BITS PILANI DUBAI CAMPUS
Knowledge Village, Dubai
I Semester 2005-06

Course No: ES UC221 **Course title: Mechanics of Solids**
Date: **Test 1- Regular (Make Up)** **Duration: 50 Min**
Max Marks: 20 **Weightage: 20%**

Q1. Two cylinders 1 and 2 rest in a horizontal channel as shown in Fig. Q1. The cylinder 1 has a height of 500 N and a radius of 180 mm. The cylinder 2 has a height of 200 N and a radius of 100 mm. The channel is 360 mm wide at the bottom with one side vertical. The other side is inclined at an angle of 60° with the horizontal. Find the reations (i) of the channel wall at the point P, (ii) of cylinder 1 on cylinder 2, (iii) of bottom surface at the point N, (iv) channel wall at L on the cylinder

[6 Marks]

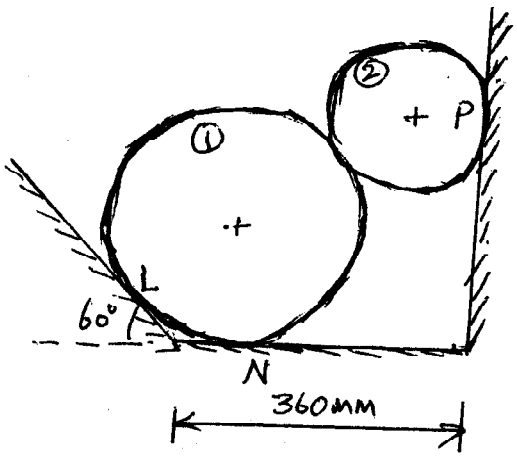


Fig. Q1

Q2. A rigid beam AC is supported at its left end A by a pin. At its right end C it is supported by another rigid bar CF, which is in turn supported by an aluminum rod at D and a steel rod at E. Before any loads are applied the rigid bars both are level. A known load P is applied at point F and an unknown load Q at point B. Find Q in terms of P if the rigid bar CF is to be level after the two loads are applied. Refer fig. Q2

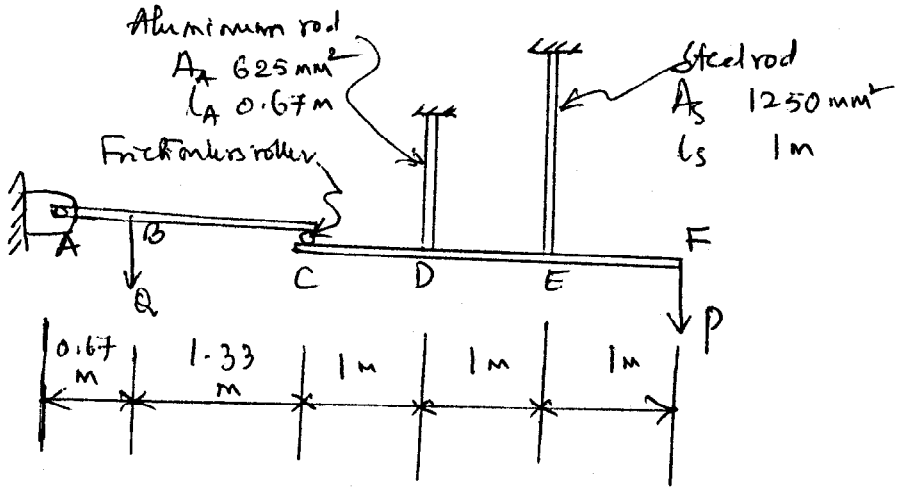


Fig. Q2

[6 Marks]

Q3. A tower used for a highline is shown in the Fig. Q3. If it is subjected to a horizontal force of 600 kN, then determine the forces in all the members

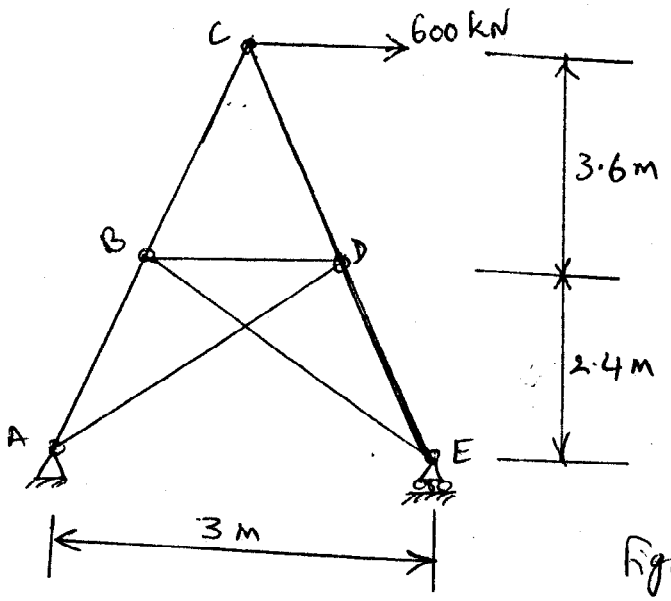


Fig Q3 [4 Marks]

Q4. A block A weighing 100 N rests on a rough inclined plane whose inclination to the horizontal is 45°. This block is connected to another block B weighing 300 N resting on a rough horizontal plane by a weighing rigid bar inclined at an angle of 30° to the horizontal. Find the horizontal force required to be applied to the block B to just move the block A in upward direction. Take the coefficient of static friction as 0.268 at all surfaces where there is sliding.

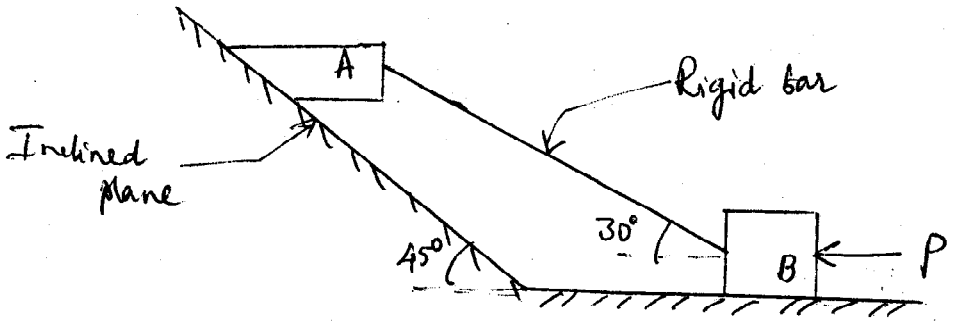


Fig Q4

[4 Marks]

BITS PILANI DUBAI CAMPUS
Knowledge Village, Dubai
I Semester 2005-06

Course No: ES UC221 **Course title: Mechanics of Solids**
Date: **Test 2- Make up (Open Book)** **Duration: 50 Min**
Max Marks: 20 **Weightage: 20%**

Q1. For the case shown in Fig. Q1, sketch the shear force and bending moment diagrams. Indicate sign convention employed and label important values. [8]

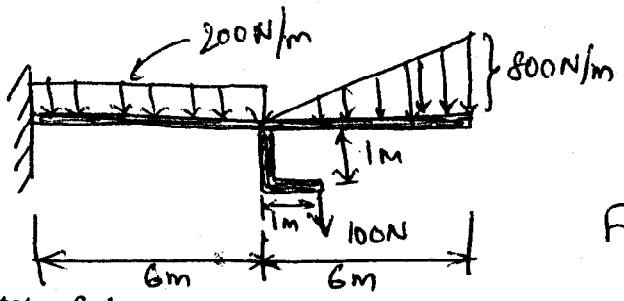


Fig.Q1

Q2. Given the following state of plane stress at a point

$\sigma_x = -40$ MPa $\quad \sigma_y = 20$ MPa $\quad \tau_{xy} = 40$ MPa

(i) Justify whether is it possible to get a normal stress of -20 MPa and a positive shear stress at this point?

(ii) If so, at what angle x-axis should be rotated to get the above state of stress given in (i).

[5]

Q3. Given the following state of plane stress at a point,

$\sigma_x = 20$ MPa $\quad \sigma_y = 40$ MPa $\quad \tau_{xy} = -10$ MPa

(i) What are the principal strains in the xy plane?

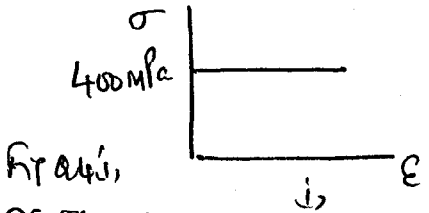
(ii) Find the strains at axes rotated 30° clockwise from xy axes.

Modulus of Elasticity=200 GPa and poisson's ratio=0.3

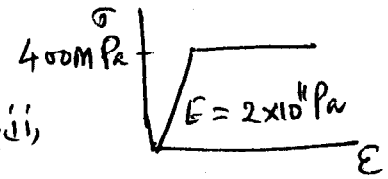
[5]

Q4. Shown in Fig. Q4 (i) perfectly plastic and Fig. Q4 (ii) is elastic perfectly plastic stress-strain idealizations. What stress is needed in each case to have a strain of 0.0005?

[1]



for Q4 i)



for Q4 ii)

Q5. The principal stresses at a point are

$\sigma_1 = 50$ MPa $\quad \sigma_2 = 40$ MPa $\quad \sigma_3 = 10$ MPa

What is the maximum shear stress at this point?

[1]

BITS PILANI DUBAI CAMPUS

First Semester 2005-06

COMPREHENSIVE EXAMINATION (CLOSED BOOK)

Course Name: Mechanics of Solids | **Course No: ES UC221**
Date: 04.01.2006 | **Weightage: 40%**
Max Marks: 40 | **Duration: 3Hrs**

Note: Answer Part A, Part B and Part C in separate answer books

PART A

Q1. On a concrete ramp (Figure Q1) a force "F" is required to (i) start pushing a block up when the slope is 30° and (ii) hold it from sliding back when the slope is 60°. What is the coefficient of static friction between the block and concrete? [4M]

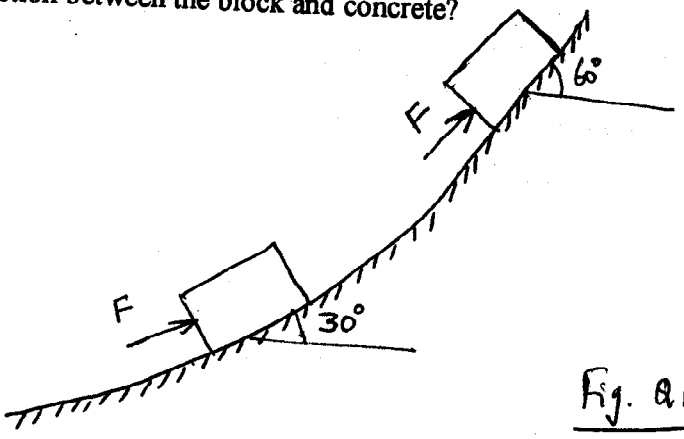


Fig. Q1

Q2. In the pin-jointed cantilever truss shown in Fig. Q2, all the members have a cross sectional area A=5000 mm^2, and elastic modulus E=200 GN/m^2. Find:
(i) the forces in all the members of the truss
(ii) the vertical deflection of the joint C. [8M]

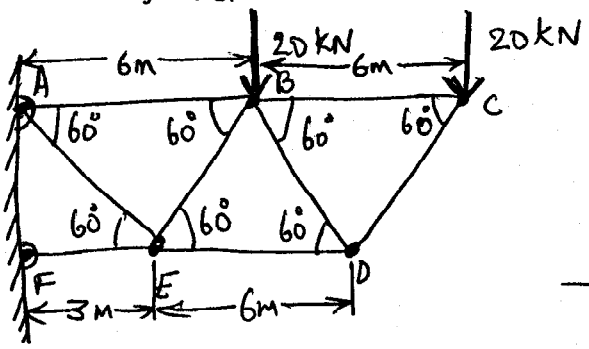


Fig. Q2

Q3. A 2m long cantilever column of square cross section 100mm x 100 mm is to be made of steel (E=200 GN/m^2). Determine the critical load for buckling of the column. [2M]

PART B

Q4. For the given loading pattern (Fig. Q4), (i) find the reactions, (ii) expressions for the shear force and bending moment as a functions of distance along the beam, and (iii) sketch shear force and bending moment diagrams and label salient points. Indicate the sign convention employed.

[6M]

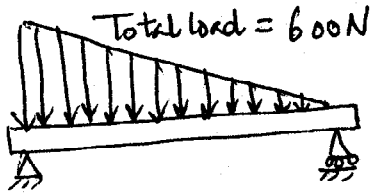


Fig. Q4

Q5. If the maximum principal stress is 100 MN/m^2, find (i) σ_y, (ii) and the angle which the principal stress axes makes with the xy axes for the case given below in Fig. Q5.

[5M]

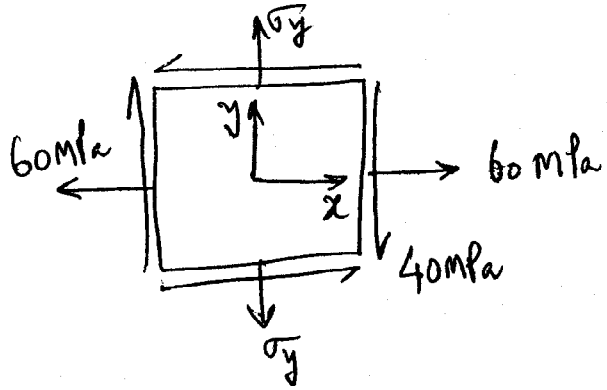


Fig Q5

Q6. Assume that a state of principal stresses developed at a point are shown in Fig. Q6. The stresses are directly proportional to a parameter "α". What is "α" based on the Mises criterion if the yield stress is 250 MPa.

[2M]

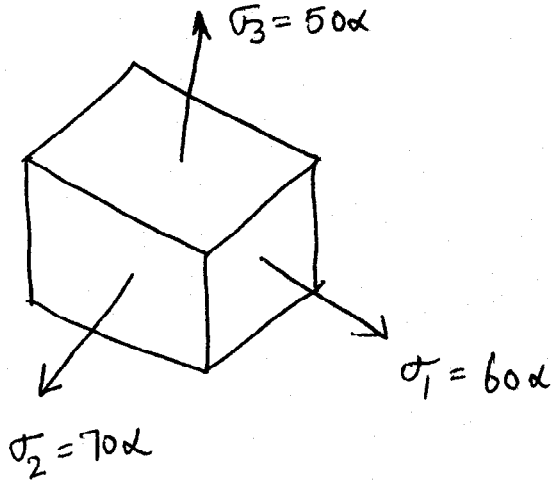


Fig. Q6

PART C

Q7. Two shafts AB and BC of the same material but different diameter are welded together at point B (Fig. Q7). Ends A and C are fastened securely so that the shafts cannot rotate at these points. An external twisting couple M_o= 100 Nm is applied to the shafts at point B. Assume the shear modulus G= 80 GN/m^2. Find the twisting couples exerted on the ends of the shafts at A and C.

[4M]

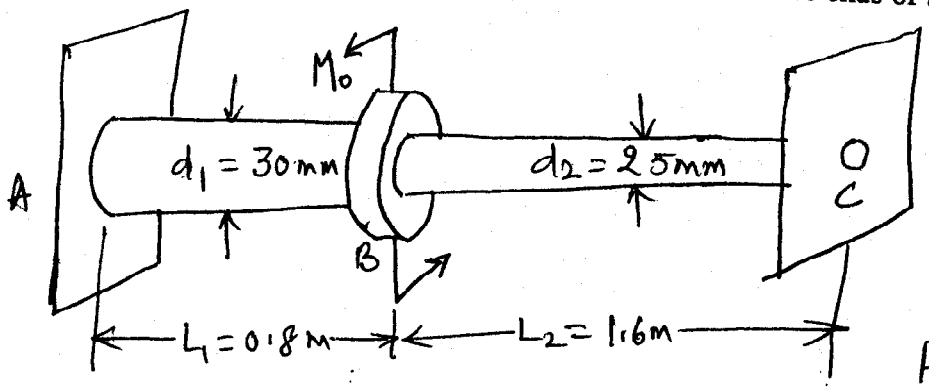
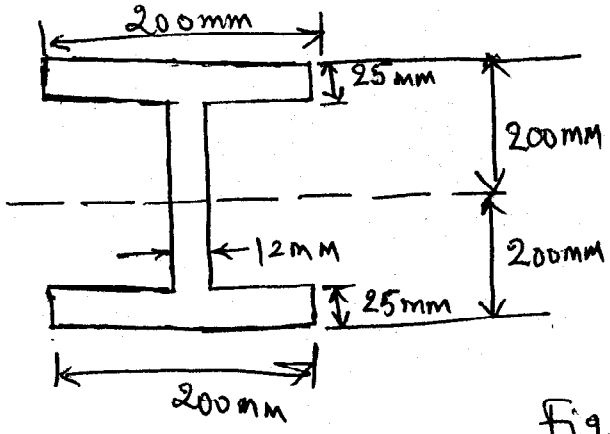


Fig. Q7

Q8. Consider the steel beam shown in Fig. Q8. Calculate the maximum bending stress in the beam.

[4M]



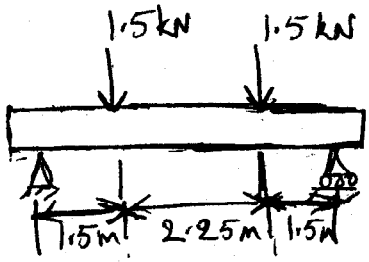


Fig. Q8

Q9. Fig. Q9 shows a cantilever beam built-in at A and subjected to a uniformly distributed load of intensity w per unit length acting on the segment AB. Determine the deflection at C due to the distributed load in terms of the constant bending modulus EI and the dimensions shown.

[5M]

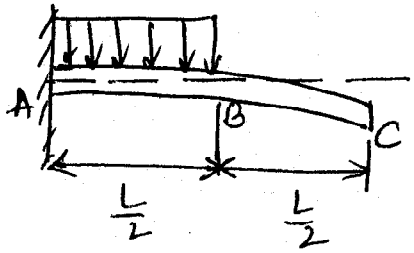


Fig. Q9

BITS Pilani Dubai Campus
Knowledge Village, Dubai
I Semester 2005-06

EUC224 — Mechanics of Solids

Max Marks 20 — Test 2 – Make Makeup (Open Book) — Weightage 2

Q1 An overhang beam is shown in Fig. 1.

(i) Calculate the reactions
(ii) Draw the shear force diagrams
(iii) Determine the location and magnitude of maximum bending moment.

[8 M]

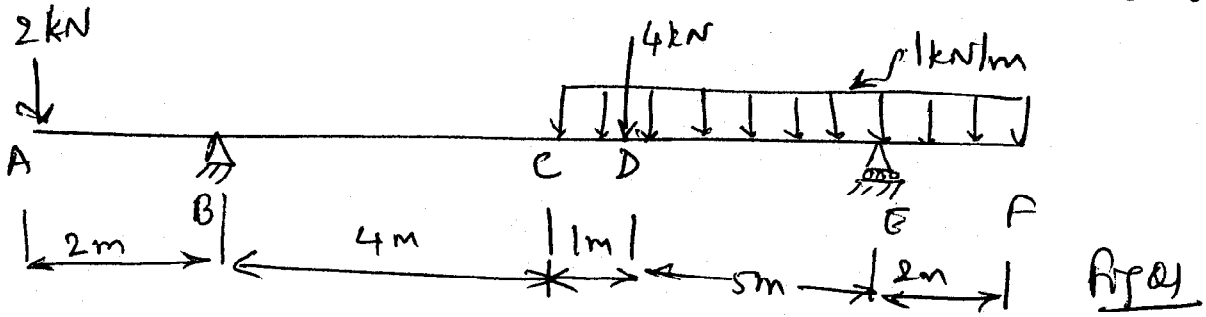
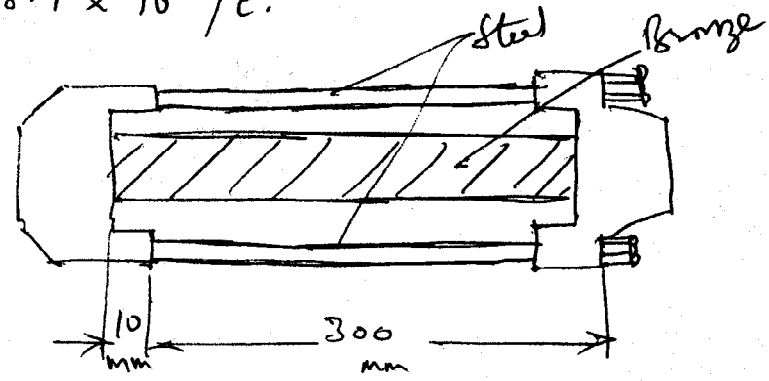


Fig Q1

Q2 A 30 mm diameter bronze cylinder is secured between a rigid cap and slab tightening two 20mm diameter steel bolts. At 20°C, no deformation and stresses exist in the assembly. Determine the stress in bronze and steel at 70°C

Use $E_s = 200$ GPa, $E_b = 83$ GPa, $\alpha_s = 11.7 \times 10^{-6}$ /°C
$\alpha_b = 18.9 \times 10^{-6}$ /°C.

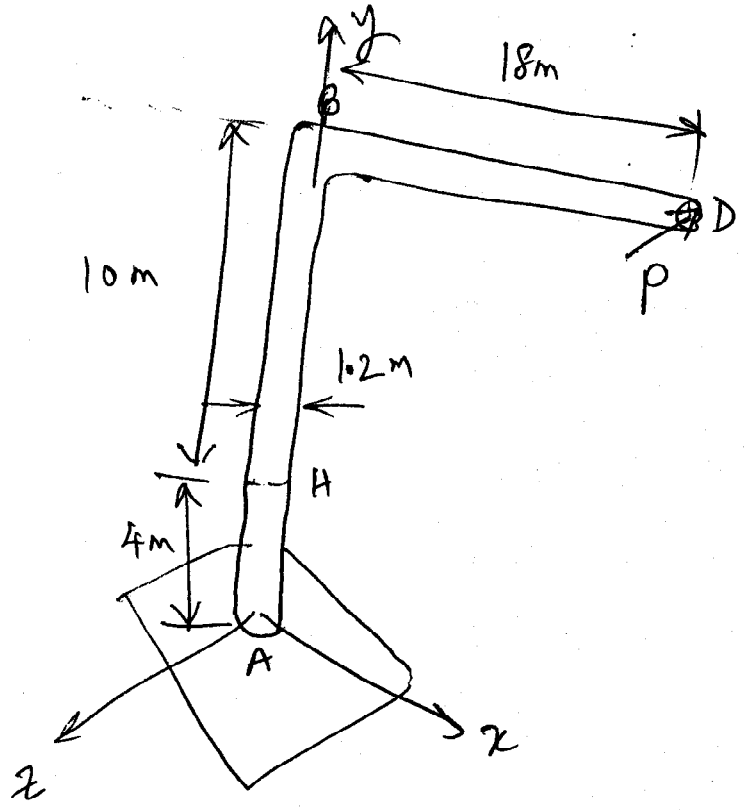
[6 M]



Q3 A single horizontal force P of magnitude 150 kN is applied at end D of lever ABD. Knowing that portion AB of the lever has a diameter of 1.2 m. Determine

(a) the normal and shearing stresses on an element located at point H and having sides parallel to x and y axes.

(b) the principal planes and principal stresses at point H? [6M]



BITS PILANI DUBAI CAMPUS
Knowledge Village, Dubai
I Semester 2005-06

Course No: ES UC221 | **Course title: Mechanics of Solids**
Date: 20.11.05 | **Test 2- Regular (Open Book)** | **Duration: 50 Min**
Max Marks: 20 | **Weightage: 20%**

Q1. For the case shown in Fig. Q1, sketch the shear force and bending moment diagrams. Indicate sign convention employed and label important values. [8]

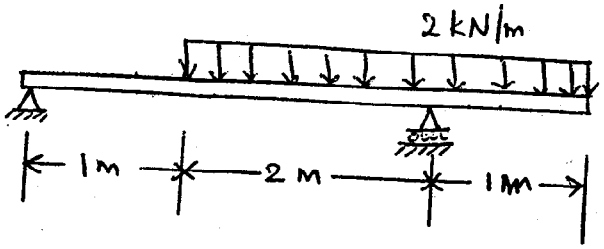


Fig. Q1

Q2. Consider a thin sheet pulled in its own plane so that the stress components with respect to the xy axes are as given in Fig. Q2. Construct the Mohr's circle and lay out the points x and y. Find the stress components with respect to ab axes which are inclined at 60° to the xy axes. Find the orientation of principal axes and axes of maximum shear. [6]

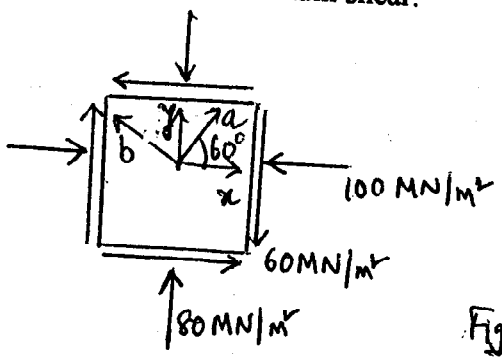


Fig Q2

Q3. A sheet of metal is deformed uniformly in its own plane so that the strain components related to set of xy axes are

$$\epsilon_x = 1000 \times 10^{-6}, \quad \epsilon_y = -600 \times 10^{-6}, \quad \gamma_{xy} = 800 \times 10^{-6}$$

Using Mohr's circle, find the magnitude of principal strains and orientation of principal strain directions. [4]

Q4. A 50 mm diameter steel rod has an initial length of 2 m. Determine the total strain along the axis of the rod after a tensile load of 25 kN is applied to the rod and the temperature of the rod increases by 20°C. For steel, Modulus of elasticity (E)=200 GN/m^2, and Coefficient of thermal expansion (α)=9x10^{-6} /°C. [2]

BITS, Pilani – Dubai Campus

Knowledge Village, Dubai
I Semester 2005 – 2006

TEST – I (Regular)

Course No.	: ES UC221.
Course Title	: Mechanics of Solids.
Nature of Exam	: Closed Book.
Weightage	: 20 %
Duration	: 50 minutes.
Date	: 02.10.2005.

No. of Pages	= 2
No. of Questions	= 3

Note: Answer all questions.

Q1. A cord connects two bodies A and B placed on an inclined plane as shown in fig.Q1.The coefficients of friction of body A is 0.15 and that of body B is 0.4. Determine

a. the inclination of the plane to the horizontal
b. the tension in the cord when motion is about to take place down the inclined plane.

(6 marks)

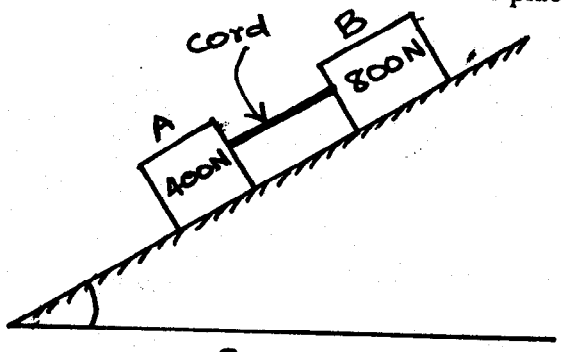


Fig. Q1.

Q2. In the pin-jointed cantilever truss shown in fig. Q2, all the members have a cross sectional area of 350 mm^2 and elastic modulus 205 G N/m^2. Find:

a. the forces in the rods due to the load 10kN & 20kN
b. the vertical deflection of the loaded joint A.

(8 marks)

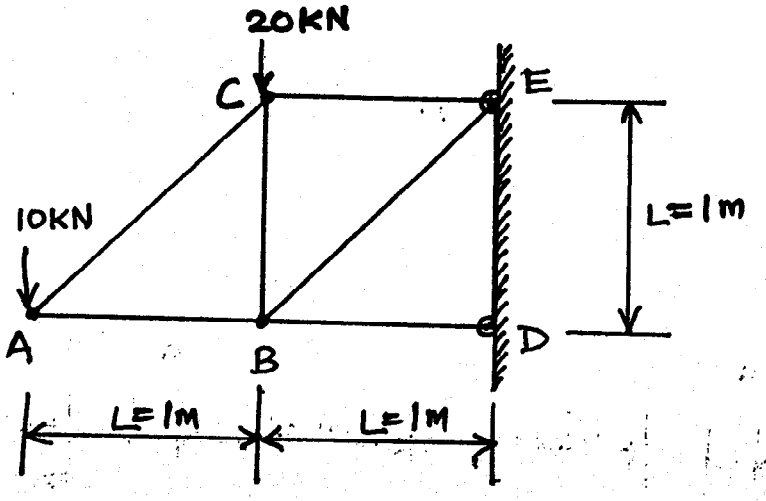


Fig. Q2.

P.T.O.

Q3. A rigid beam AD is supported by a smooth pin at A and by horizontal bars (1) and (2) attached to the beam at points B and C respectively. Bar (1) is brass with cross sectional area of 350 mm^2 and an elastic modulus of 110 G N/m^2. Bar (2) is steel with cross sectional area of 175 mm^2 and an elastic modulus of 190 G N/m^2. A concentrated load of 8 kN is applied to the tip of the beam at D as shown in fig. Q3. Assume that the pin connections at B and C are ideal, meaning that there are no gaps. Compute the

a. normal stresses in both the brass and steel bars. (6 marks)

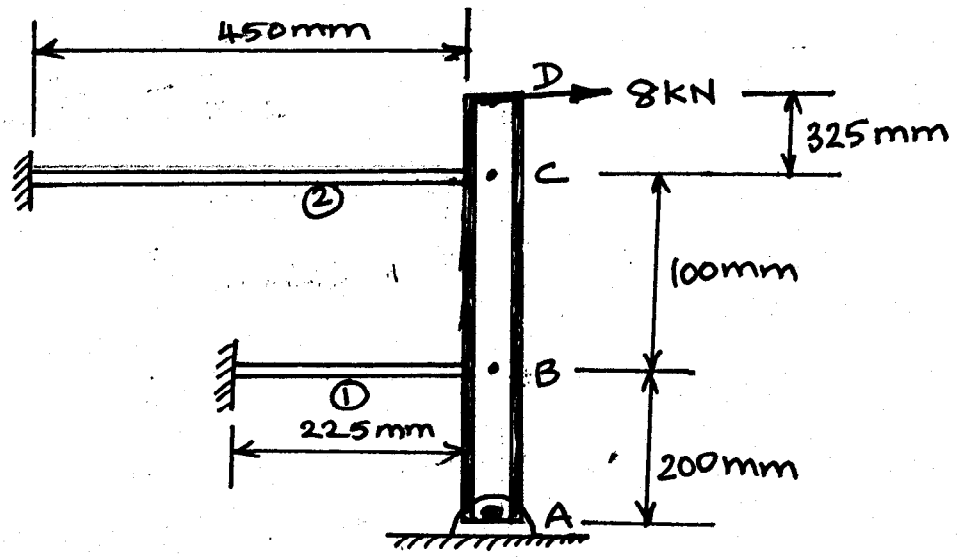


Fig. Q3.