

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

King Fahd University of Petroleum & Minerals
DEPARTMENT OF CIVIL ENGINEERING
First Semester 1433-34 / 2012-13 (121)
CE 203 STRUCTURAL MECHANICS I

Major Exam II

Tuesday, December 4, 2012 7:00-9:30 P.M.

Student Name	Family					First			
ID No. (9 Digits)									

CIRCLE YOUR COURSE--SECTION NO.							
Section #	1&2	3	4	5	6	7	8
Instructor	Hamdan	Suwaiyan	Shamshad	Salah	Mesfer	Khathlan	Saeid

Summary of Scores

Problem	Full Mark	Score
1	20	
2	20	
3	20	
4	20	
5	20	
Total	100	
Remarks		

Notes:

1. A sheet that includes selected Basic Formulae and definitions is provided with this examination.
2. Write clearly and show all calculations, FBDs, and units.

Problem 1: (20 points)

The shown shaft which is made from a circular steel tube AB and a solid circular brass shaft BC, is subjected to torques at B and C as shown.

- Determine the maximum value for T_0 if the allowable shear stress for both materials is 150MPa and the allowable angle of twist at B is 4° .
- Using the results obtained above, determine the rotation of end C.
- Calculate the maximum shear stress in brass.
- Calculate $\Phi_{B/C}$

For steel (AB)

$d_{out} = 30 \text{ mm}$

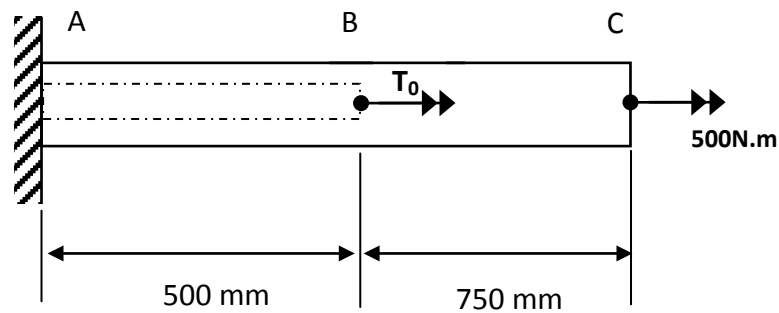
$d_{in} = 20 \text{ mm}$

$G_{steel} = 80 \text{ GPa}$

For brass (BC)

$d = 30 \text{ mm}$

$G_{brass} = 40 \text{ GPa}$

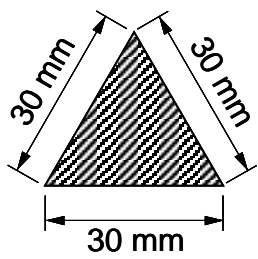
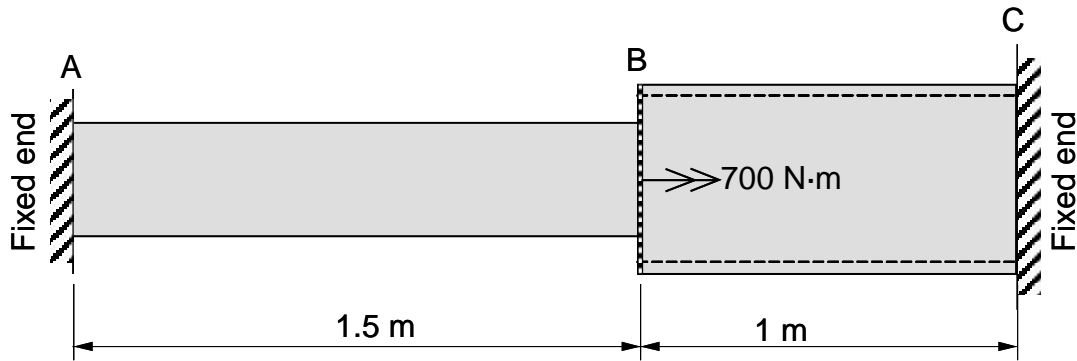


Problem 2: (20 points)

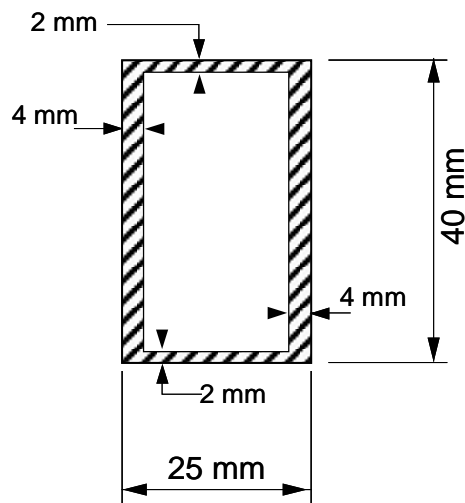
The steel shaft is made from two segments: AB is a solid triangular section, and BC is a thin tube.

- Determine the reactions at A and C.
- Determine the maximum shear stress in the whole shaft and indicate its location.
- Determine the angle of twist of B.

$G_{\text{steel}} = 75 \text{ GPa}$



Cross-Section AB



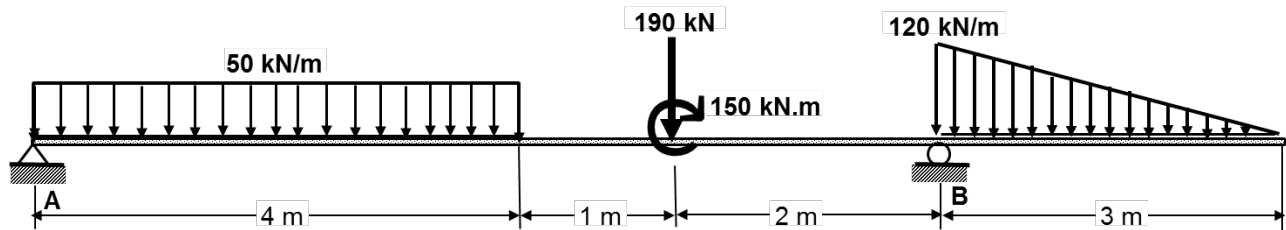
Cross-Section BC

Problem 3 (20 pts.)

Draw the **shear force and bending moment diagrams** for the beam shown below using the **summation (graphical) method**. Write the degree (2,3, etc.) of the curve on each one. Put the values on the diagrams, but you do NOT need to show the calculations.

Use appropriate scale. **No credit will be given if another method is used.**

The reactions are: $A_y = 150 \text{ kN} \uparrow$; $B_y = 420 \text{ kN} \uparrow$



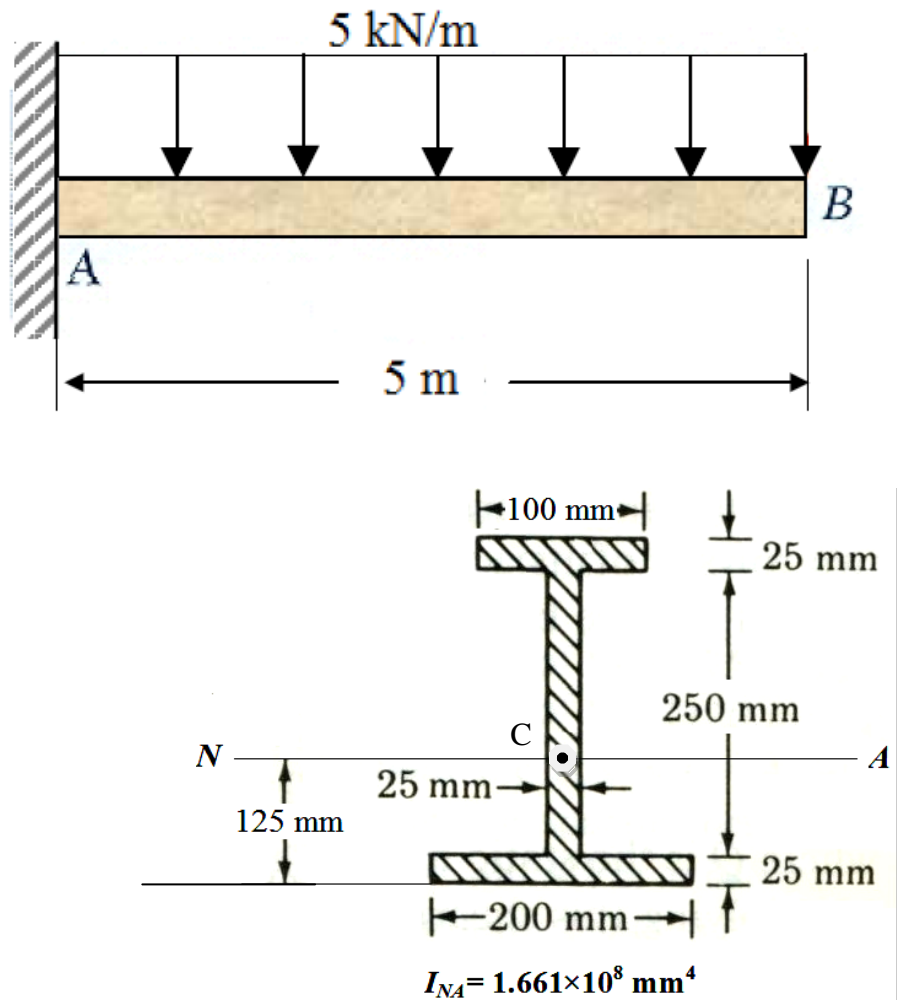
SFD
(kN)

BMD
(kN.m)

Problem 4: (20 points)

A cantilever beam along with its cross-section is shown in the figure below. Determine the following at point A of the beam:

- Maximum tensile stress and its location
- Maximum compressive stress and its location
- Normal stress distribution along the depth of the cross-section
- Magnitude of the normal force on the lower flange.



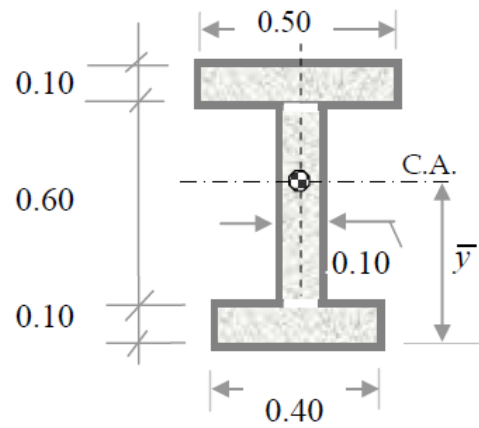
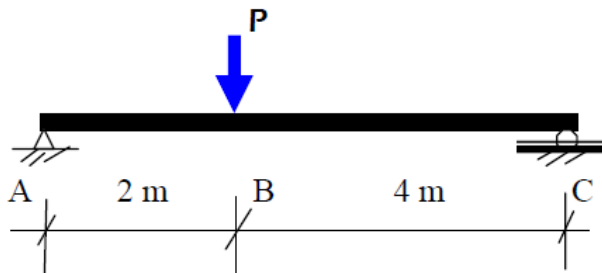
Problem 5: (20 points)

The beam ABC shown with details of the cross-section given below is made from a material whose ultimate shear strength is 450 MPa.

- a) Show that the centroidal values for the cross section are:

$$\bar{y} = 0.4233 \text{ m}, \text{ and } I_{CA} = 1.2818 \times 10^{-2} \text{ m}^4.$$

- b) Using a factor of safety (FS) value of 1.5 and the centroidal values given in part a, determine the allowable value for load P.
- c) Sketch (*qualitatively*) the shear-stress distribution $\tau(y)$ along the beam-depth at the location of maximum shear force. On the diagram clearly indicate the maximum and minimum values.



Cross-section (units: in m)