BITS - PILANI DUBAI CAMPUS

DUBAI INTERNATIONAL ACADEMIC CITY, DUBAI, UAE

First Semester : 2011-2012

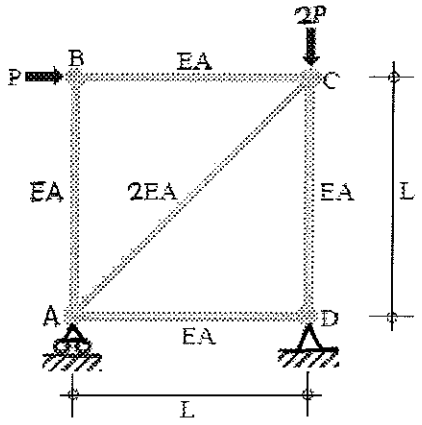
COMPREHENSIVE EXAMINATION (Closed book)

Year : II	Date : 09.01.2012	
Course No. : ES C221	Course Title : Mechanics of Solids	
Duration : 3 hours.	Marks: 120	Weightage : 40%

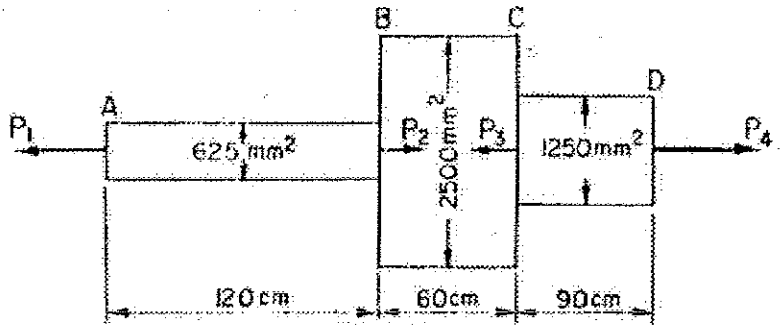
Note: (i) Answer all the questions.
(ii) Answer Part A, Part B and Part C in different answer books.

PART A

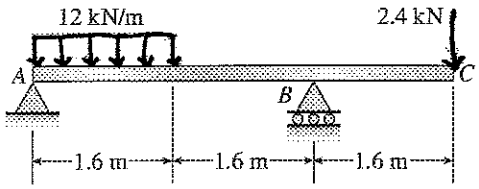
1. Consider a statically determinate truss subjected to nodal loads as shown below. The cross sectional area A, and the Young modulus E, of each member are indicated in the figure. Determine the vertical displacement at a point C using Castigliano's theorem. **[15 M]**



2. A member ABCD is subjected to point loads P_1, P_2, P_3 and P_4 as shown in the figure below. Calculate the force P_2 necessary for equilibrium, if P_1 = 45 kN, P_3 = 450 kN and P_4 = 130 kN. Determine the total elongation of the member, assuming the modulus of elasticity to be 2.1×10^5 N/mm. **[15 M]**

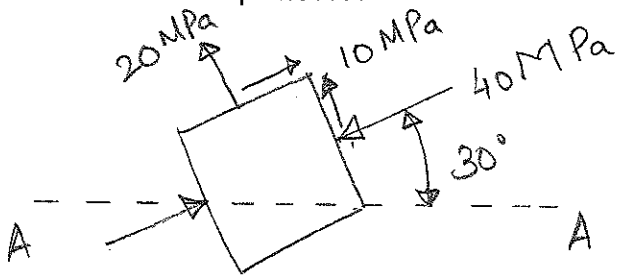


3. The beam *ABC* has simple supports at *A* and *B* and loaded as shown in the diagram. Calculate and draw the shear-force and bending-moment diagrams for this beam. **[15 M]**



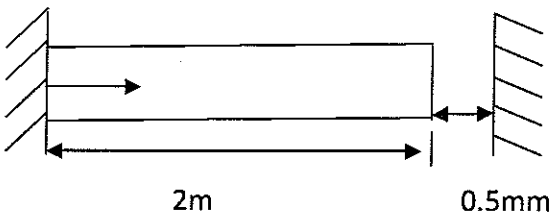
4. For the element shown below, and using Mohr's Circle Method, Determine the following:

a) The magnitude of the principal stress.
b) The direction of principal stress.
c) Stresses on the horizontal plane A-A **[15 M]**

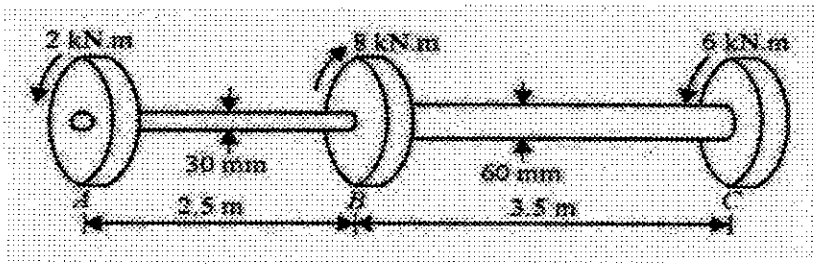


PART B

5. A circular bar (E=200GPa, v= 0.32 and α= 11.7μ/°C) has a diameter of 100mm.The bar is built into a rigid wall on the left and a gap of 0.5mm exists between the right wall and the bar prior to an increase in temperature as shown in the figure. The temperature of the bar is increased uniformly by 80°C. Determine the average axial stress and the change in the diameter of the bar. **[15 M]**



6. Find the angle of twist between A and B and between A and C for the arrangement of shafts and pulleys shown in the figure. Take G=78GPa. **[15 M]**



PART C

7. A simply supported beam, as shown below, is subjected to a uniformly distributed load of 29 kNm^{-1}. The length of the beam is 7.5m. The cross-section has an 'I' shape with the dimensions mentioned in the figure. If the elastic modulus of the material is 210 GPa, estimate the following.

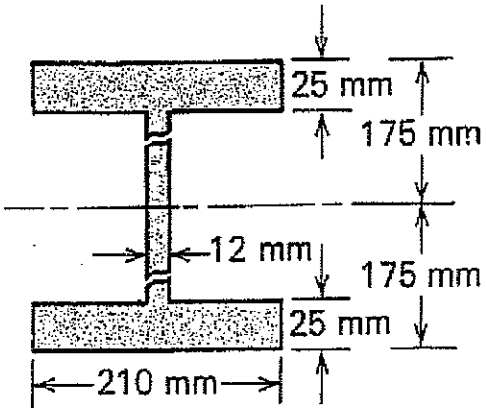
(a) The position of the centroid hence the polar moment of inertia of the given frame of section about its centroid axis. **[8M]**

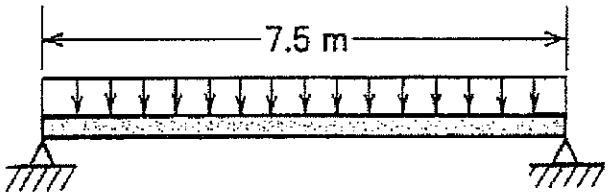
(b) The maximum bending stress. **[5M]**

(c) The radius of curvature and the curvature. **[5M]**

(d) The equation for the slope angle at the supports and its value. **[6M]**

(e) The expression for deflection produced and its maximum value. **[6M]**





BITS PILANI, DUBAI CAMPUS

FIRST SEMESTER 2011- 2012

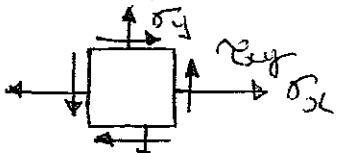
II YEAR I SEMESTER

Course Code: ES C221 **Date:** 11.12.2011

Course Title: Mechanics of Solids **Max Marks:** 60

Duration: 50 minutes **Weightage:** 20%

Q1. For the state of stress shown, it is given that the normal and the shearing stress are directed as shown and that σ_x = 100 MPa, σ_y = 60 MPa and σ_{min} = 35 MPa. Determine a) the orientation of the Principal planes, b) the Principal stress σ_{max}, c) the maximum in-plane shearing stress. **[15]**



Q2. For a particular point on the oil tank, the local strains where found to be -800 x10^{-6} and 400 x10^{-6} in the horizontal (x) and vertical (y) directions, respectively. The shear strain was found to be 400x 10^{-6}. Construct a Mohr's circle for the strain and find **[15]**

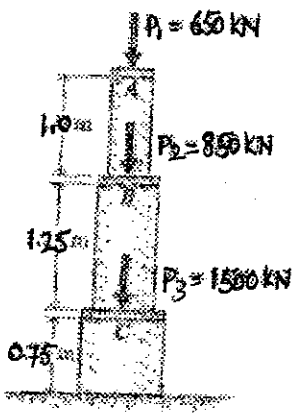
a) principal direction and principal strains,
b) maximum shear strain direction and the maximum shear strain, and
c) the strain state if the element is rotated 30° (counter-clockwise).

Q3. The tensile yield strength of a material is 400 MPa. The material is subjected to a balanced biaxial compression (σ= –150 MPa) along the two axes orthogonal to the tensile axis. **[15]**

a) Determine the value of the tensile stress necessary to cause yielding according to Maximum shear stress criterion (Tresca's criterion).
b) How does this stress value compare to that predicted by von Mises' criterion?

Q4. A 10 m section of steel [Elastic modulus = 210 GPa and Coefficient of linear expansion = 11.9x10^{-6} $^0C^{-1}$] rail has a cross sectional area of 7500 mm^2. Both ends of the rail are tight against adjacent rails that, for this problem, can be assumed to be rigid. The rail is supported against lateral movement. For an increase in temperature of 50°C, determine (a) the normal stress in the rail and (b) the internal force on a cross-section of the rail. **[3+2]**

Q5. The compression member shown in the figure consists of a solid aluminum bar A, which has an outside diameter of 100 mm; a brass tube B, which has an outside diameter of 150 mm and an inside diameter of 100 mm and a steel pipe C, which has on outside diameter of 200 mm and an inside diameter of 125 mm. The moduli of elasticity of aluminum, brass and steel are 73, 100 and 210 GPa respectively. Determine the overall shortening of the member under the action of the indicated loads. **[10]**



BITS PILANI, DUBAI CAMPUS

FIRST SEMESTER 2011- 2012

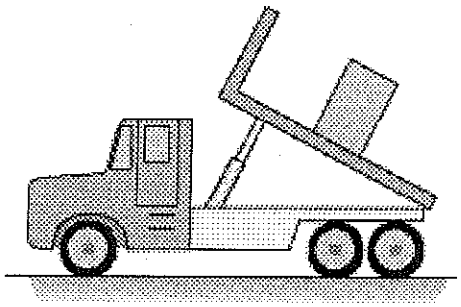
II YEAR I SEMESTER

Course Code: ES C221 **Date:** 16.10.2011

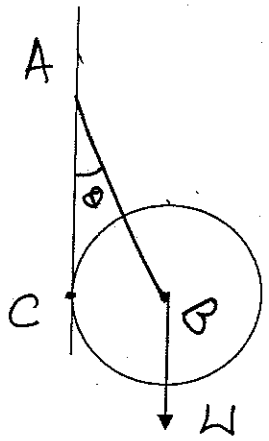
Course Title: Mechanics of Solids **Max Marks:** 25

Duration: 50 minutes **Weightage:** 25%

Q 1. It is observed that when a flat bed of the dump truck is raised to an angle of 22.5°, a box that was loaded on the bed begins to slide. Determine the static coefficient of friction between box and the surface of bed of dump truck. . The box is 6 feet high and 4 feet wide and its center of gravity is at its center. [5]



Q 2. A circular roller of weight 100 N and radius 10 cm hangs by a tie rod AB = 20 cm and rests against a smooth vertical wall at C as shown in the figure. Determine: i) the force F in the rod and ii) the reaction R_c at point C [5]



Q 3. The rigid bar BDE is supported by two links AB and CD. Link AB is made of Aluminium (E = 70 GPa) and has a cross-sectional area of 500 mm^2. Link CD is made of steel (E = 200 G Pa) and has a cross-sectional area of 600 mm^2. For the 30 kN load shown, Determine

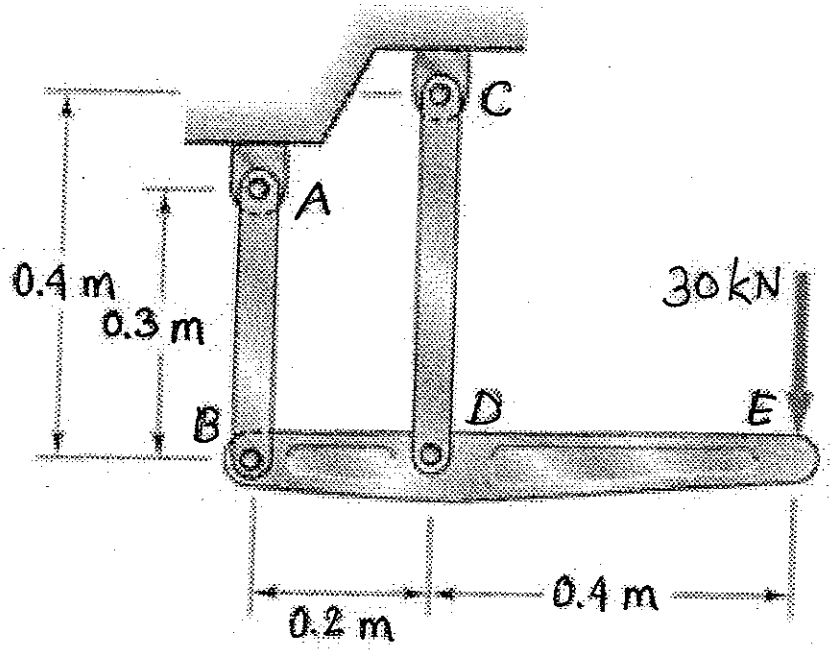
A) The forces in the members AB and CD [5]

B) The deflections [10]

i) of B

ii) of D and

iii) of E



NAME:

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A

BITS PILANI, DUBAI CAMPUS

FIRST SEMESTER 2011- 2012

II YEAR

QUIZ II

Course Code: ES C221

Course Title: Mechanics of Solids

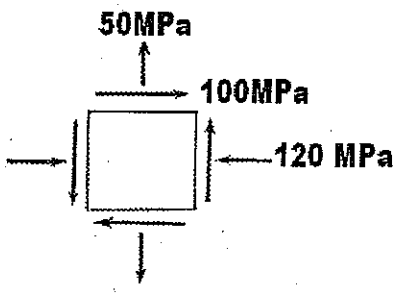
Duration: 20 minutes

Date: 29.11.2011

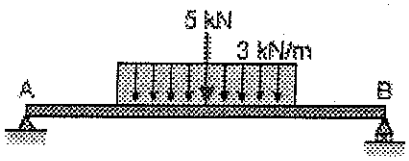
Max Marks: 21

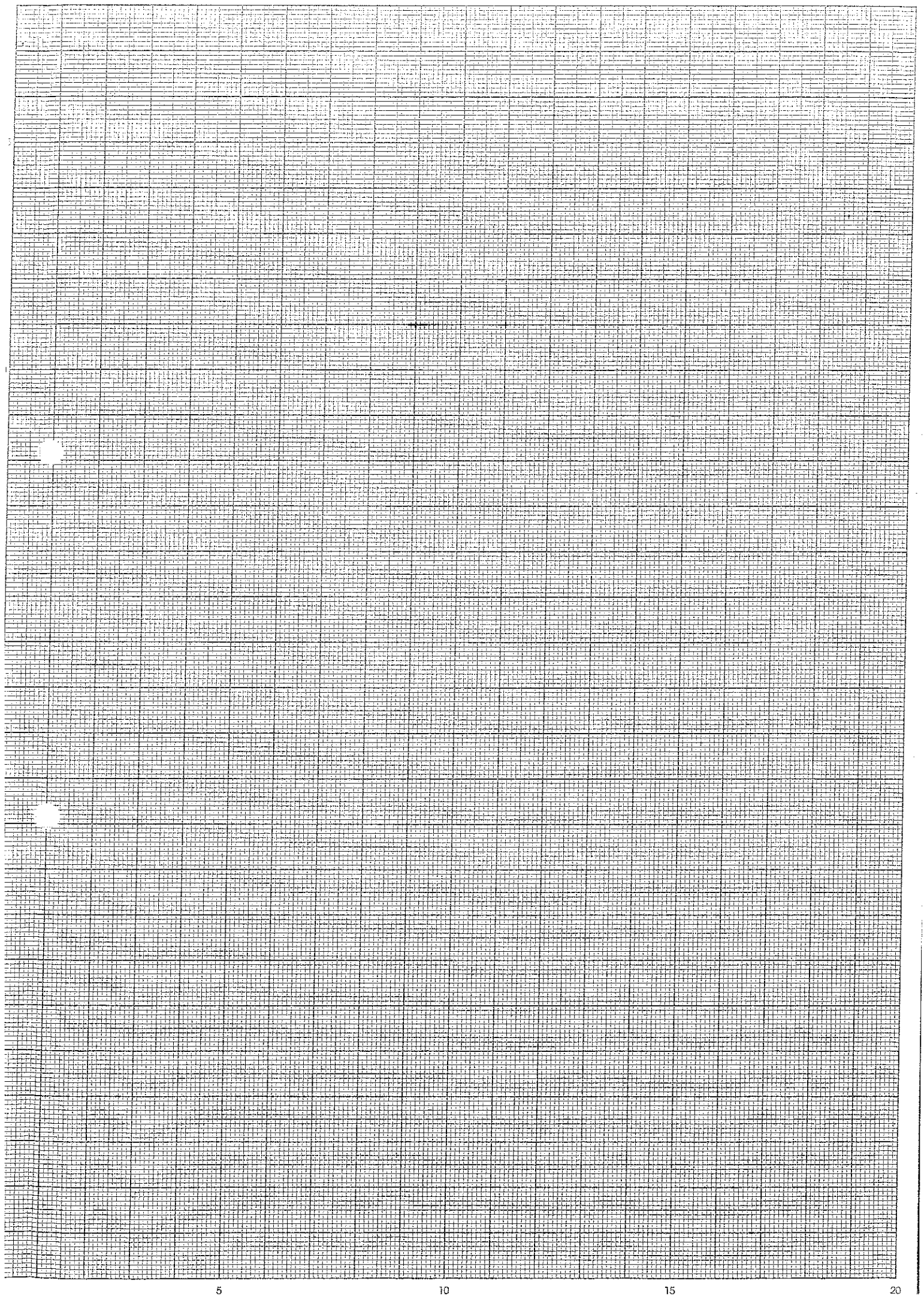
Weightage: 7%

1. Find the following after drawing the Mohr's Circle. [5 marks]
   a) Magnitude and orientation of the principal planes of shear stress [4 marks]
   b) Magnitude and orientation of the maximum shear stress [3 marks]
   c) Magnitude of stresses at an angle 22.5^0 clock-wise with respect to the given above axes in the diagram. [3 marks]



2. Draw shear force and bending moment diagrams (Magnitude and calculations not necessary) for the following arrangement. [6 marks]

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A

BITS PILANI, DUBAI CAMPUS

FIRST SEMESTER 2011- 2012

II YEAR

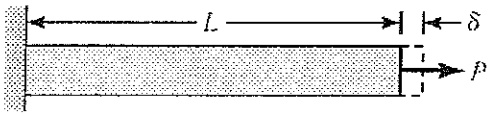
QUIZ I

Course Code: ES C221 **Date:** 01.11.2011

Course Title: Mechanics of Solids **Max Marks:** 24

Duration: 20 minutes **Weightage:** 8%

Q1. Find the deflection for the beam given below using Castigliano's theorem when a force of 20 kN is acting on it. The length of the beam is 4 m with square cross sectional area of 0.7 cm. E = 205 x 10^9 N/m^2. (6 Marks)



Q2. With the help of diagrams show (10 Marks)

i) 3 different types of beams
ii) 3 different types of loads
iii) Sign convention for Shear Force and Bending Moment

Q3. A cantilever 1.5m long is loaded with a UDL of 2kN/m run over a length of 1.25m from the free end. It also carries a point load of 3 kN at a distance 0.25m from the free end. Draw the SF and BM diagrams of the cantilever. (8 Marks)

2kN