object is moving, the friction is proportional and perpendicular to the normal force (N)</li> <li>Friction is independent of the area of contact so long as there is an area of contact.</li> <li>The coefficient of static friction is slightly greater than the coefficient of kinetic friction.</li> <li>Within rather large limits, kinetic friction is independent of velocity.</li> <li>Friction depends upon the nature of the surfaces in contact.</li> </ol>	5 x 1	5	

<p>(b)</p>		<p>2</p>		
	<p>Let R, F, W and P are the Normal reaction, Frictional force, Weight of body and external force respectively.</p> <p>Considering vertical forces,  <math>\Sigma F_y = 0</math>  <math>-W \cos 30 + R + P \sin 20 = 0</math>  <math>R = W \cos 30 - P \sin 20</math>  <math>= 500 \cos 30 - 400 \sin 20</math>  <math>= 296.20 \text{ N}</math></p> <p>Considering horizontal forces  <math>\Sigma F_x = 0</math>  <math>-F - W \sin 30 + P \cos 20 = 0</math>  <math>F = P \cos 20 - W \sin 30</math>  <math>= 400 \cos 20 - 500 \sin 30</math>  <math>= 125.88 \text{ N}</math></p> <p>Coefficient of friction = <math>F/R</math>  <math>= 125.88 / 296.20</math>  <math>= 0.425</math></p>	<p>3</p> <p>3</p> <p>2</p>	<p>10</p>	<p>15</p>
<p>VI.(a)</p>	<p>The c.g of a body or a plane figure is calculated with reference to some assumed axis known as axis of reference. The axis of reference of plane figure, is generally taken as the lowest line of the figure for calculating y and the left of the figure calculating x</p> <p>Sometimes the given section, whose c.g. is required to be found out, is symmetrical about XX axis YY and axis. In such cases the procedure for calculating the c.g. of the body is very much simplified as we have only to calculate either x or y. This is due to the reason that c.g. of the body will lie on the axis of symmetry. If the axis of symmetry is YY axis calculate y, if it is XX calculate x.</p>	<p>2.5 x 2</p>	<p>5</p>	

(b)



$$a_1 = 80 \times 30 = 2400 \text{ mm}^2$$

$$a_2 = 70 \times 25 = 1750 \text{ mm}^2$$

$$a_3 = 30 \times 10 = 300 \text{ mm}^2$$

$$y_1 = 30/2 = 15 \text{ mm}$$

$$y_2 = 30 + 70/2 = 65 \text{ mm}$$

$$y_3 = 50 \text{ mm}$$

$$y = (a_1 y_1 + a_2 y_2 - a_3 y_3) / (a_1 + a_2 - a_3)$$

$$= 35 \text{ mm}$$

$$I_{G1} = bd^3/12 = (80 \times 30^3)/12 = 180000 \text{ mm}^4$$

$$I_{G2} = bd^3/12 = (25 \times 70^3)/12 = 714583.33 \text{ mm}^4$$

$$I_{G3} = bd^3/12 = (10 \times 30^3)/12 = 22500 \text{ mm}^4$$

$$h_1 = y - y_1 = 35 - 15 = 20 \text{ mm}$$

$$h_2 = y - y_2 = 35 - 65 = -30 \text{ mm}$$

$$h_3 = y - y_3 = 35 - 50 = -15 \text{ mm}$$

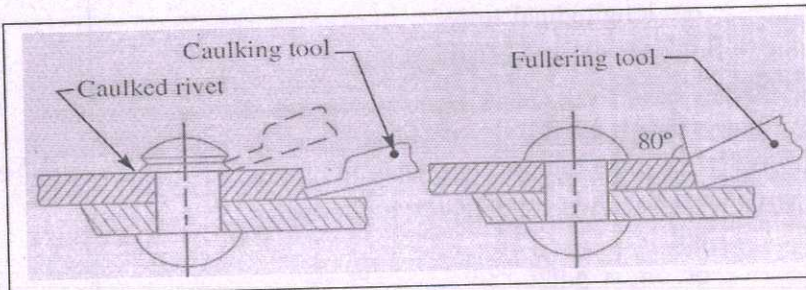
$$I_{y1} = I_{G1} + a_1 h_1^2 = 180000 + (2400 \times 20^2) = 1140000 \text{ mm}^4$$

$$I_{y2} = I_{G2} + a_2 h_2^2 = 714583.33 + (1750 \times 30^2) = 2289583.33 \text{ mm}^4$$

$$I_{y3} = I_{G3} + a_3 h_3^2 = 22500 + (300 \times 15^2) = 90000 \text{ mm}^4$$

$$I_{yy} = I_{y1} + I_{y2} - I_{y3} = 3339583.33 \text{ mm}^4$$

VII(a)



4

4

2

10

15

	<p><b>Caulking:</b> Caulking is an operation in which the outer edges of the parts are hammered and driven – in by caulking tool to prevent leakage through the joint. The edges of the parts are beveled with about 80 degree. The caulking tool is in the shape of blunt chisel as shown in fig.</p> <p><b>FULLERING:</b> Fullering is similar to caulking except that fullering tool is equal to the width of edges of the plates as shown in fig. Fullering is also employed to produce a leak proof joint similar to caulking. Both caulking and fullering operations are carried out by applying pneumatic pressure.</p>	2.5 x 2	5	
(b)	<p>t= 10mm d= 25mm p= 90 mm <math>\sigma_t = 150 \text{ N/mm}^2</math> <math>\sigma_s = 80 \text{ N/mm}^2</math> <math>\sigma_c = 175 \text{ N/mm}^2</math> for single riveted butt joint, n= 1</p> <p>Tensile strength <math>P_t = \sigma_t (p-d)t</math> <math>= 150(90-25) \times 10 = 97500 \text{ N/mm}^2</math></p> <p>Shear strength <math>P_s = 2 \times (\pi/4) \times d^2 \times \sigma_s \times n</math> <math>= 2 \times ((\pi/4) \times 25^2 \times 80 \times 1) = 78540 \text{ N/mm}^2</math></p> <p>Crushing or bearing strength <math>P_c = \sigma_c \times t \times d \times n</math> <math>= 175 \times 10 \times 25 \times 1 = 43750 \text{ N/mm}^2</math></p> <p>Strength of plate <math>P = \sigma_t \times p \times t</math> <math>= 150 \times 90 \times 10 = 135000 \text{ N/mm}^2</math></p> <p>Efficiency <math>= (\text{Least of } P_t, P_s \text{ or } P_c) / P</math> <math>= 43750 / 135000</math> <math>= 0.3241 = 32.41 \%</math></p>	2 2 2 2 2 2	10	15
VIII (a)	<p>When a cylindrical vessel is subjected to internal fluid pressure, two types of tensile stresses are acts.</p> <ol style="list-style-type: none"> <li>1. Longitudinal stress- acts along the axis of the cylinder Let , p= internal pressure of fluid, d= dia of cylinder t= thickness of cylinder <math>\sigma_t</math>= longitudinal stress Force due to fluid pressure = Resisting force i.e. <math>p \times (\pi/4) \times d^2 = \sigma_t \times \pi dt</math> or <math>\sigma_t = pd/4t</math></li> <li>2. Circumferential or hoop stress- acts along the circumference and perpendicular to the axis. <math>pdl = 2 \times \sigma_h \times l</math> or <math>\sigma_h = pd/2t</math></li> </ol>	2.5 x 2	5	

<p>(b)</p>	<p> <math>P = 200 \text{ kW} = 20000 \text{ W}</math>  <math>N = 100 \text{ rpm}</math>  <math>\tau = 60 \text{ MPa} = 60 \text{ N/mm}^2</math>  <math>d = 0.5 D</math>                      or <math>k = 0.5</math>                      Using relation  <math>P = 2\pi NT/60</math>                      Or <math>T = 60P/(2\pi N)</math>  <math>= (60 \times 20000)/(2\pi \times 100)</math>  <math>= 1909.86 \text{ N-m}</math>  <math>= 1909.86 \times 10^3 \text{ N-mm}</math>                      Also, <math>T = (\pi/16) \tau \times D^3 (1-k^4)</math>                      Or <math>D^3 = 16T/(\pi \tau (1-k^4))</math>  <math>= (16 \times 1909.86 \times 10^3)/(\pi \times 60 \times (1-0.5^4))</math>  <math>= 172921.54 \text{ mm}^3</math>    <math>D = 55.71 \text{ mm}</math> say <b>60mm</b>  <math>d = 30 \text{ mm}</math> </p>	<p>1</p> <p>3</p> <p>1</p> <p>3</p> <p>1</p> <p>1</p>	<p>10</p>	<p>15</p>
<p>IX (a)</p>	<p> <ul style="list-style-type: none"> <li> <b>Open Coiled Helical Springs</b>                              These types of helical springs are referred as compression springs, as they strongly resist compression. These springs have a high pitch, which creates a large space between the coils. These large spaces give a distinct identity to these springs. Also, one can see that turns of the springs lie at inclined angles towards the helical axis. The different types of open coiled helical springs are barrel springs, barbell springs, and conical springs.                         </li> <li> <b>Closed Coiled Helical Springs</b>                              These helical spring variants are also known as extension/tension springs, and are clearly distinguishable due to hook or an eye at its ends. The closed coiled helical springs are designed to resist twisting, as well as stretching. Hence, bending stress is always negligible, when compared with torsional stress. These springs have coils that are not only closely wound, but also lie on the same helical axis. The spring have turns that lie at 90 degrees to the helical axis.                         </li> </ul> </p>	<p>2.5 x 2</p>	<p>5</p>	<p>7</p>

<p>(b)</p>		<p>SF calculation &amp; diagram (4)</p> <p>BM calculation &amp; diagram (6)</p>	<p>10</p>	<p>15</p>
<p>X(a)</p>	<ol style="list-style-type: none"> <li>1. The material of the column is homogeneous and isotropic.</li> <li>2. The compressive load on the column is axial only.</li> <li>3. The column is free from initial stress.</li> <li>4. The weight of the column is neglected.</li> <li>5. The column is initially straight (no eccentricity of the axial load).</li> <li>6. Pin joints are friction-less (no moment constraint) and fixed ends are rigid (no rotation deflection).</li> <li>7. The cross-section of the column is uniform throughout its length.</li> <li>8. The direct stress is very small as compared to the bending stress The length of the column is very large as compared to the cross-sectional dimensions of the column.</li> <li>9. The column fails only by buckling. This is true if the compressive stress in the column does not exceed the yield strength</li> <li>10. The column fails only by buckling. This is true if the compressive stress in the column does not exceed the yield strength</li> </ol>	<p>Any 5</p> <p>1 X 5</p>	<p>5</p>	
<p>(b)</p>	<p><math>l = 5 \text{ m} = 5000 \text{ mm}</math></p> <p><math>b = 120 \text{ mm}</math></p> <p><math>d = 200 \text{ mm}</math></p> <p><math>W = 70 \text{ kN} = 70 \times 10^3 \text{ N}</math></p> <p><math>E = 2.1 \times 10^5 \text{ N/mm}^2</math></p>			

	<p>Moment of inertia <math>I = \frac{bd^3}{12} = \frac{120 \times 200^3}{12}</math>  <math>= 80 \times 10^6 \text{ mm}^4</math></p> <p>Deflection, <math>y = \frac{Wl^3}{48EI}</math>  <math>= \frac{(70 \times 10^3 \times 5000^3)}{(48 \times 2.1 \times 10^5 \times 80 \times 10^6)}</math>  <math>= 10.85 \text{ mm}</math></p> <p>Slope at the supports <math>= \theta_{\text{left}} = \theta_{\text{right}} = \frac{Wl^2}{16EI} \text{ rad}</math>  <math>= \frac{(70 \times 10^3 \times 5000^2)}{(16 \times 2.1 \times 10^5 \times 80 \times 10^6)}</math>  <math>= 0.00651 \text{ rad}</math>  <math>= 0.00651 \times 180/\pi \text{ degrees}</math>  <math>= 0.373^\circ</math></p>	2	7	
		4	10	15
		4		