

بسم الله الرحمن الرحيم

King Fahd University of Petroleum & Minerals
DEPARTMENT OF CIVIL ENGINEERING
Second Semester 1433-34 / 2012-13 (122)
CE 203 STRUCTURAL MECHANICS I
Major Exam II

Tuesday, April 23, 2013 7:00-9:30 P.M.

Student Name	Family					First			
ID No. (9 Digits)									

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

Summary of Scores

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

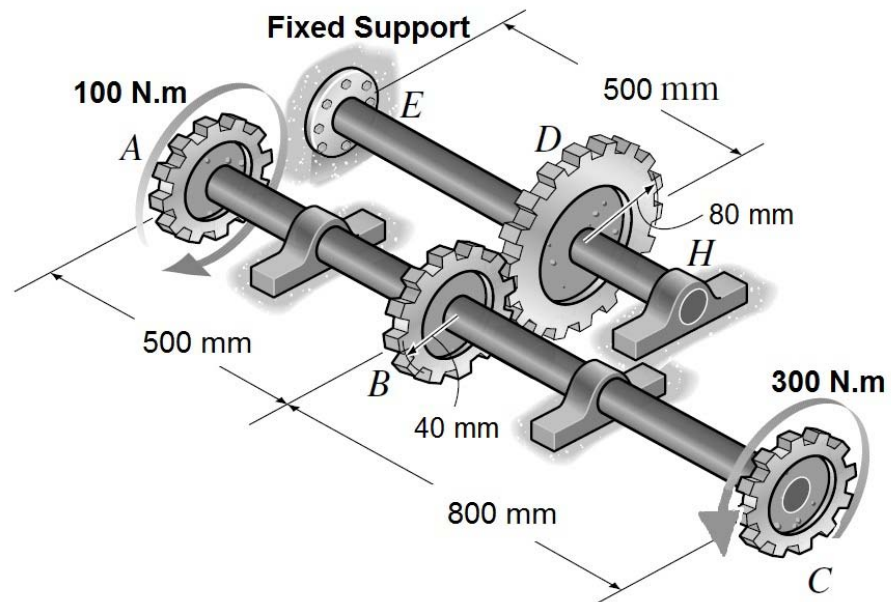
Notes:

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)

Shafts ABC and EDH are connected using the shown gear system. Both shafts have circular cross sections (**radius = 20 mm**) and material shear modulus $G = 100 \text{ GPa}$.

- Determine the magnitude of the maximum shear stress in the whole structure. Also, indicate where this maximum stress is located.
- Determine the relative angle of twist of point C with respect to point A .
- Determine the angle of twist of point C .



Problem 2: (20 points)

The shown shaft is made by connecting two segments, AB which has an equilateral triangular cross section and BC which has a thin hollow equilateral triangular cross section.

Determine:

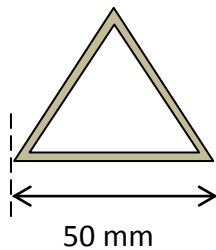
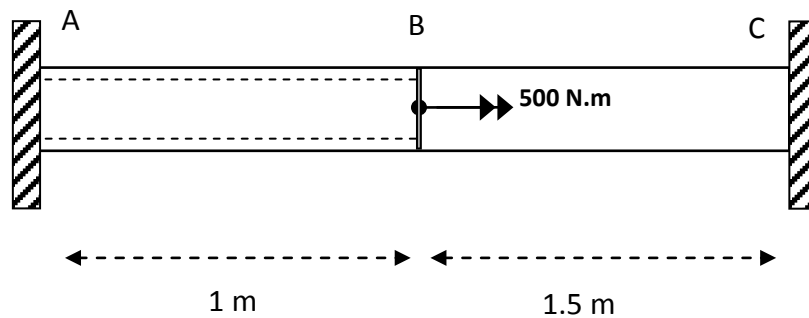
- The maximum shear stress in the whole shaft and indicate its location.
- The angle of twist of point B.

Given:

Side width = 50 mm

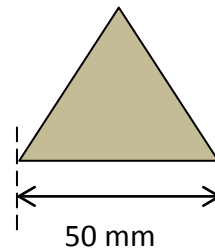
Thickness = 2 mm

$G = 30 \text{ GPa}$



Cross section between A and B

($t = 2 \text{ mm}$)

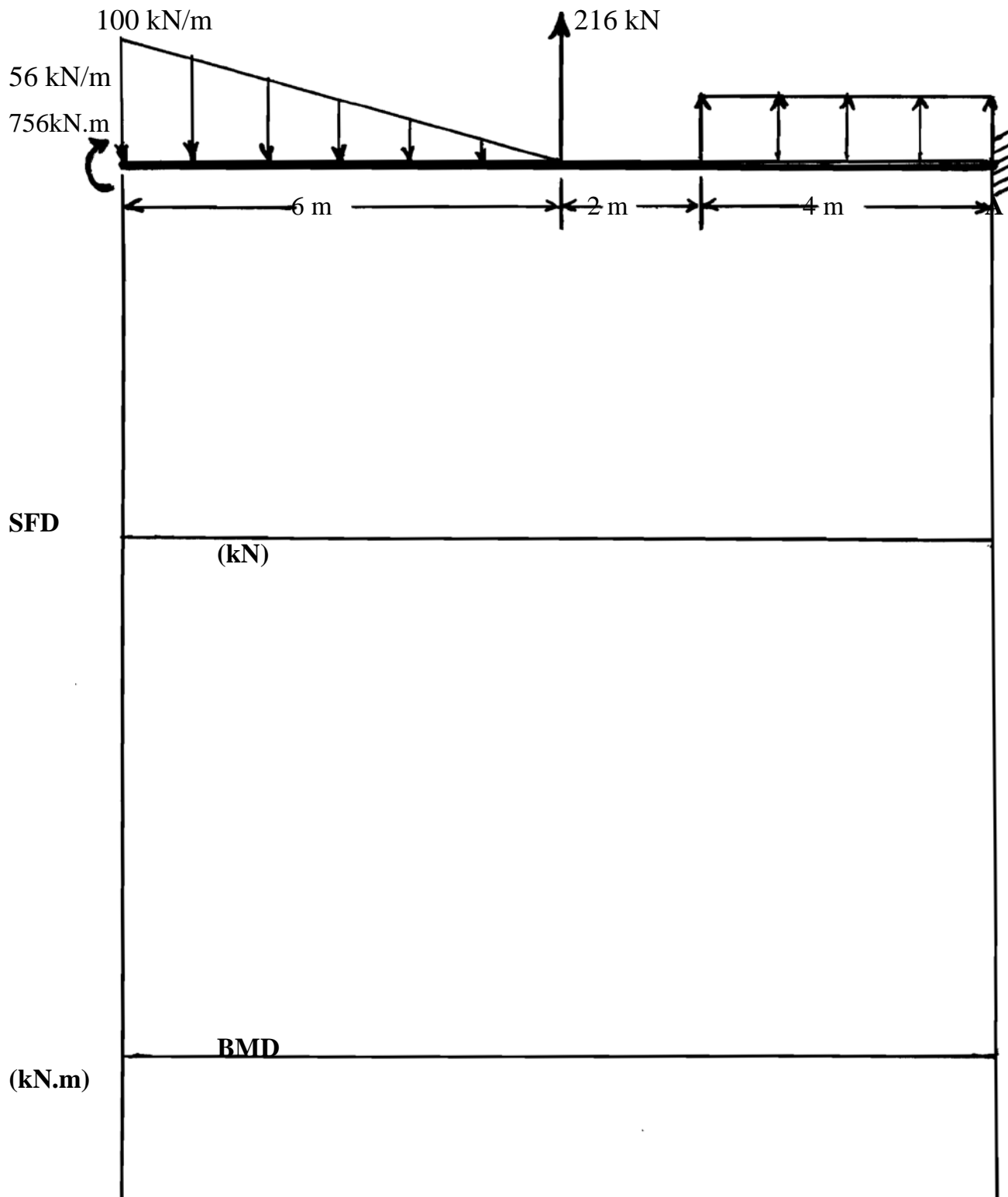


Cross section between B and C

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 all values on the diagrams. Use appropriate scale. *No credit will be given if another method is used.*

The reactions are: $R_A = 140 \text{ kN}$ $\downarrow M_A = 500 \text{ kN.m}$ \curvearrowright



Problem 4: (20 points)

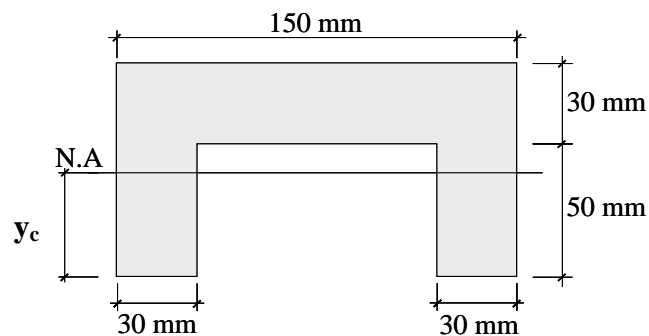
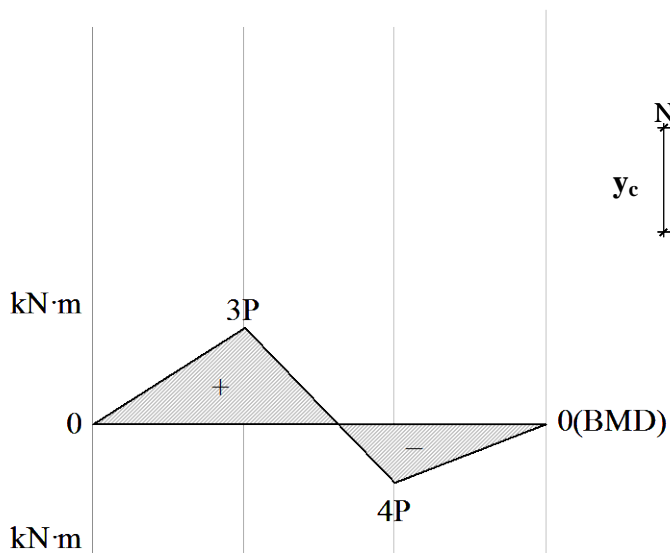
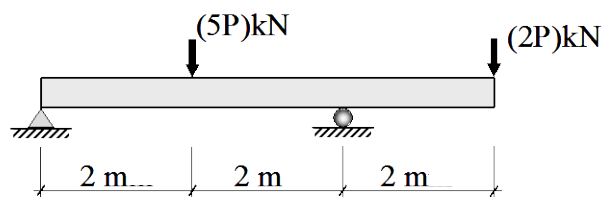
Beam ABCD is shown with the bending moment diagram and the cross-section details.

If for the used material

$(\sigma_{\text{allowable}})_{\text{Tension}} = 20 \text{ MPa}$ and

$(\sigma_{\text{allowable}})_{\text{Compression}} = 15 \text{ MPa}$.

- a) Verify that $y_c = 49 \text{ mm}$ from the bottom of the cross-section and that $I_{N.A.} = 3.8425 \times 10^6 \text{ mm}^4$.
- b) Using the values of y_c and $I_{N.A.}$ given in part (a) and the given bending moment diagram, compute the maximum load P that can be safely applied to the beam.



Problem 5: (20 points)

The vertical shear force in a beam, with the cross-section shown below, is 500 kN.

- Qualitatively* (without numbers), **draw the vertical shear stress distribution (τ)** on the section (to the right of shown section).
- Determine the **shear stresses** at points A and B (just above and just below line LL).
- Determine the **value and location of the maximum shear stress**.

The Centroidal Axis (C.A.) is located as shown on the cross section and $I_{C.A.} = 9.884(10)^7 \text{ mm}^4$.

