بسم الله الرحمن الرحيم

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.**

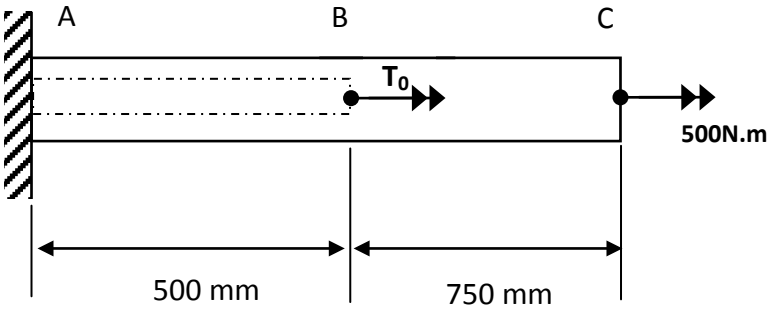
Problem 1: (20 points)

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.

a) 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^o.
b) Using the results obtained above, determine the rotation of end C.
c) Calculate the maximum shear stress in brass.
d) Calculate $\Phi_{B/C}$

For steel (AB)
d_{out}**= 30 mm**
d_{in}**= 20 mm**
G_{steel} **= 80 GPa**

For brass (BC)
***d* = 30 mm**
G_{brass} **= 40 GPa**

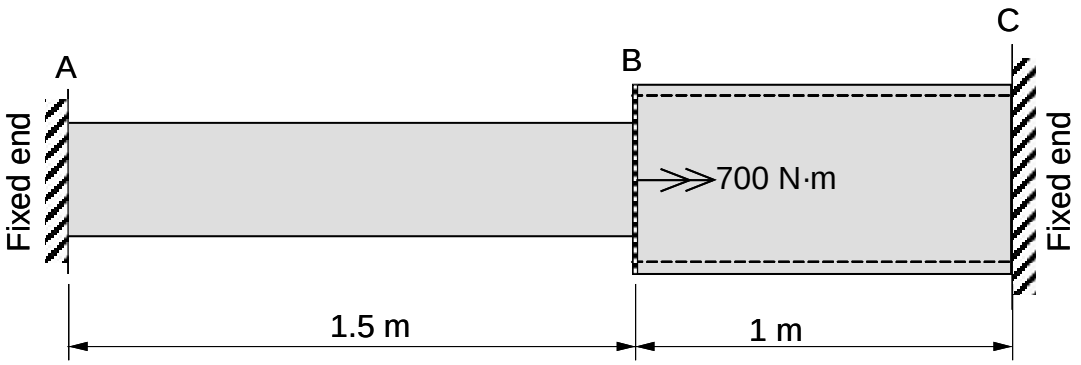


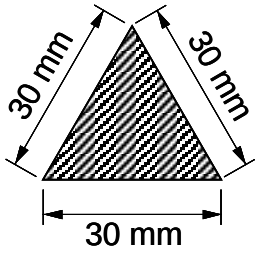
Problem 2: (20 points)

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

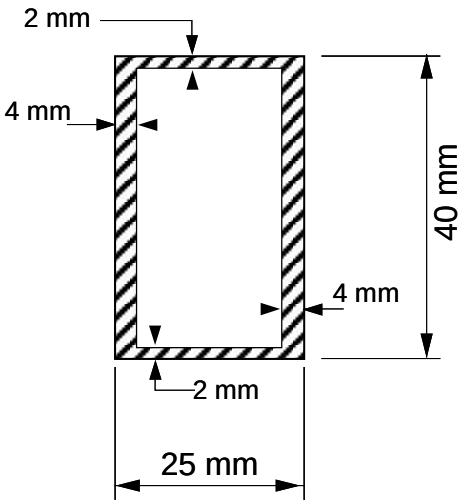
a) Determine the reactions at A and C.
b) Determine the maximum shear stress in the whole shaft and indicate its location.
c) Determine the angle of twist of B.

G_{steel}= 75 GPa





Cross-Section AB

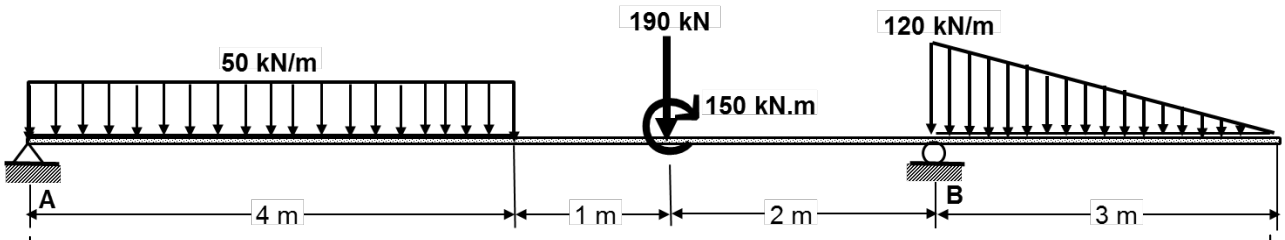


Cross-Section BC

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: $\mathbf{A_y = 150\ kN\uparrow}$ **;** $\mathbf{B_y = 420\ kN\uparrow}$



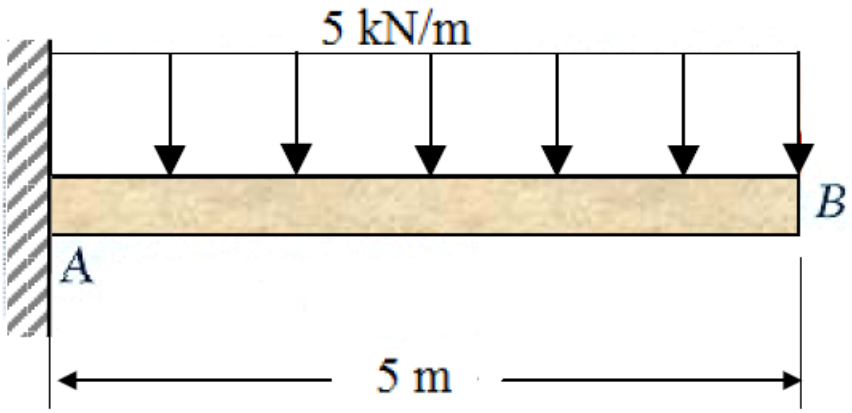
SFD
(kN)

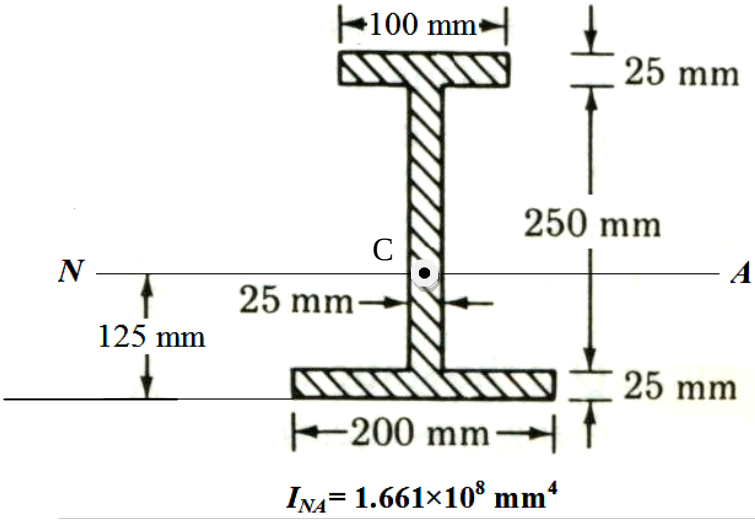
BMD
(kN.m)

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:

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





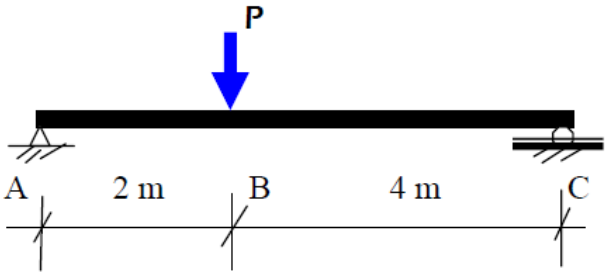
Problem 5: (20 points)

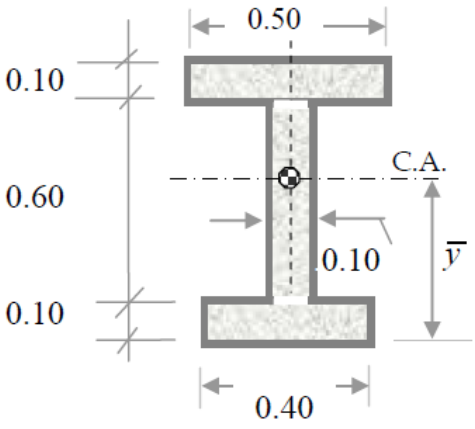
The beam ABC shown with details of the cross-section given below is made from a material whose ultimate shear strength is 450 MPa.

a) Show that the centroidal values for the cross section are:
$\bar{y} =$ 0.4233 m , and $I_{CA} =$ 1.2818 x 10^{-2} 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 τ(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*)