UNIVERSITY OF JOHANNESBURG

PROGRAM	:	BACCALAUREUS INGENERIAE *MECHANICAL ENGINEERING SCIENCE*
SUBJECT	:	**INTRODUCTION TO ENGINEERING DESIGN 1A**
CODE	:	**IINEEA1/IIN1A11**
DATE	:	WINTER EXAMINATION JUNE 2019
DURATION	:	(1-PAPER) 180 Minutes
WEIGHT	:	50:50
TOTAL MARKS	:	80

EXAMINERS	:	DR. M. BHAMJEE
MODERATOR	:	DR. A. MANESCHIJN
NUMBER OF PAGES	:	18 PAGES

REQUIREMENTS	:	CALCULATOR

INSTRUCTIONS TO CANDIDATES:

- THIS IS A BLACKBOARD TEST
- ANSWER ALL THE QUESTIONS
- DO NOT UNSTAPLE THESE SHEETS
- QUESTION PAPERS MUST BE HANDED IN
- NAME AND EXPLAIN ALL ASSUMPTIONS WHERE REQUIRED
- SHOW ALL THE STEPS IN YOUR CALCULATIONS CLEARLY WHERE REQUIRED
- ENSURE THAT YOU CAPTURE YOUR ANSWERS ON BLACKBOARD AND SAVE REGULARLY

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- NO ANSWERS WILL BE GRADED FROM THE HARD COPY
- THE HARD COPY IS A BACKUP IN THE EVENT THAT THERE IS A BLACKBOARD ISSUE
- IN ADDITION, PLEASE COPY THE ANSWERS IN ANSWER BOOKLET PROVIDED AS A BACKUP
- THE ANSWER BOOKLET MAY BE USED FOR ROUGH WORK
- IF YOU EXPERIENCE ANY ERRORS WITH THE BLACKBOARD TEST PLEASE DISCUSS WITH THE HEAD INVIGILATORS IMMEDIATELY

QUESTION 1: [5]

Define Hooke's Law and give the equation that describes Hooke's Law.

QUESTION 2: [5]

Explain the parallel-axis theorem for moments of inertia.

QUESTION 3: [2]

Truss members supporting a roof are connected to a gusset plate by a pin as shown in Figure 1. Are the pins in single shear, double shear or compression?

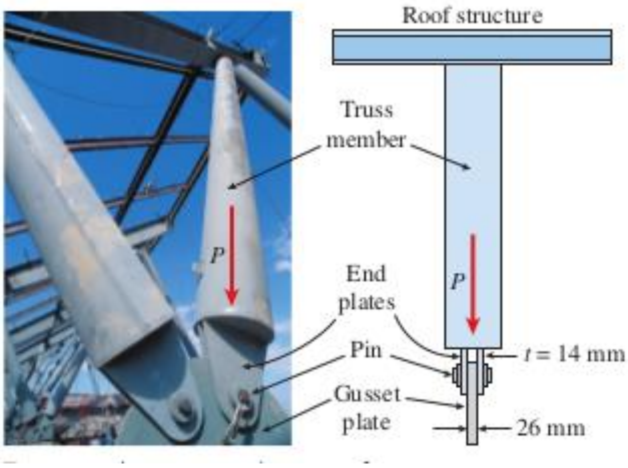

Figure 1. Truss members supporting a roof.

QUESTION 4: [2]

Truss members supporting a roof are connected to a 26 mm thick gusset plate by a [d] mm diameter pin as shown in Figure 1. The two end plates on the truss members are each 14 mm thick. If the load P = [T] kN, calculate the shear stress in the pin in MPa. Provide the answer to two decimal places.

QUESTION 5: [3]

Explain the method you used to get to the answer in the previous question. You may use formulae.

<u>QUESTION 6:</u> [2]

Truss members supporting a roof are connected to a 26 mm thick gusset plate by a pin as shown in the Figure 1. The two end plates on the truss members are each 14 mm thick. If the load P = [T] kN, calculate the normal stress in the truss in MPa. Provide the answer to two decimal places

<u>QUESTION 7:</u> [2]

What is the formula that relates the shear strain (y) to the shear stress (t) and the modulus of rigidity (G)? Use / for divide and * for multiply.

<u>QUESTION 8:</u> [5]

A solid brass rod with diameter 25 mm is placed concentrically inside a steel tube with an inside diameter of 25 mm and an outside diameter of 50 mm. The rod and the tube are rigidly connected at both ends and have an original length of 1 m. The temperature is increased from 15ºC to 95ºC. Indicate which bar is in tension and which is in compression.

$$\alpha_{tube} = 11.6\,(10^{-6})/\,℃ \text{ and } \alpha_{rod} = 18.7\,(10^{-6})/\,℃$$

$$E_{tube} = 200\ GPa \text{ and } E_{rod} = 100\ GPa$$

Determine the following values:

$\boldsymbol{A_{rod}} =$ ______________ $\boldsymbol{mm^2}$ (up to two decimal places)

$\boldsymbol{A_{tube}} =$ _____________ $\boldsymbol{mm^2}$ (up to two decimal places)

$\Delta\boldsymbol{T} =$ _______________ ℃

$\boldsymbol{\sigma_{rod}} =$ ______________ $\boldsymbol{MPa}$ (up to two decimal places) **Tension/Compression**

$\boldsymbol{\sigma_{tube}} =$ _____________ $\boldsymbol{MPa}$ (up to two decimal places) **Tension/Compression**

QUESTION 9: [5]

Explain the method you used to get to the answer in the previous question. You may provide the final formulae or indicate the steps used to obtain the formulae.

QUESTION 10: [15]

The beam shown in Figure 2 is pin supported at A and roller supported at B.

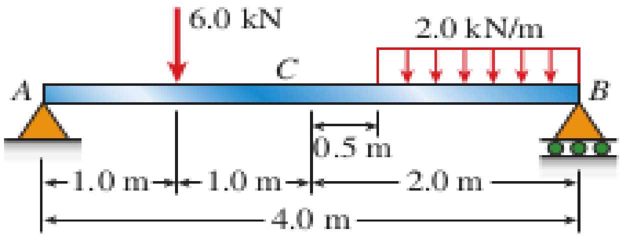

Figure 2: A beam.

a) Determine the support reactions at A and B for the beam as shown in Figure 2. Provide the answers up to two decimal places. (3)

$A_x =$ ________________ kN

$A_y =$ ________________ kN

$B_y =$ ________________ kN

b) Determine the following internal loads. Where required indicate if the internal load is constant, varies linearly or varies parabollically. (12)

For $x = 0.5\ m$

$V =$ ______________ kN **Constant/Linear/Parabolic**

$M =$ ______________ kNm **Constant/Linear/Parabolic**

For $x = 2.0\ m$

$V =$ ______________ kN **Constant/Linear/Parabolic**

$M =$ ______________ kNm **Constant/Linear/Parabolic**

For $x = 3.0\ m$

$V =$ ______________ kN **Constant/Linear/Parabolic**

$M =$ ______________ kNm **Constant/Linear/Parabolic**

QUESTION 11: [2]

What is the formula that is used to calculate the Centroid for a composite section?

QUESTION 12: [2]

What is the formula that is used to calculate the moment of inertia of a cross section about its centroid?

QUESTION 13: [2]

What is the formula that is used to calculate the bending stress in the beam?

QUESTION 14: [15]

Given the section of the I-beam as shown in Figure 3. Take the base flange as section 1, the web as section 2 and the top flange as section 3. The width b = 250mm.

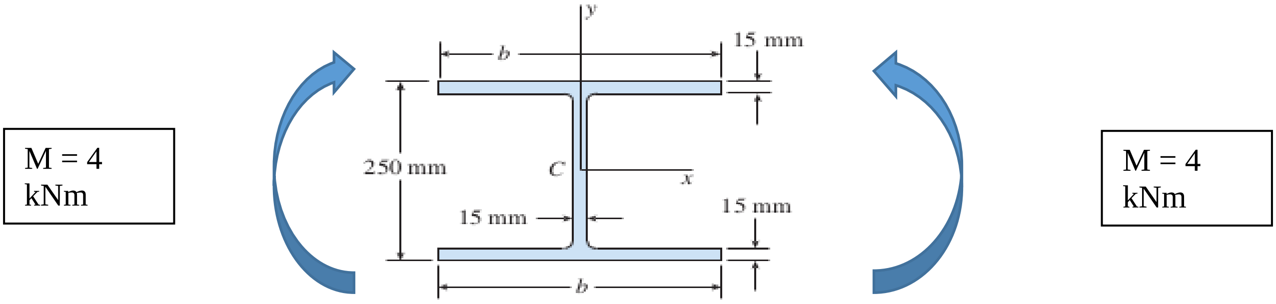

Figure 3. I-Beam Cross Section

Calculate the following values:

$A_1 =$ ________________ $10^{-3}m^2$ (up to two decimal places)

$A_2 =$ ___________________ $10^{-3}m^2$ (up to two decimal places)

$A_3 =$ ___________________ $10^{-3}m^2$ (up to two decimal places)

$A_1 + A_2 + A_3 =$ ___________________ $10^{-3}m^2$ (up to two decimal places)

$y_1 =$ ___________________ m (up to four decimal places)

$y_2 =$ ___________________ m (up to four decimal places)

$y_3 =$ ___________________ m (up to four decimal places)

$I_1 =$ _________________ $10^{-8}m^4$ (up to three decimal places)

$I_2 =$ ___________________ $10^{-8}m^4$ (up to three decimal places)

$I_3 =$ ___________________ $10^{-8}m^4$ (up to three decimal places)

$I_1 + I_2 + I_3 =$ ___________________ $10^{-8}m^4$ (up to three decimal places)

$\overline{y} =$ ___________________ m (up to three decimal places)

$I_{xx} =$ ___________________ $10^{-4}m^4$ (up to three decimal places)

$\sigma_t =$ ___________________ MPa (up to two decimal places)

$\sigma_c =$ ___________________ MPa (up to two decimal places)

QUESTION 15: [13]

The plane truss shown in Figure 4 is roller supported at A and has a pin support at C.

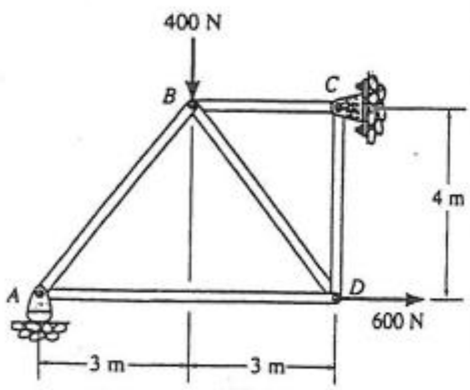

Figure 4. Truss members.

a) Find support reactions at joints A and C in kN? Report all values to two decimal places. (3)

$A_y =$ ___________________ kN

$C_y =$ ___________________ kN

$C_x =$ ___________________ kN

b) Solve for forces in members AB, AD, BD, BC and CD in kN? Indicate for each member if the member is in tension or compression. If in tension only write T in the space provided and if in compression only write C in the space provided. Report all values to two decimal places. (10)

$F_{AB} =$ ___________________ kN **Tension/Compression**

$F_{AD} =$ ___________________ kN **Tension/Compression**

$F_{BD} =$ ___________________ kN **Tension/Compression**

$F_{BC} =$ ___________________ kN **Tension/Compression**

$F_{CD} =$ ___________________ kN **Tension/Compression**

ROUGH WORK PAPER: