BITS, Pilani –Dubai

Dubai International Academic City, Dubai, U.A.E

II Year I Semester 2010-2011

COMPREHENSIVE EXAM

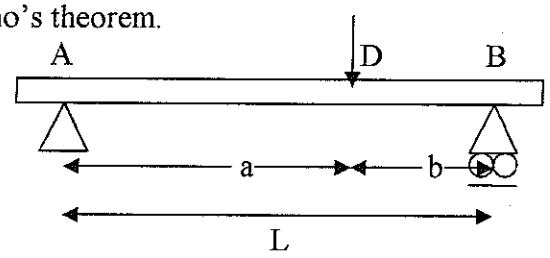
Course No.: ES C221; **Course Title:** Mechanics of solids

Date: 21.12.2010; **Weightage:** 40%; **Max. Marks:** 80

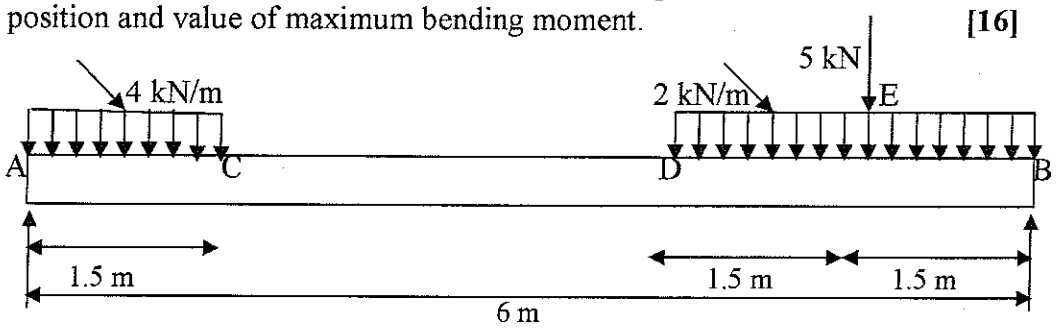
(All Questions are compulsory and should be attempted in order.)

SECTION A (BLUE ANSWERBOOK)

Q1. The simple beam shown in the figure supports a concentrated load P acting at distance a from the left-hand support and distance b from the right-hand support. Determine the deflection δ_D at point D where the load is applied. Obtain the solution by determining the strain energy of the beam and then using Castigliano's theorem. **[16]**



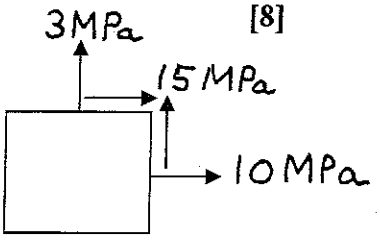
Q2. A simply supported beam AB 6 m long is loaded as shown in the figure. Construct the shear force and bending moment diagrams for the beam and find the position and value of maximum bending moment. **[16]**



Q3. **i)** Draw the Mohr's circle for the given strain state, $\varepsilon_x = 400\mu$, $\varepsilon_y = 100\mu$ and $\gamma_{xy} = 200\mu$. Find the values of ε_1, ε_2 and γ_{max} and θ_p. ***(Graph sheet is provided)*** **[8]**

ii) An element is subjected to normal and shear stresses as shown in the figure. Use the analytical method to find the following: **[8]**

a) the maximum principal stress σ_1
b) the minimum principal stress σ_2
c) the maximum shear stress τ_{max}
d) the angle θp

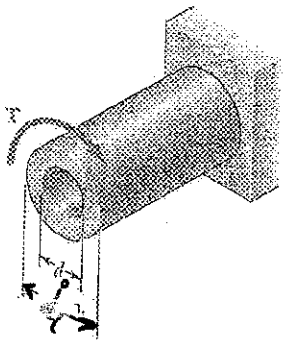


SECTION B (GREEN ANSWERBOOK)

Q4. **i)** An aluminum alloy yields in uniaxial tension at the stress $\sigma_o = 330$ MN/m^2. If this material is subjected to the following state of stress, will it yield according to (a) the Mises criterion, and (b) the maximum shear-stress criterion? **[10]**

$\sigma_x = 138$ MN/m^2 $\quad \tau_{xy} = 138$ MN/m^2
$\sigma_y = -69$ MN/m^2 $\quad \tau_{yz} = 0$
$\sigma_z = 0$ $\quad \tau_{zx} = 0$

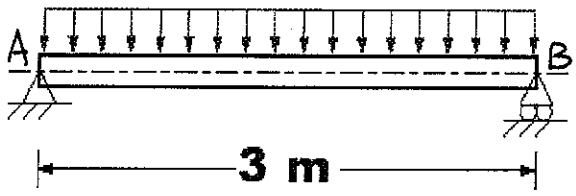
ii) Determine the (a) maximum shear stress, $\tau_{\theta z}$; (b) the angle of twist, φ, for the following tube. **[6]**

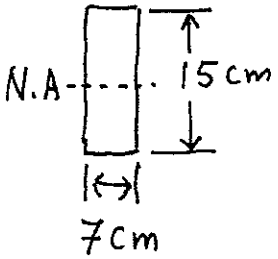


Specifications:
Inner diameter, d_o, = 3.86 cm
Length of the tube, L= 1.5m
Applied torque = 2238 Nm
Material (Steel), G= 75.2 G N/m^2

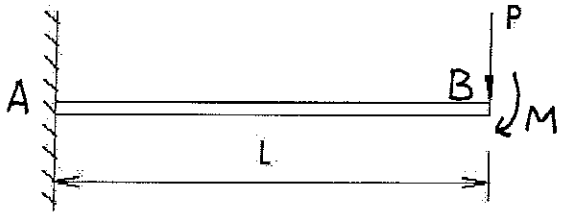
Outer diameter, $d_1 = 4.064$cm

Q5. **i)** A simply supported beam of length 3 m is loaded by a uniformly distributed load of 6 kNm^{-1}.The cross-section of the beam is rectangular, 7 cm x 15 cm as shown in the diagram. Determine the maximum bending stress in the beam, neglecting its weight. Also find the bending stress 2 cm below the upper surface of the beam at the section midway between the supports. **[8]**





ii) A uniform cantilever beam has bending modulus EI and length L. It is built in at A and subjected to a concentrated load P and moment M applied at B as shown in figure. Find the deflection and the slope angle. **[8]**



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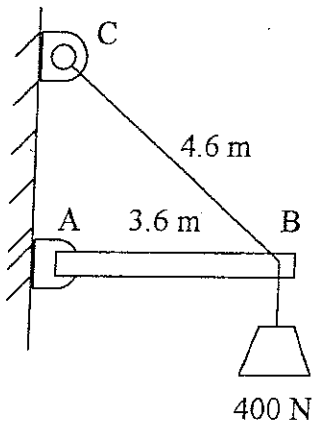
II Year I Semester 2010-2011

Test 2 (Open Book)

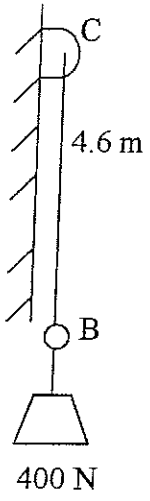
Course No.: ES C221; **Course Title:** Mechanics of solids

Date: 07.11.2010; **Weightage:** 20%; **Max. Marks:** 40

Q1. In a structure shown in a) the member AB is very rigid in comparison to BC. It is desired to estimate the vertical deflection at B when a load of 400 N is supported at B. It is known that when the 400 N is supported entirely by BC, as shown in b), the deflection at B is 23 mm. [8]



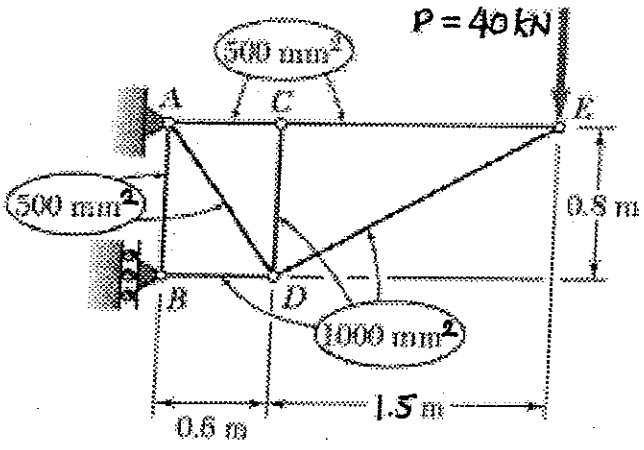
(a)



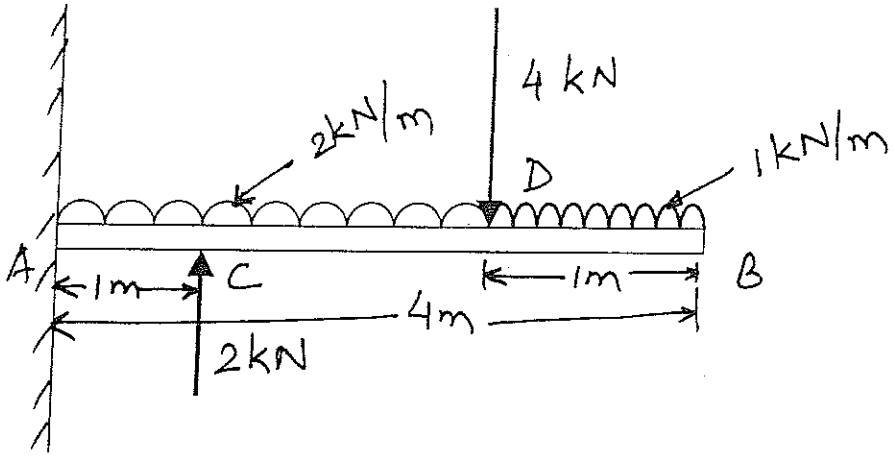
(b)

Q2. Members of the truss shown consist of sections of aluminum pipe with the cross-sectional areas indicated. Determine the vertical deflection of the joint C caused by the load P. [10]

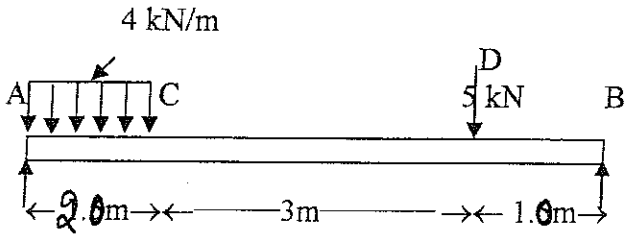
(take E = 73 GPa)



Q3. A cantilever beam, AB, of length 4 m is loaded uniformly distributed load of 2 kN/m for a distance of 3 m from A. And a uniformly distributed load of 1 kN/m for the remaining length of the beam. A point load of 4 kN is applied at a distance of 3 m from A, in the downward direction. And a point load, 2 kN, in upward direction is applied at a distance of 1 m from A. Draw S.F and B.M. Diagrams for the cantilever beam. [14]



Q4. A simply supported beam AB 6 m long is loaded as shown in figure. Construct the SF and BM diagrams for the beam and find the position and value of maximum bending moment. [8]



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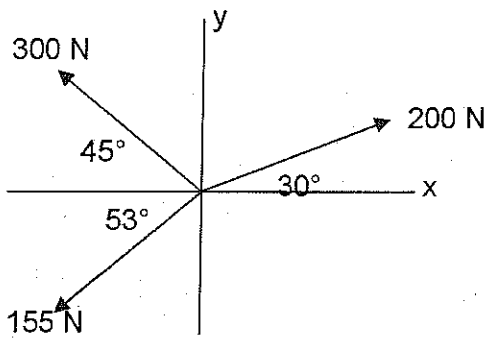
II Year I Semester 2010-2011

Test No.1 (Closed Book)

Course No.: ES C221 ; **Course Title:** Mechanics of solids

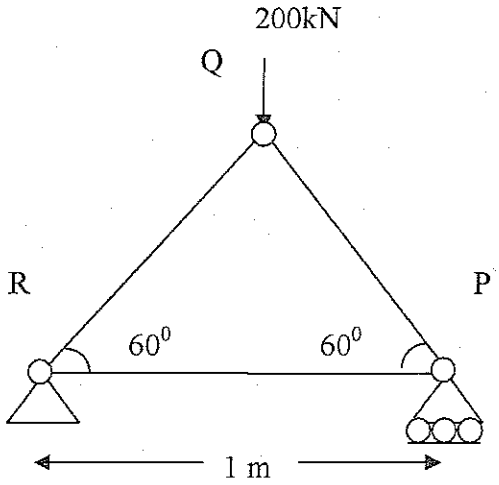
Date: 26.09.2010; **Weightage:** 25%; **Max. Marks:** 50

Q1. Three customers are fighting over the same bargain basement coat. They apply the three horizontal forces to the coat that are shown in the figure, where the coat is located at the origin. Find the x and y components of the net force on the coat, and find the magnitude and direction of the net force. **[8]**

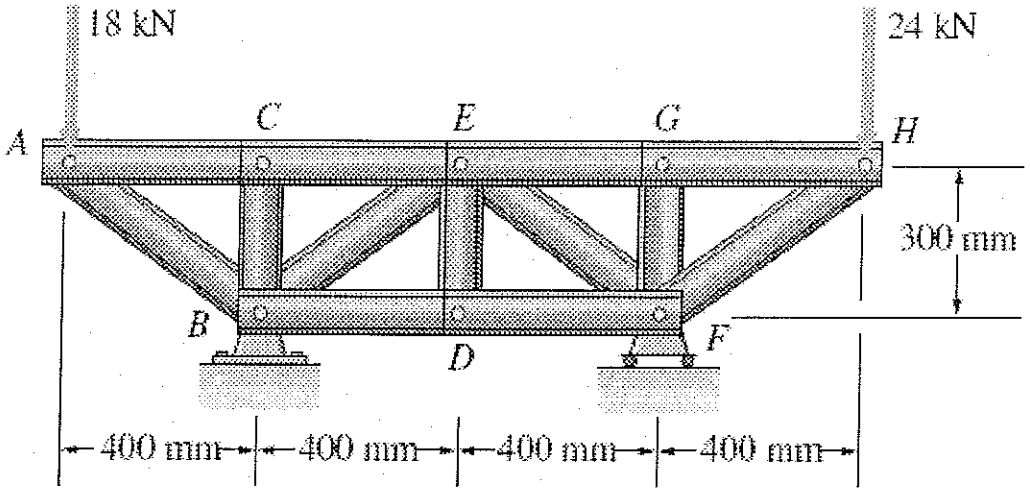


Q2. AB is a rod of length 3 m weighing 500 N. A force of 100 N acts at A and another force 450 N at B such that the rod can rotate in clock-wise direction about its centre of gravity. To keep the rod in equilibrium condition, find (a) the force required and (b) its distance from A. **[8]**

Q3. A steel truss is shown in Fig.1. Find forces in all the steel members and mention their nature (Tensile or compressive) **[12]**



Q4. The following truss supports loads at A and H. Calculate the Reaction forces at the fixed points B and F **[12]**



Q5. A delivery company has just unloaded a 500 N crate full of goods on the side walk in front of your house. You find that to get it started moving towards your front door, you have to pull with a horizontal force of magnitude 230 N. Once it starts to move, you can keep it moving at constant velocity with only 200 N. a) what are the coefficients of static and kinetic frictions? b) How much distance will you have moved the crate if a horizontal force of 50 N is applied to it when it is at rest? **[10]**

NAME:	ID. NO.

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II Year I Semester 2010-2011

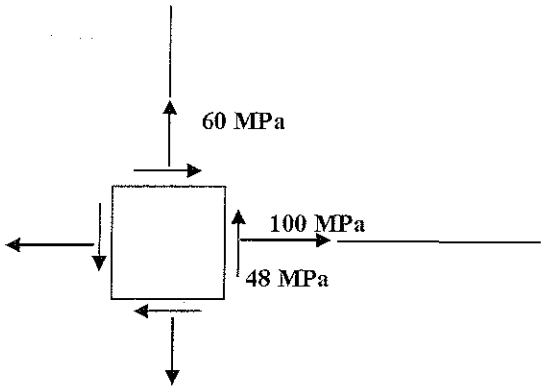
QUIZ II

Course No.: ES C221 ; **Course Title:** Mechanics of solids

Date: 30.11.2010; **Weightage:** 07%; **Max. Marks:** 14

Note: The graph sheet is provided on the reverse side of the paper

1. For the state of plane stress shown, Plot Mohr's circle to determine (a) the principal plane and principal stresses, (b) the stress component exerted on an element obtained by rotating the given element counterclockwise through 30°.



Ans: $\theta_p =$

$\sigma_1 =$

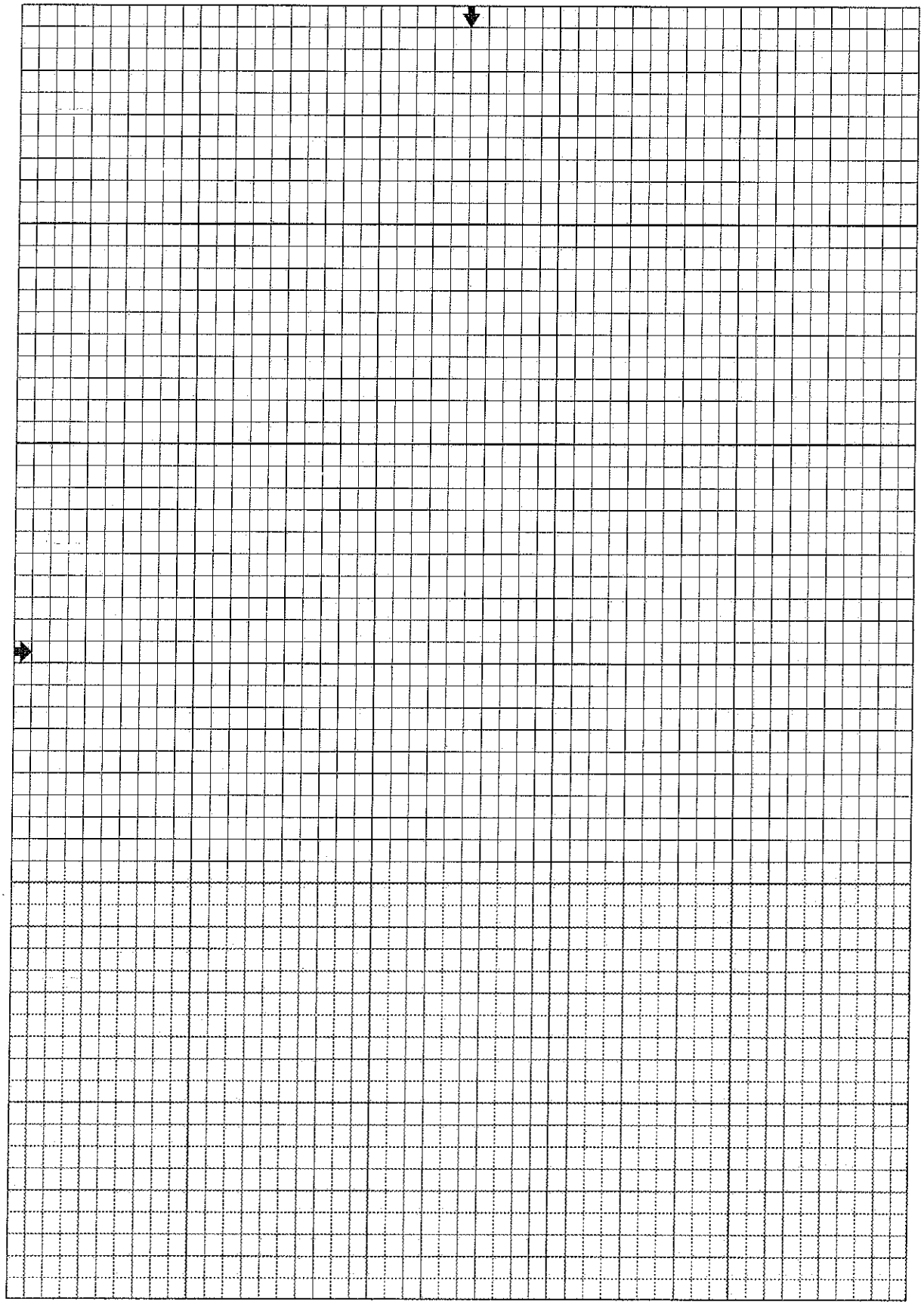
$\sigma_2 =$

$\tau_{max} =$

$\sigma_{x'} =$

$\sigma_{y'} =$

$\tau_{x'y'} =$



BITS, PILANI – DUBAI

2nd Year, First SEMESTER 2010 – 2011

QUIZ - 1

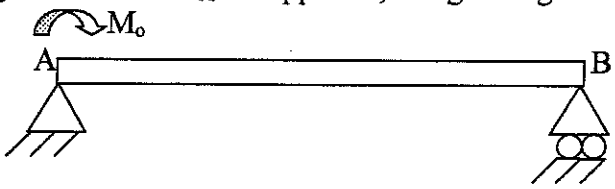
Course Code:	**ES C221**	Date:	**19.10.2011**
Course Title:	**Mechanics of Solids**	Maximum Marks:	**24**
Duration:	**20 minutes**	Weightage:	**8 %**

Name _____

ID No: _____ **Program:** _____ **Section** _____

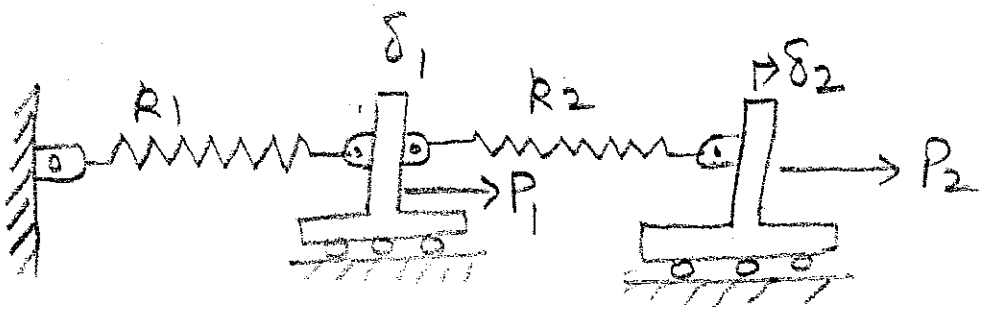
Instruction : ***Answer all the questions.***

1. A simple beam AB of length L is loaded at the left hand end by a couple of moment M_o (see diagram). If the strain energy on the beam is $\frac{M_o^2 L}{6EI}$, determine the angle of rotation θ_A at support A, using Castigliano's theorem. (6 marks)



2. Calculate the spring constant of a spring made of a bar of steel 10^3 mm^2 in area and 1 m long. The modulus of elasticity is 205 GN/m^2. (6 marks)

3. Consider a system of two springs as shown below. Use Castigliano's theorem to obtain the deflections δ_1 and δ_2 which are due to external loads P_1 and P_2 .To satisfy the equilibrium requirements the internal spring forces are $F_1 = P_1 + P_2$ and $F_2 = P_2$. (6 marks)



4. A square reinforced concrete pier 0.3 m x 0.3 m in cross-section and 1.5 m high is having a load of 700 kN on the top square surface parallel to the vertical axis of structure. The concrete is strengthened by the addition of six 30mm x 30 mm square steel reinforcing bars placed symmetrically about the vertical axis of the pier. Find the deflection produced.
(Take $E_{concrete}$= 17 GPa and E_{steel} = 205 GPa) (6 marks)