BITS PILANI, DUBAI INTERNATIONAL ACADEMIC CITY, DUBAI
II Year First Semester 2009-2010
COMPREHENSIVE EXAMINATION

Course Name: Mechanics of Solids
Course No. : ES C221
Date : 29 --12--2009

Max Marks: 120
Weightage: 40%
Duration: 3 Hrs.

Instructions:

i) Write your ID Number on the top immediately on the receipt of this paper.
ii) Draw the FBD for supporting your answers & describe the symbols used.
iii) Answer Part A, Part B and Part C in separate answer books.
iii) Attempt all the questions & ***maintain the order of questions in the answer script***, *as they* appear *in question paper.*

[PART–A]

A.1

A square reinforced-concrete pier 0.3 **x** 0.3 m in cross section and 1.2 m high is loaded as shown in the figure A1. The concrete is strengthened by the addition of eight vertical 25 x 25 mm square steel reinforcing bars placed symmetrically about the vertical axis of the pier. Find the stress in the steel and concrete also the deflection. For concrete, take E=17GN/m^2. **[15 Marks]**

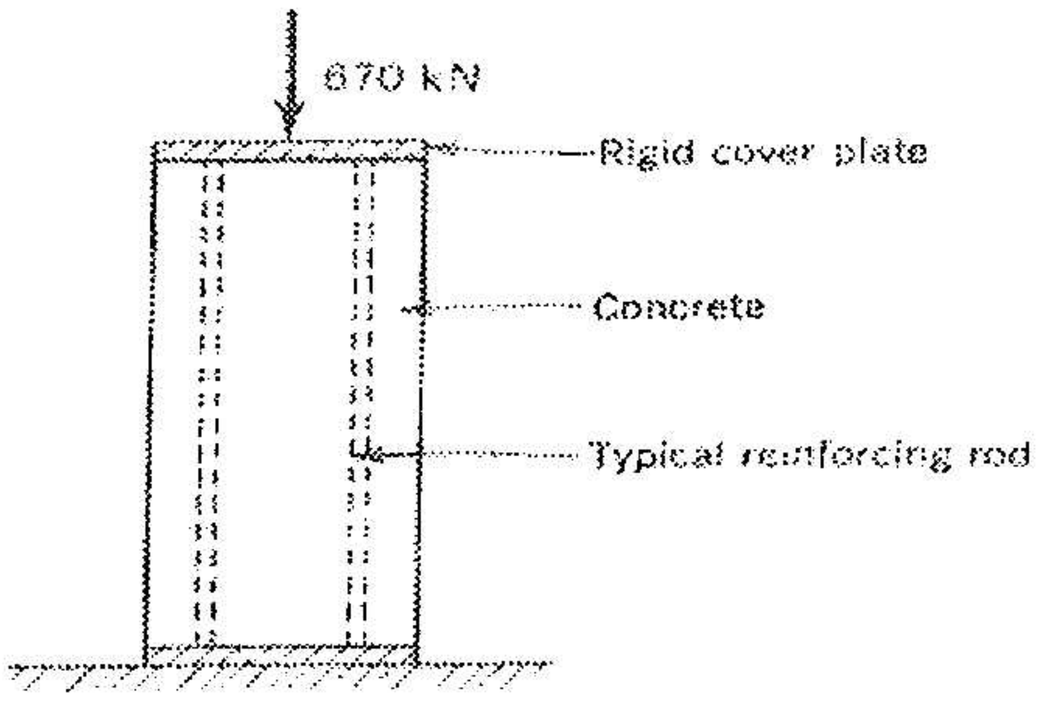

Figure-A1

A.2

A simply supported beam AB of span 4meter is carrying point load as well as uniform distributed load as shown in Figure A2. Draw the Shear force and bending moment diagram for the for the beam. **[15 Marks]**

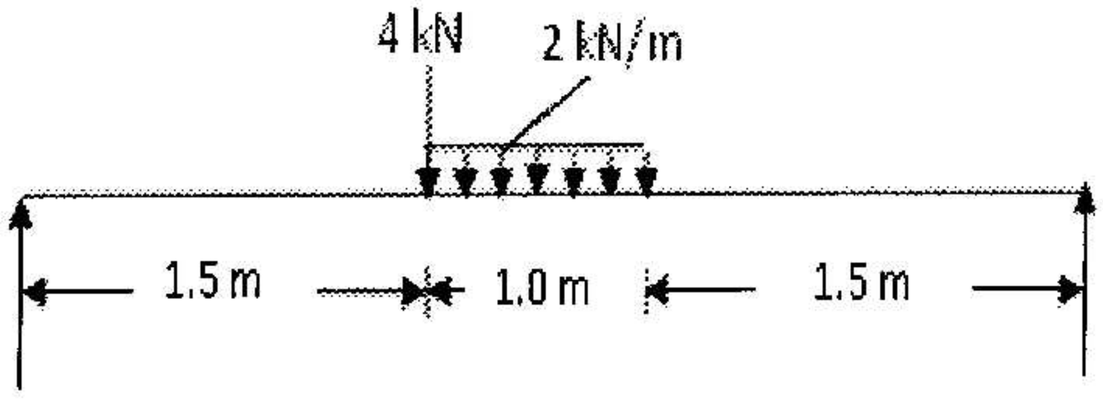

Figure-A2

[PART–B]

B1.

A couple of 70 kN-m is applied to a hollow cast iron shaft of 15 cm outer diameter and 5 cm inner diameter exactly at the mid span B (length AB = BC) as shown in figure B1. The ends A and C of the shaft are built in and prevented from rotating. If the angle of twist $Ø_{AB}$ is 1°, find the length 'L' of the shaft. Take $G_{cast\ iron}$ = 50 GN/m^2

[15 Marks]

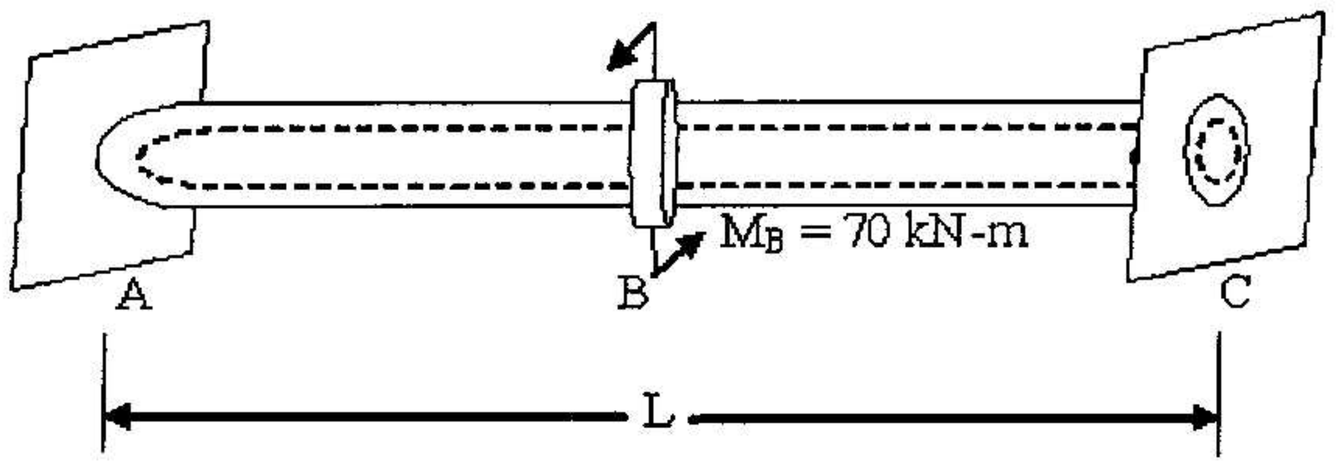

Figure-B1

B2.

Toyota Motor Corporation (TMC) has to display the new model of land cruiser weighing 6000 N for the international motor show. It plans to place the car as a point load on a beam pinned to supports at A and B as shown in figure B2, where the support B is on rollers and free to move horizontally. A steel beam 10 meters long with a rectangular cross section of 100 cm wide and 150 cm deep is available in their warehouse. TMC wants to make use of this beam for the car display. Find the maximum bending stress on the beam.

[Marks:15]

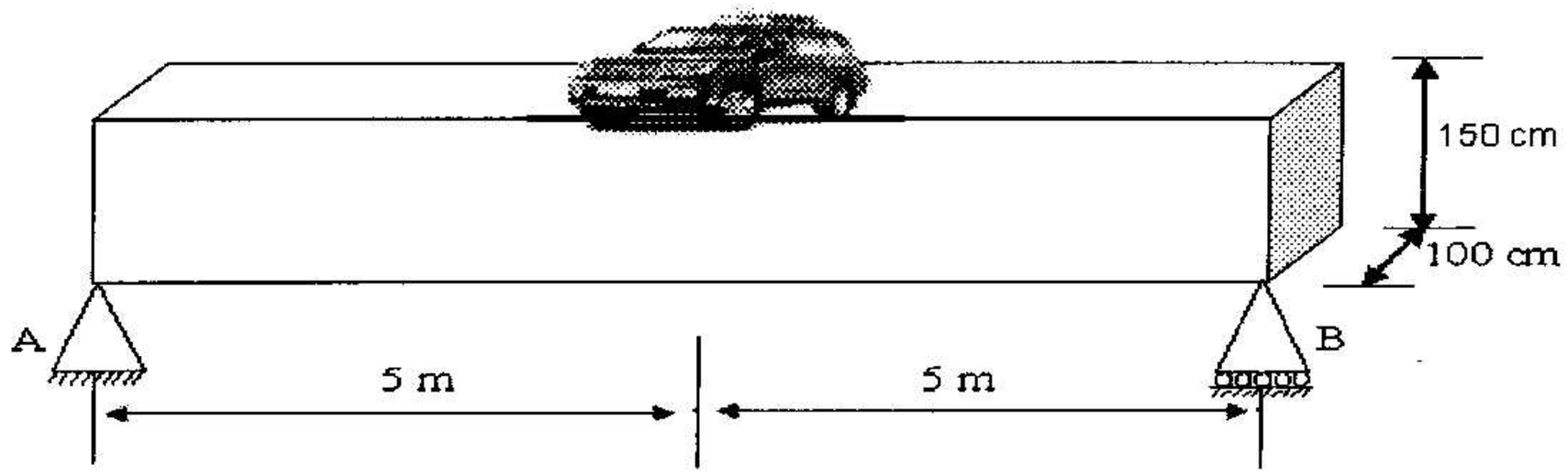

Figure-B2

[PART–C]

C.1

A cantilever beam of 4 m length is fixed at one end and carries a point load of 2 kN at the free end. The beam is of rectangular cross section 50 mm × 100 mm. Find the deflection of the beam. Take the modulus of the elasticity of the material of the beam as 11 GPa. **[20 Marks]**

C.2

Find the critical load for a column of 8 m height with one end clamped and the other end free. The modulus of elasticity of the material of the beam is 20 GPa and the moment of inertia of the cross section of the beam is 23.7 × 10^6 mm^4. **[10 Marks]**

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Your I.D:----------

BITS PILANI, DUBAI INTERNATIONAL ACADEMIC CITY, DUBAI
II Year First Semester 2009-2010
Open Book (Test-II)

Course Name: Mechanics of Solids
Course No. : ES C221
Date : 16 --12--2009

MAX MARKS: 60
WEIGHTAGE: 20%
Duration: 50 Minutes

Instructions:

i) Write your ID Number on the top immediately on the receipt of this paper.
ii) Draw the f FBD for supporting your answers & describe the symbols used.
iii) Prescribed Text Book & Hand written class Notes are allowed.
iv) Attempt all the questions *& **maintain the order of questions in the answer script**, as they* appear *in question paper.*

Q.1 The stresses in a flat steel plate in a condition of plane stress at ambient temperature of 20°C are:

$\sigma_x = 80\ MN/m^2$
$\sigma_y = -40\ MN/m^2$
$\tau_{xy} = 50\ MN/m^2$

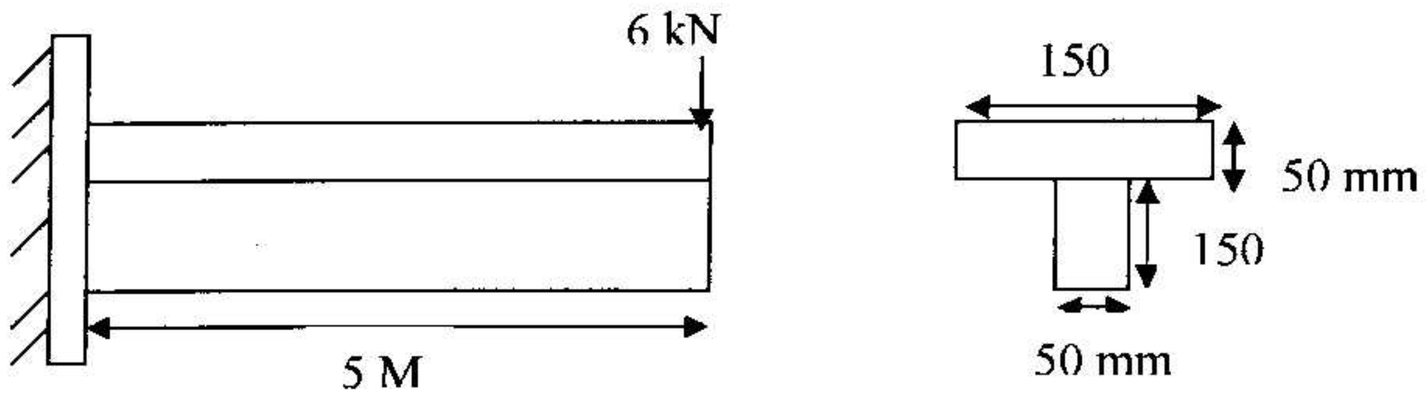
Find the principal strains in the plane of the plate when the temperature changes to 30°C.
Take $\alpha = 15 \times 10^{-6}/°C$, $E = 207\ GN/m^2$, $\upsilon = 0.33$ and $G = 77\ GN/m^2$ ***(Marks:15)***

Q.2 Emirates Metal Testing Laboratory performed a uniaxial tension test of Aluminum alloy Hindalium by Universal Testing Machine. Test results of Hindalium shows that yielding occurs at a stress of 330 MN/m^2. This alloy was used by Ocean King Company to make a component of ship. The component was subjected to the following state of stress

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

Check for the above state of stress, whether the component will fail (yield) according to Von-mises criterion or Maximum Shear stress. ***(Marks:15)***

Q.3 Two wooden planks 150 mm x 50 mm each are connected to form a T-section of a cantilever beam 5 m long, whose cross section is shown below is loaded 6 kN at the free end. *Find the maximum bending stress in the beam.*



(Marks:15)

Q.4 A solid aluminum shaft 1 m long and 50 mm diameter is to be replaced by a hollow steel shaft of the same length and same outside diameter as that of solid shaft, such that each of the two shafts could have the same angle of twist per unit torque over the total length.
Find the inner diameter and the Polar moment of inertia of the hollow shaft. Modulus of rigidity of the steel is three times that of aluminum. ***(Marks:15)***

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Your I.D:----------

BITS PILANI, DUBAI INTERNATIONAL ACADEMIC CITY, DUBAI
FIRST SEMESTER 2009-2010
Closed Book Test

Course Name: Mechanics of Solids
Course No. : ES C221
Date : 01 --11--2009

Max Marks: 75
Weightage: 25%
Duration: 50 Minutes

Instructions:

i) Write your ID Number on the top immediately on the receipt of this paper.
ii) Draw the FBD for supporting your answers & mention the symbols used.
iii) Attempt all the questions *& **maintain the order of questions in the answer script**, as they* appear *in question paper.*

Q.1 **(Marks:20)**

Three identical spheres each of radius r and each weighing W are stacked on smooth surfaces each inclined at an angle θ with the horizontal, as shown in Fig.1. Determine the least value of angle θ to prevent stack from falling.

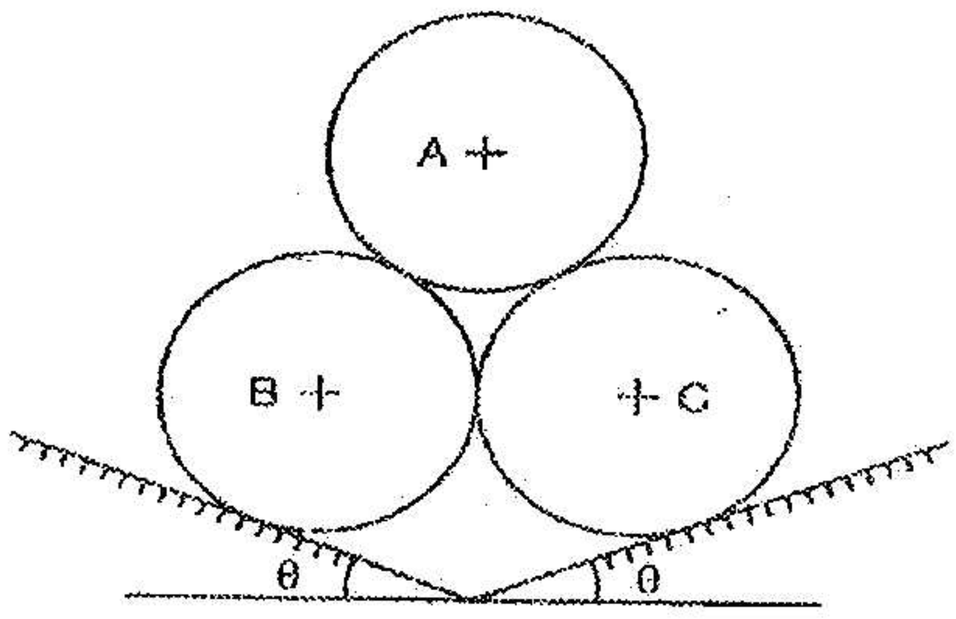

Figure-1

Q.2 **(Marks:20)**

A rigid bar **ABC** is hinged at **A** and suspended at two points **B** and **C** by two bars **BD** and **CE** made of aluminum and steel respectively as shown in the **Fig.Q2**. The bar **ABC** carries a load of 20 kN, midway between **B** and **C**. The areas of cross section of bars **BD** and **CE** are 3 mm^2 and 2 mm^2 respectively. Determine
(a) deformations of the bars,
(b) loads taken up by the bars and
(c) stresses developed in each bar.

Take modulii of elasticity of aluminum and steel as 70 GPa and 200 GPa respectively.

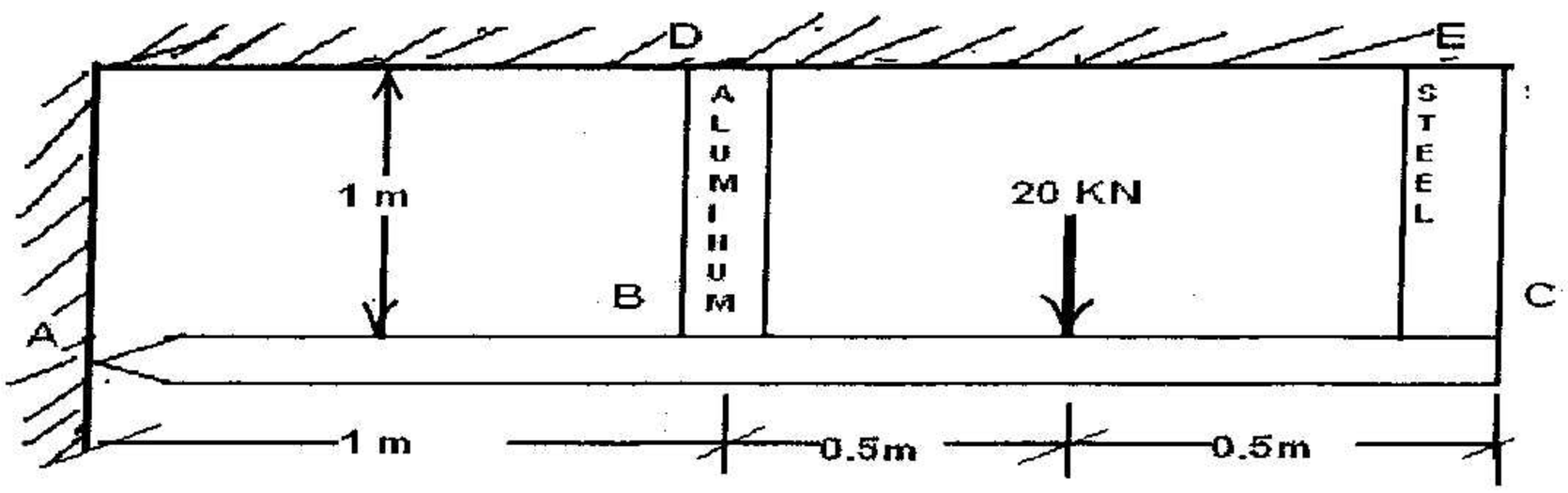

Figure 2

Your I.D:----------

Q.3 **(Marks:20)**

A steel truss is shown in figure 3. The cross-sectional area of all the steel members is 1000 mm^2 and modulus of elasticity of steel is 200 GN/m^2. Find the horizontal deflection of the point 'P' using Castigliano's theorem.

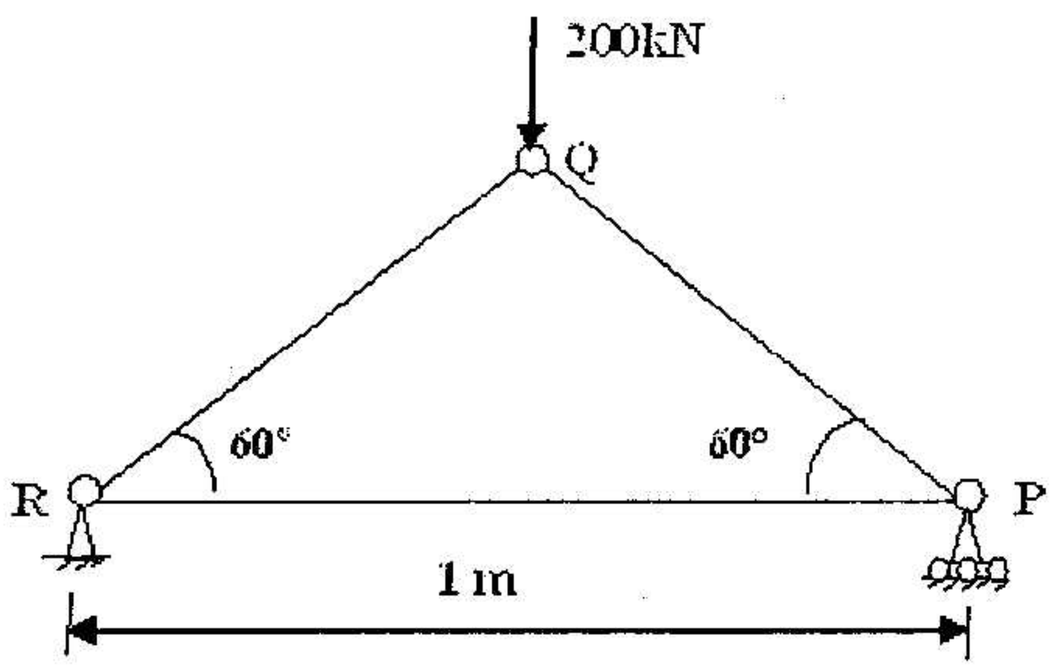

Figure 3

Q.4 **(Marks:15)**

A simply supported beam AB of span 4 meter is carrying two point loads of 3 KN & 4 KN as shown in Fig.4.

a) Calculate the reactions at the supports.
b) Find the shear force & bending moment at salient points.
c) Draw the Shear force and bending moment diagram for the Beam.

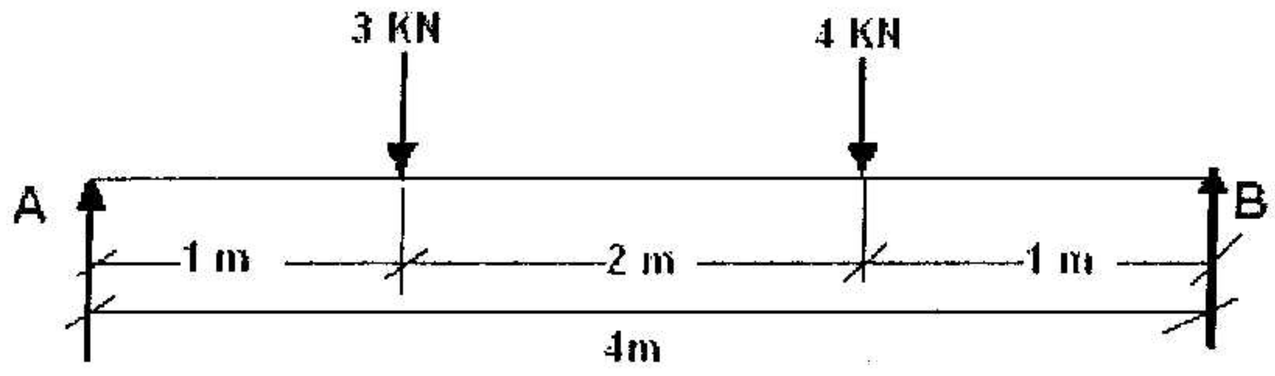

Figure-4

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SET- A

BITS, PILANI – DUBAI

FIRST SEMESTER 2009 – 2010

Course Code: ES C221
Course Title: Mechanics of Solids
Duration : 20 minutes

IInd YEAR (Quiz-II)

Date:17.11.09
Max Marks: 21
Weightage: 7%

Name: ..... ID No: ..... Prog: .....

Instructions:

i) Change of answer & overwriting is not permitted.
ii) Give the answers precisely.
iii) Give the answer on the back your question paper

Q.1.

A plane element of a body is subjected to a tensile stresses of 50 MN/m^2 in x-x direction and 10 MN/m^2 in y-y direction. Each of the above stress is subjected to a shear stress of 20 MN/m^2 as shown in following figure-1. Draw the Mohr's circle for this stress system & determine the following:

(Marks: 6+ 3x5=21)

i) Magnitude Maximum Principal Stress.

ii) Magnitude Minimum Principal Stress.

iii) Magnitude Maximum Shear stress.

iv) Orientation of Maximum Principal Stress Plane.

v) Orientation of Maximum Shear Stress Plane.

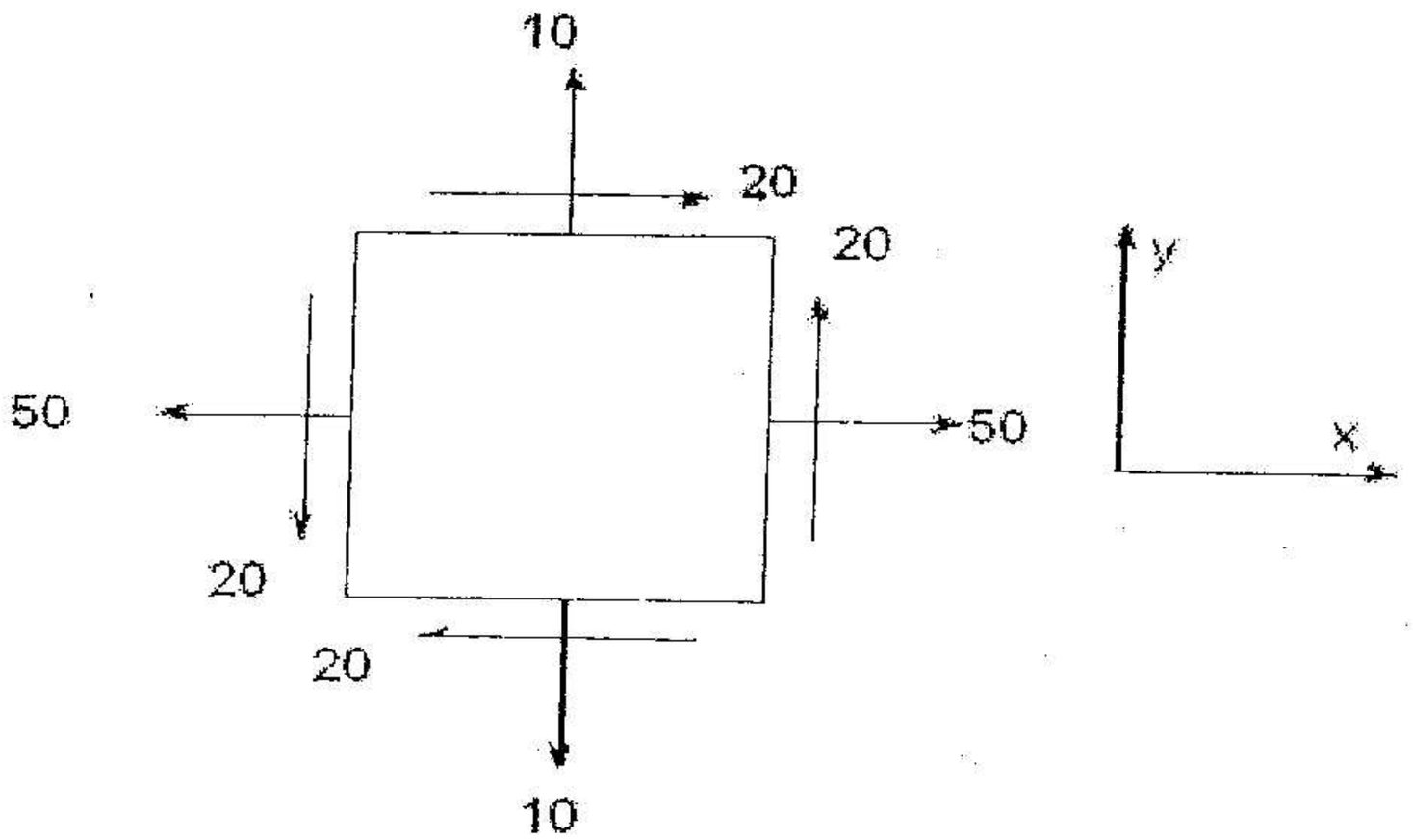
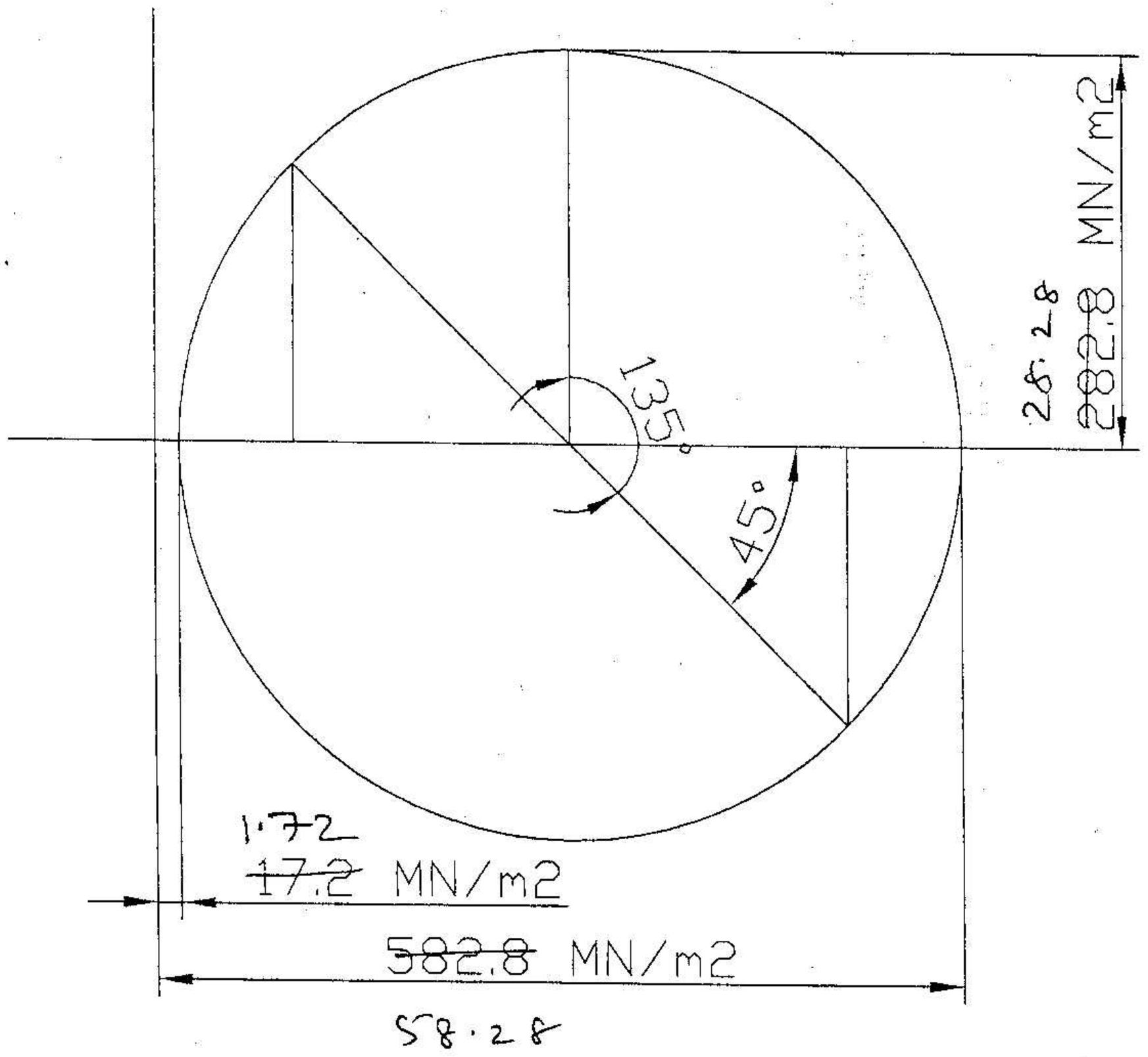


Figure-1

P.T.O

Quiz - 2(b)



$\sigma_x = 60 MPa$

$\sigma_y = 30 MPa$

$\tau = 40 MPa$

Set----A *Section:* _____

BITS, PILANI – DUBAI

FIRST SEMESTER 2009 – 2010

SECOND YEAR

Course Code: ES C221
Course Title: Mechanics of Solids
Duration : 25 minutes

Date: 20.10.09
Max Marks: 24
Weightage: 8%

Name: ..... **ID No:** ..... **Prog:** .....

Instructions:

i) Attempt all the questions.
ii) Draw the F B D wherever required.

Q.1

Force system shown in Figure-1 has each square of size 0.5mX 0.5m.

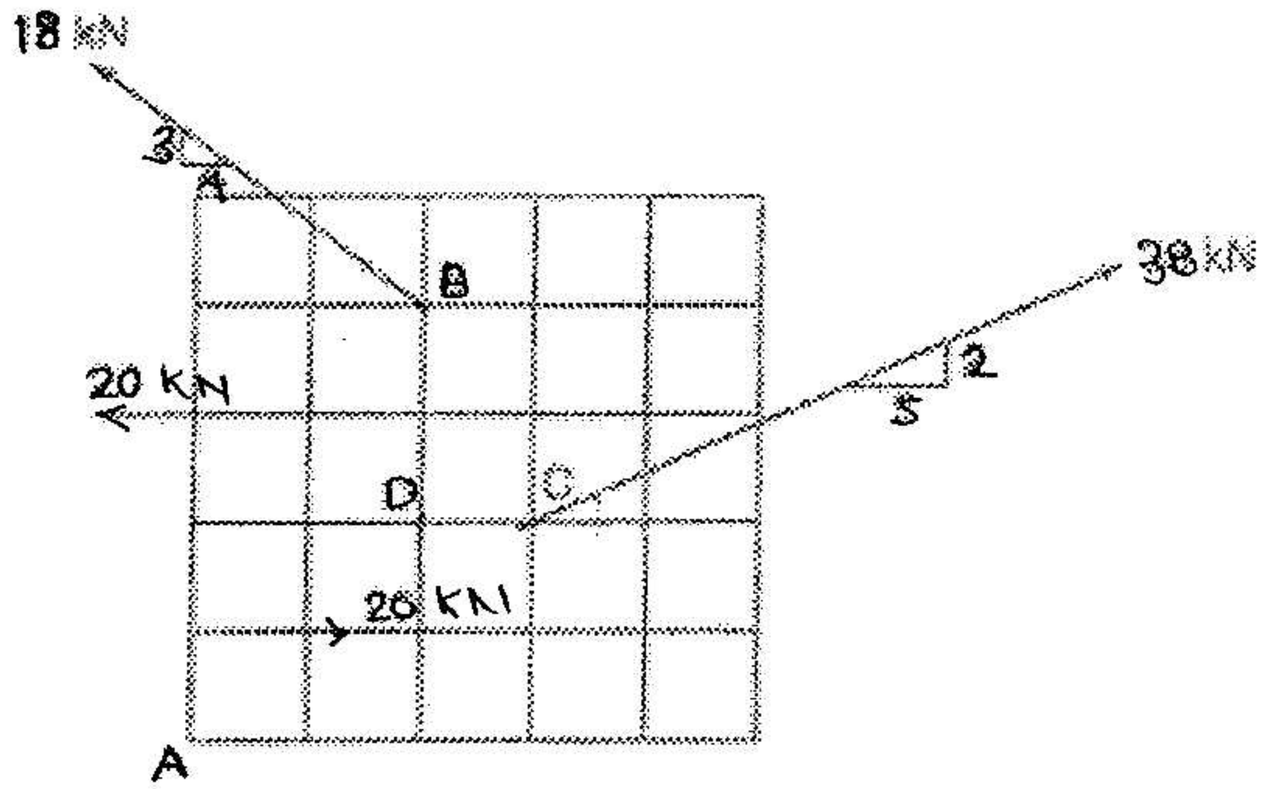


Figure-1

(a) Determine the moment of all the forces about the point A. **[3M]**

(b) Determine the moment of all the forces about the point D. **[3M]**

Set---A

Section: _____

Q.2

A body of weight 70 N is placed on a rough horizontal plane. To just move the body on the plane a push of 20 N inclined at 20^0 to the horizontal plane is required. Find

a) Determine the coefficient of friction between the block & planes. **[3M]**

b) Find the force of friction. **[3M]**

Set----A

Section: _____

Q.3

A copper bar whose length, area of cross section and modulus of elasticity are 3 m, 250 mm^2 and 100 GPa respectively is subjected to a tensile stress of 50 MPa.

(a) Determine the stiffness of the bar material **[3M]**

(b) Calculate the extension in the bar. **[3M]**

Q.4

Use castigliano's theorem to find the deflection for the member ABC shown in Figure-2. Take the following data:

- Load P = 30 kN
- Load Q = 0 kN (fictitious load)
- Stiffness K_{AC} = 50 MN/m^2 and K_{BC} = 500 MN/m^2

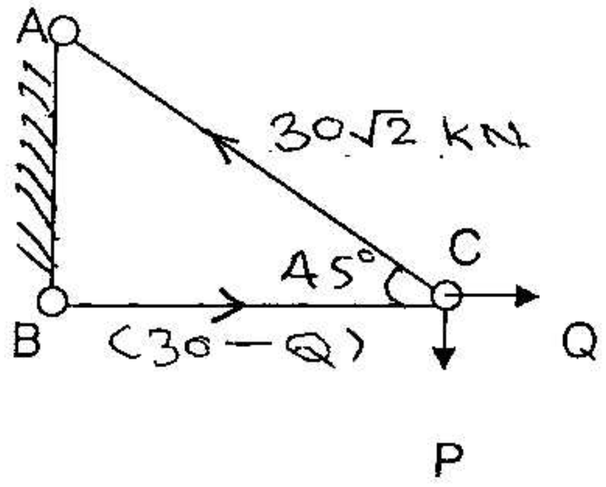


Figure-2

a) Find the vertical deflection at the joint C. **[3M]**

b) Find the horizontal deflection at the joint C. **[3M]**