Tutorials for

Structural Analysis – I

(3140603)

B.E. Semester - 4

(Civil Engineering)

Shantilal Shah Engineering College, Bhavnagar

Directorate of Technical Education
Gandhinagar, Gujarat

Shantilal Shah Engineering College, Bhavnagar

Certificate

This is to certify that Mr./Ms. ______________________________________ Enrollment No. _________________ of B.E. Semester 4th Civil Engineering of this institute (GTU Code: 043) has satisfactorily completed the tutorial work for the subject Structural Analysis – I (3140603) for the academic year ______________________.

Place: Bhavnagar

Date: ___________

Name and Sign of Faculty member

Head of the Department

Name of Student :

Enrollment Number :

Name of Subject : Structural Analysis – I

Subject Code : 3140603

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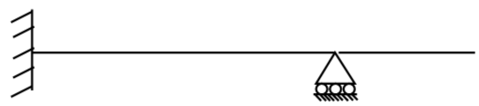
Assignment No:	**01**	**Unit:1 - Fundamental of Statically Determinate Structures**
Date:	**05/02/2024**	
Sub Code	**3140603**	**Title of Subject**: **STRUCTURAL ANALYSIS - I**

#	Questions
	Basics
1	Describe with illustrations types of statically determinate and indeterminate structures.
2	Define SI & KI.
3	Write Maxwell's reciprocal theorem and Principle of superposition.
4	Find static and kinematic indeterminacy for the structures shown below. Also comment about stability.

Figure – 1 (a)



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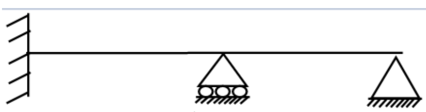

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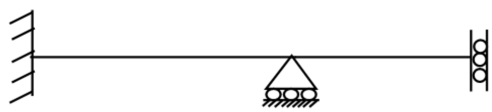

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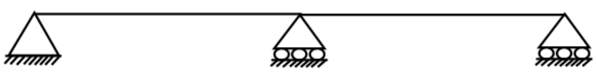

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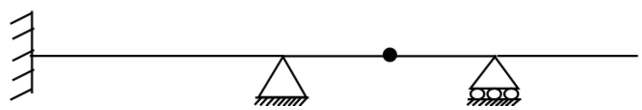

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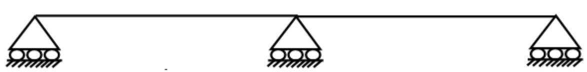

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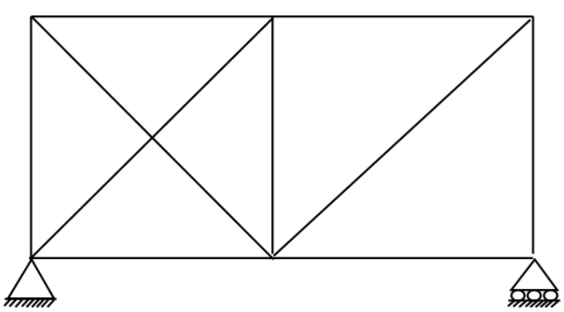

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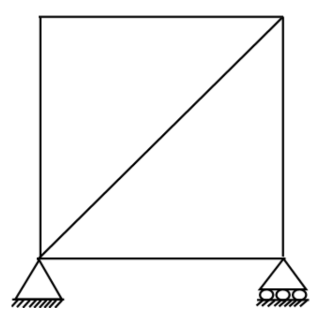

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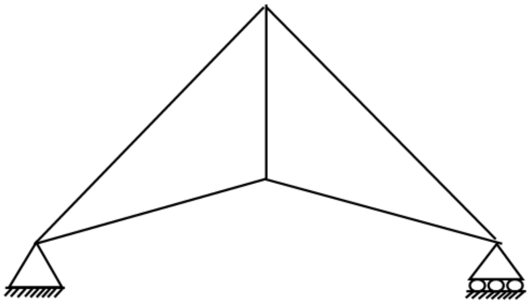

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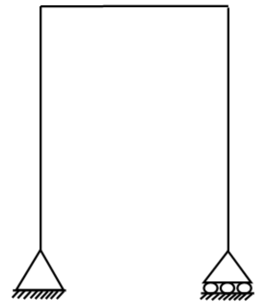

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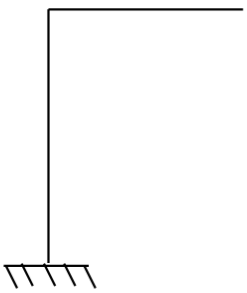

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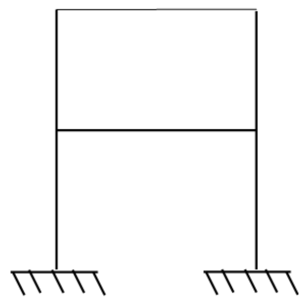

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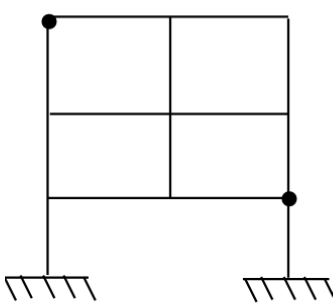

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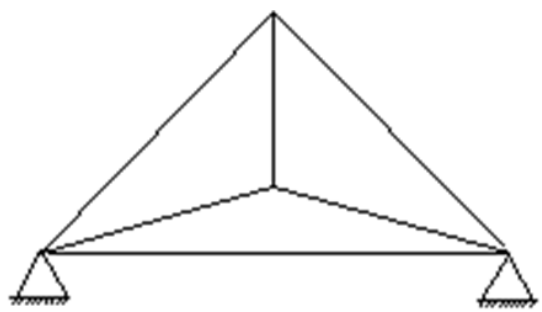
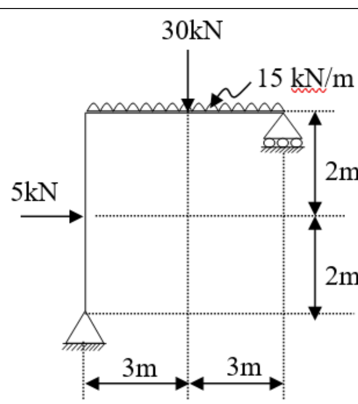
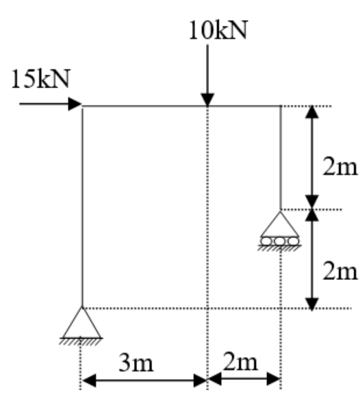
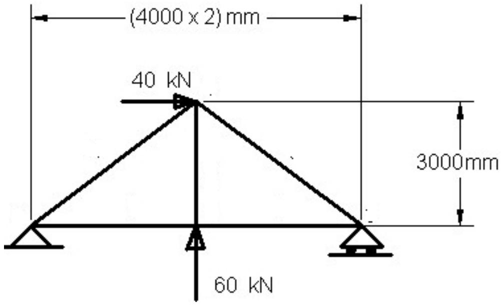
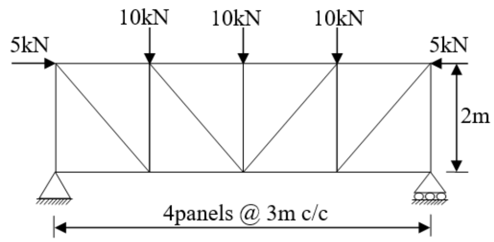
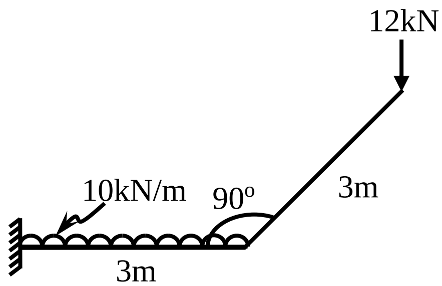
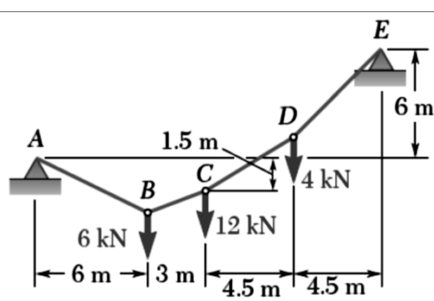
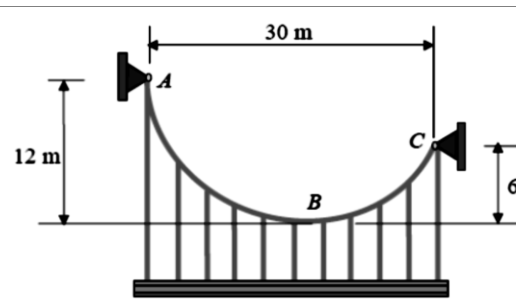


Figure – 1 (r)

Framed Structures	
5	Draw shear force diagram, bending moment and axial force diagram for the following structures:





6	Analyse the trusses given below by the analytical methods.
	 
7	Analyze the grid shown in figure below and draw shear force, bending moment & twisting moment diagrams.
	
	Arches & Cables
8	A three-hinged parabolic arch of 100 feet span with a central rise of 20 feet, carries loads of 20 and 30 tons at horizontal distances of 30 and 40 feet respectively from the ends. Calculate the B.M., normal thrust and shear force at each quarter-point.
9	For a three hinged parabolic arch having rise of 6m, span of 40m and loaded by a point load of 250 kN at 10m from left support and an UDL of 20kN/m over right half. Calculate the maximum B.M. in both the halves. Also calculate the bending moment, shear force and normal thrust at 15m from left support.
10	The cable AE supports three vertical loads from the points indicated. If point C is 1.5 m below the left support, determine (a) the elevation of points B and D, and (b) the maximum slope and maximum tension in the cable.
	 

Thin cylinder	
11	A cylindrical pipe of diameter 1.5m and thickness 15mm is subjected to an internal fluid pressure of 1.2 N/mm^2. Determine longitudinal stress and circumferential stress developed in the pipe.
12	A thin cylinder of internal diameter 1.25m contains a fluid at an internal pressure of $2N/mm^2$. Determine the maximum thickness of the cylinder if: (i) the longitudinal stress is not to exceed $30N/mm^2$ (ii) the circumferential stress is not to exceed 45 N/mm^2.

Assignment No:	**02**	**Unit:2 – Strain Energy & Displacement of Statically Determinate Structures**	
Date:	**05/02/2024**		
Sub Code	**3140603**	**Title of Subject**	**STRUCTURAL ANALYSIS - I**

#	Questions
	Strain Energy
1	Define: Resilience, Proof resilience and Modulus of resilience.
2	Find an expression for the strain energy stored in a body when (i) The load is applied with impact (ii) The load causes bending
3	A steel rod is 3.00 m long and 50 mm in diameter. An axial pull of 100 kN is applied to the rod. Calculate (i) Stretch in the rod, (ii) Stress in the rod, (iii) Strain energy absorbed by the rod. If 80 kN load is suddenly applied, determine (i) Instantaneous stress induced, (ii) Instantaneous elongation produced in the rod, (iii) Strain energy absorbed by the rod. Take E = 200 GN/m^2.
4	A uniform metal bar has a cross-sectional area of 700 mm^2 and a length of 1.5 m. If the stress at the elastic limit is 160 N/mm^2, what will be its proof resilience? Determine also the maximum value of an applied load, which may be suddenly applied without exceeding the elastic limit. Calculate the value of the gradually applied load which will produce the same extension as that produced by the suddenly applied load above. Take E = 2 X 10^5 N/mm^2.
5	A weight of 15 kN falls by 30 mm on a collar rigidly attached to lower end of a vertical bar 4.00 m long and 1000 mm^2 in section. The upper end of the vertical bar is fixed. Find the instantaneous expansion, stress and energy absorbed by the bar. Find also impact factor. Take E = 200 GPa.
6	Find the strain energy in a simply supported beam of "L" m length, carrying uniformly distributed load "w" kN/m run. Assume uniform flexural rigidity.
7	Find the strain energy of cantilever beam of 3.00 m length, carrying point load of 50 kN at free end. Take E = 2 X 10^5 N/mm^2, I = 4 X 10^6 mm^4.
8	A tension bar is made up of 5.00 m long is made up of two parts, 3.00 m of its length has a cross sectional area of 10 cm^2 while remaining 2.00 m has cross sectional area of 20 cm^2. An axial load of 80 kN is gradually applied. Find the total strain energy produced in the bar and compare this value that obtained in a uniform bar of the same length and having same volume when under the same load. Take E = 2 X 10^5 N/mm^2.

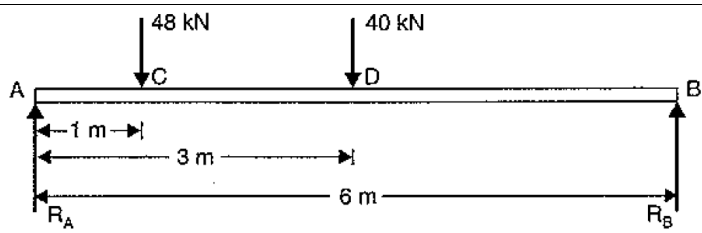
Displacement of Determinate Beams

1 Obtain the differential equation given below for the deflection curve of a beam stating clearly assumptions made in deriving it. $\frac{d^2y}{dx^2} = \pm \frac{M}{EI}$

2 State and explain moment area theorems with neat sketches.

3 What is conjugate beam? Differentiate between real beam and conjugate beam. Justify the support condition in conjugate beam.

4 Find out the quantities asked by using Macaulay's method for the beams shown in figure 1 to 4. E = 200 kN/mm^2 and I = 3 X 10^8 mm^4



θ_C, y_D, y_{max}

Figure - 1

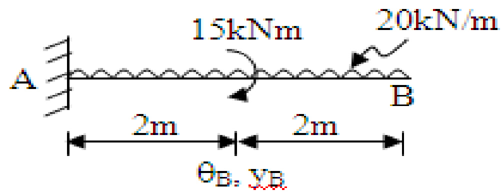


Figure - 2

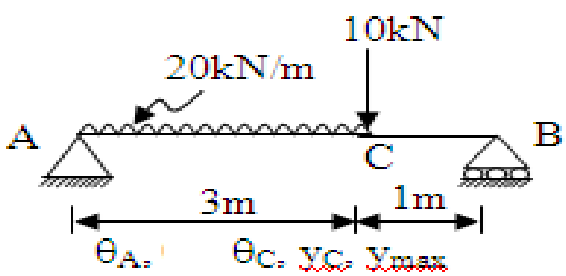


Figure – 3

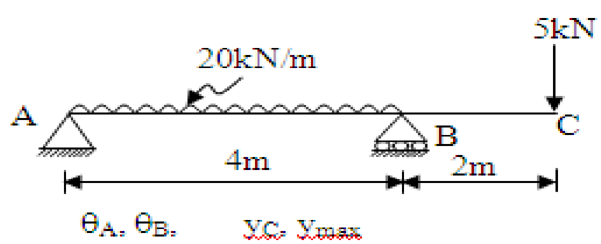


Figure – 4

5 Find out the quantities asked by using Moment area method for the beams shown in figure – 5 to 8. E = 200 kN/mm^2 and I = 3 X 10^8 mm^4.

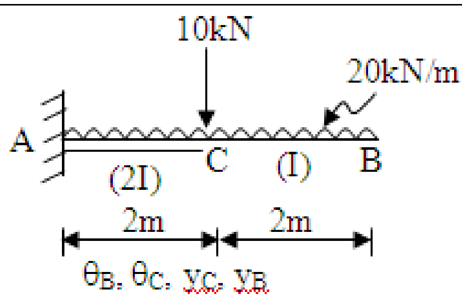


Figure - 5

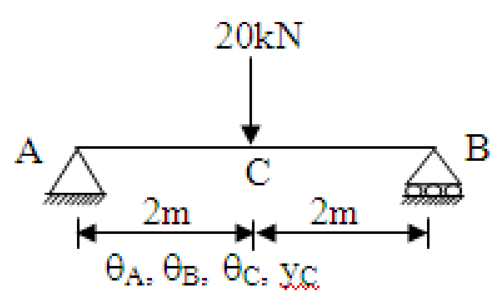


Figure - 6

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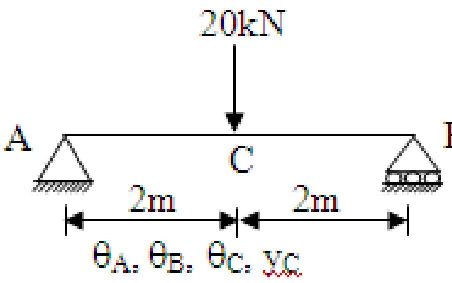

Figure – 7

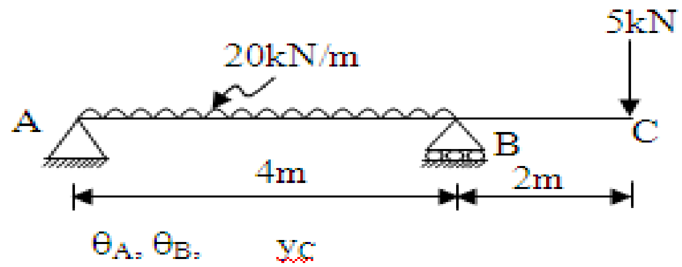

Figure – 8
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<tr>
<td>6</td>
<td>Find out the quantities asked by using Conjugate beam method for the beams shown in figure – 9 to 12. E = 200 kN/mm^2 and I = 3 X 10^8 mm^4.</td>
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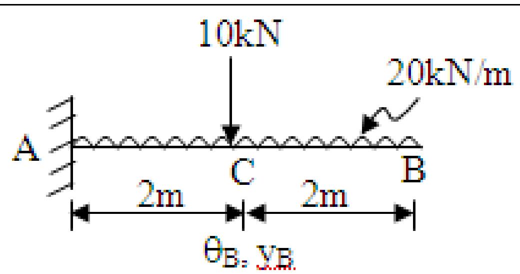

Figure - 9

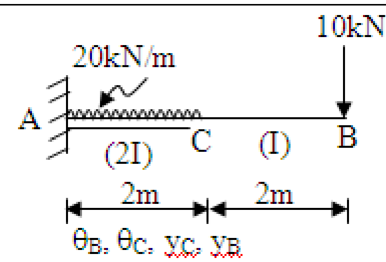

Figure - 10

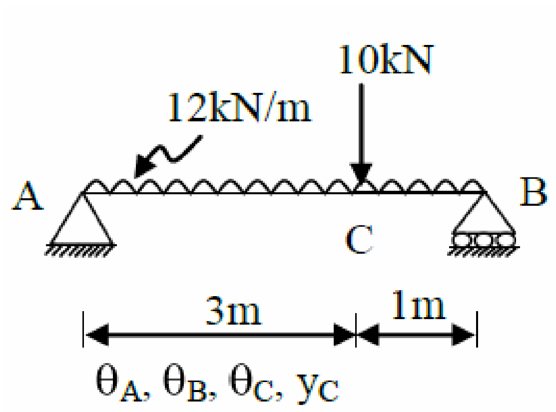

Figure – 11

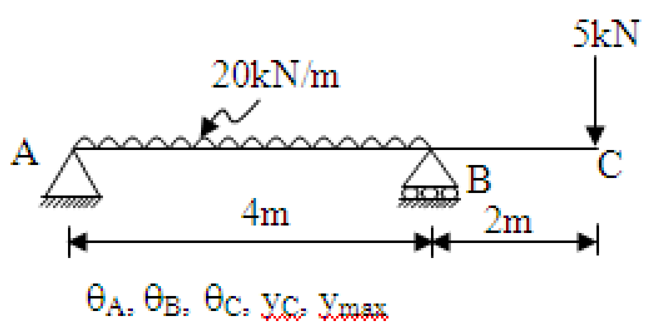

Figure – 12
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<td>7</td>
<td>Find the deflection at the free end of cantilever of span "l" subjected to point load "P" at free end by equating strain energy to work done.</td>
</tr>
<tr>
<td>8</td>
<td>Find the deflection under the load in simply supported beam of span 4.00 m subjected to eccentric point load of 40 kN at 1.00 m from end "A" by equating strain energy to work done.</td>
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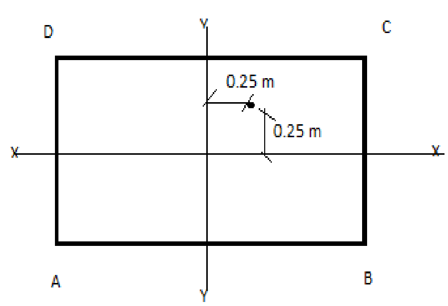
Assignment No:	03	Unit:3 – Direct and Bending Stresses + Column & Struts	
Date:	05/02/2024		
Sub Code	3140603	Title of Subject	STRUCTURAL ANALYSIS - I

#	Questions
	Direct and Bending Stresses
1	Distinguish between direct and bending stress.
2	Obtain a relation for the maximum and minimum stresses at the base of a symmetrical column when it is subjected to **a)** An eccentric load about one axis, **b)** An eccentric load about two axis.
3	Explain kernel of a section. Show that for no tension at the base of a short column, the line of action of the load should be within the middle third.
4	Draw a neat sketches of Kernel of following cross-section: a) Rectangular 200 mm X 300 mm b) Hollow circular cylinder with external diameter = 300 mm, thickness = 50 mm c) Square with 600 cm^2 area
5	A hollow rectangular column is having external and internal dimensions as 120 cm deep X 80 cm wide and 90 cm deep X 50 cm wide respectively. A vertical load of 200 kN is transmitted in the vertical plane bisecting 120 cm side and at an eccentricity of 10 cm from the geometric axis of the section. Calculate the maximum and minimum stresses in the section.
6	A rectangular pier of 1.50 m X 1.00 m is subjected to a compressive load of 450 kN with as shown in figure. Find the stress on all four corners of the pier. 
7	A masonry dam of rectangular cross-section 12.00 m high and 5.00 m wide has water up-to the top on its one side. If the density of masonry is 2300 kg/m^3, find a) Pressure force due to water per meter length of dam, b) Resultant force and the point at which it cuts the base of dam

	c) The maximum and minimum stress intensities at the base of the dam
8	A trapezoidal masonry dam is of 20.00 m height. The dam is having water up-to a depth of 16.00 m on its vertical side. The top and bottom width of the dam are 3.00 m and 9.00 m respectively. The density of the masonry is given as 2000 kg/m^2. Determine a) The resultant force on the dam per meter length b) The point where the resultant cuts the base c) The maximum and minimum stress intensities at the base
Columns and Struts	
1	A strut 2.50 m long is 60 mm in diameter. One end of the strut is fixed while its other end is hinged. Find the compressive load for the member using Euler's formula, allowing a factor of safety of 3.5. Take E = 2.10 X 10^5 N/mm^2.
2	Calculate the critical load for a strut which is made of a bar circular in section and 5.00 m long and which is pin jointed ant both ends. The same bar when freely supported gives a mid span deflection of 10 mm under a load of 80 N at the centre.
3	A steel column of "I" section ISHB 300 is used as a column 4.00 m long with both ends hinged. Determine Euler's critical load for the column. If the section is strengthened by a cover plate of 310 mm X 8 mm for each flange. What would be Euler's critical load? Take for the "I" section area = 7485 mm^2, I_{xx} = 1.2545 X 10^8 mm^4, I_{yy} = 2.1936 X 10^7 mm^4, modulus of elasticity E = 2 X 10^5 N/mm^2.
4	A steel bar of rectangular section 30 mm X 40 mm pinned at each end is subjected to axial compression. The bar is 1.75 m long. Determine the buckling load and the corresponding axial stress using Euler's formula.
5	A round steel rod of diameter 15 mm and length 2.00 m is subjected to a gradually increasing axial compressive load. Using Euler's formula, find the buckling load. Find also the maximum lateral deflection corresponding to the buckling condition. Both ends of the rod maybe taken as hinged. Take E = 2.1 X 10^5 N/mm^2 and the yield stress of steel = 250 N/mm^2.
6	A hollow cast iron column 5.00 m long is fixed at both ends and has an external diameter of 300 mm. The column supports an axial load of 1200 kN. Find the internal diameter of the column, adopting a factor of safety of 5. Take f_c = 550 N/mm^2 and α = 1/1600. E = 200 GPa.

SHANTILAL SHAH ENGINEERING COLLEGE, BHAVNAGAR
APPLIED MECHANICS DEPARTMENT

Assignment No:	**04**	**Unit:4 Statically Indeterminate Beams**	
Date:	**05/02/2024**		
Sub Code	**3140603**	**Title of Subject**	**STRUCTURAL ANALYSIS - I**

<table>
<tr><th>#</th><th>Questions</th></tr>
<tr><td>1</td><td>Advantages and Disadvantages of Indeterminate Structures.</td></tr>
<tr><td>2</td><td>Find the fixed end moments if one of the supports of fixed beam settles by “δ” units.</td></tr>
<tr><td>3</td><td>A Fixed Beam of 7.00 m span carries a uniformly distributed load of 10 kN/m from left end for 3.00 m. Analyze the beam and draw Bending Moment Diagram (B.M.D.) showing important values.</td></tr>
<tr><td>4</td><td>Determine fixed end moments for the fixed beam loaded as shown in figure. Take EI = constant.</td></tr>
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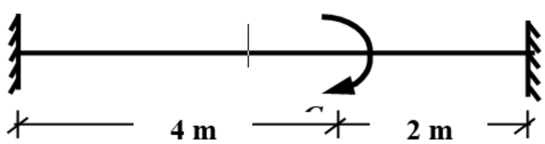

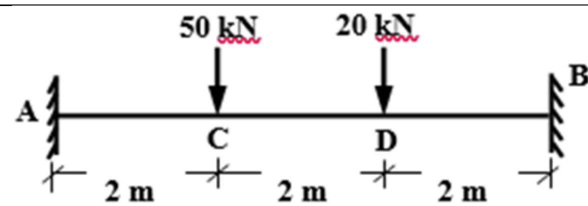

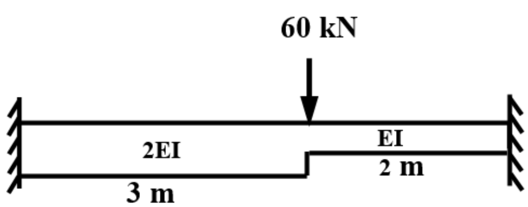

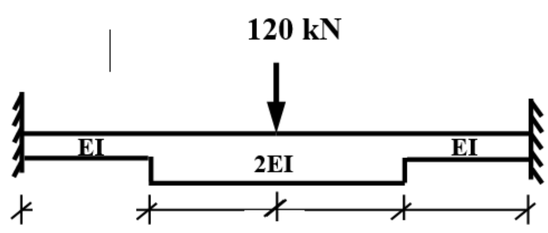

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<tr><td>5</td><td>Analyse a propped cantilever beam of span 6.00 m and subjected to a U.D.L. of 24 kN/m over entire span using consistent deformation method. Draw shear force and bending moment diagram.</td></tr>
<tr><td>6</td><td>Using the method of consistent deformation, analyze the following propped cantilever beams. Take E = 200 GPa & I = 80 X 10^6 mm^4.</td></tr>
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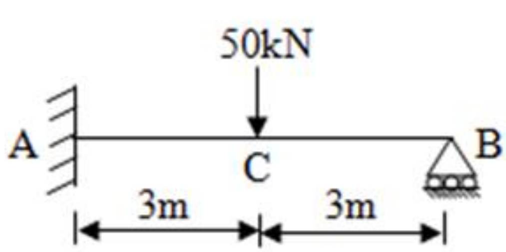

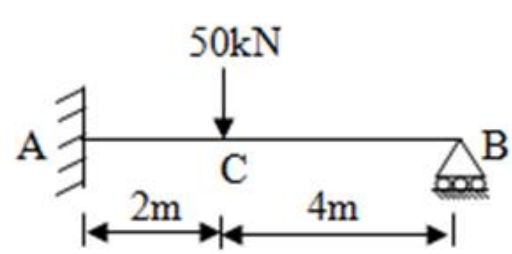

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	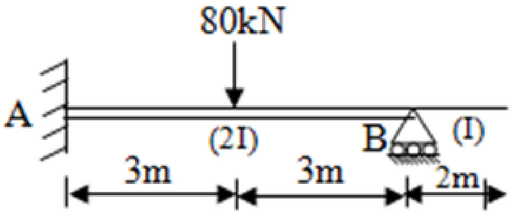 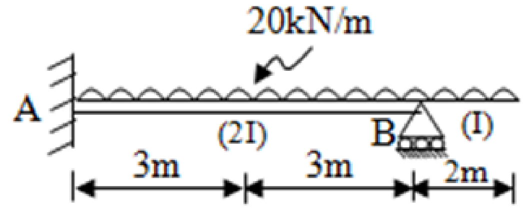
6	Using the moment distribution method, analyze the following continuous beams