POLITEKNIK
Jabatan Pengajian Politeknik

EXAMINATION AND EVALUATION DIVISION
DEPARTMENT OF POLYTECHNIC EDUCATION
(MINISTRY OF HIGHER EDUCATION)

MECHANICAL ENGINEERING DEPARTMENT

FINAL EXAMINATION

JUNE 2012 SESSION

J3009 : STRENGTH OF MATERIALS 1

DATE : 22 NOVEMBER 2012 (THURSDAY)
DURATION : 2 HOURS (8.30 – 10.30 AM)

This paper consists of **SEVEN (7)** pages including the front page.
Section A : Structured (6 questions – answer 4 questions)

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SECTION A

STRUCTURED (100 marks)

INSTRUCTION:

This section consists of **SIX (6)** structured questions. Answer **FOUR (4)** questions only.

QUESTION 1

a) Explain clearly the following terms:

i. Stress

ii. Strain

iii. Hooke's Law

(6 marks)

b) A bar with a diameter 35mm is subjected to a compressive force of 150 kN. This load causes a reduction in length of 0.17×10^{-3} m. The original length of the bar is 200mm. Determine the Modulus of Elasticity of this material.

(5 marks)

c) A bar with a 30 mm diameter and 80 mm length is subjected to a tensile force of 100kN. The ultimate stress is 230 MN/m^2. As a result of this force, the bar elongates by 0.0585 mm and the diameter becomes 29.994 mm. Determine:

i. the tensile stress

ii. the tensile strain in x-x direction

iii. the tensile strain in y-y direction

iv. Modulus of elasticity

v. Strain energy

vi. safety factor

vii. Poisson's ratio.

(14 marks)

QUESTION 2

A composite bar as shown in Figure 1 is made up of steel and brass connected in parallel with a cross sectional area of 600mm^2 and 1000mm^2 respectively. The bar is rigidly fixed at both ends.

a) Calculate the stress in each bar when a compressive load of 60kN is applied axially on the composite bar.

(10 marks)

b) Calculate the stress developed in each bar when the temperature is raised through 100^{0}C at the moment the load is applied.

Given:

E_{Steel}= 206GN/m^2 α_{Steel} = 12x10^{-6}/^{0}C

E_{Brass}= 107GN/m^2 α_{Brass} = 16.5x10^{-6}/^{0}C

(15 marks)

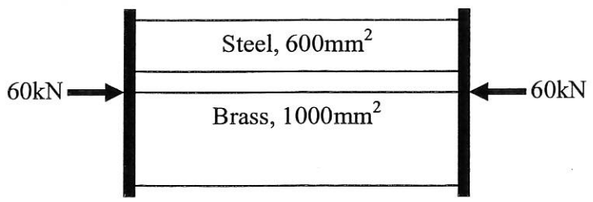

Figure 1

QUESTION 3

A 9 m long horizontal beam ABCD, as shown in Figure 2 is simply supported at A and D. It carries a uniformly distributed load of 50 kN/m between A and B, and a concentrated load of 20 kN at C. The length of the various portions are: AB = 5 m, BC = 2 m and CD = 2 m.

a) Draw the shear force diagram, and determine the position from A at which shear force is zero.

(16 marks)

b) Determine the value of bending moment at this point.

(6 marks)

c) Sketch the bending moment diagram approximately to scale quoting the principal values.

(3 marks)

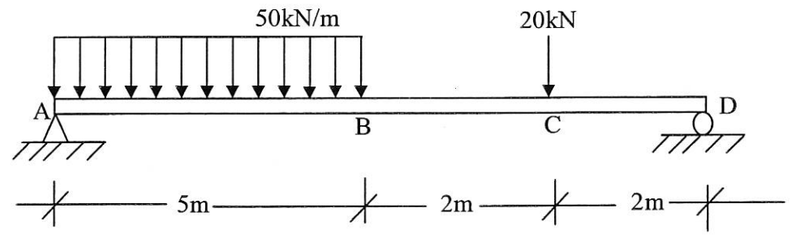

Figure 2

QUESTION 4

a) A 5m cantilever beam of cross-section 150mm × 300mm carries a uniformly distributed load of 0.05 kN/m along the beam and a concentrated load of 30kN at its free end as shown in Figure 3. Determine the maximum bending stress at a section 2m from the free end.

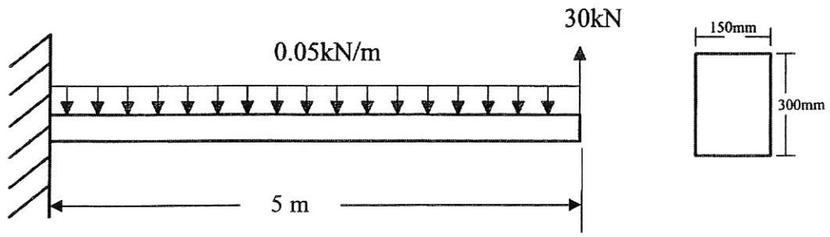

Figure 3

(10 marks)

b) A 5m steel beam having an *I*- cross section as shown in Figure 4 is simply supported at its ends. The tensile stress in the beam must not exceed 25MN/m^2. Determine the maximum uniformly distributed load, w that can be supported by the entire beam.

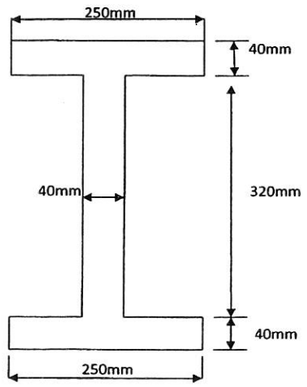

Figure 4 (15 marks)

QUESTION 5

A steel bar with a cross section as shown in Figure 5 below, is subjected to a 200 kN shear force along YY axis.

a) Determine the position of the neutral axis. (8 marks)

b) Draw the neutral axis based on Figure 5. (3 marks)

c) Calculate the moment of inertia. (6 marks)

d) Calculate the shear stress at cross section AA and BB (8 marks)

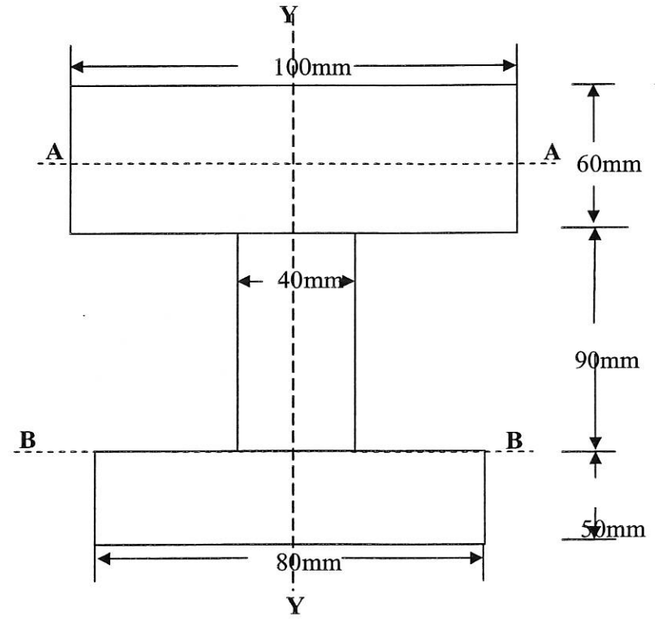

Figure 5

QUESTION 6

a) A shaft with a diameter of 150 mm and 2 m in length is transmitting 45 kW power at 500 r.p.m. Calculate the value of shear stress induced in the shaft.

(10 marks)

b) A solid shaft which consists of two portions, portion AB and portion BC, is subjected to a torque of 100 Nm at the end of BC as shown in Figure 6 below. Determine the value of the maximum shear stress in the shaft and total angle of twist in radian if G =75 GN/m^2.

(15 marks)

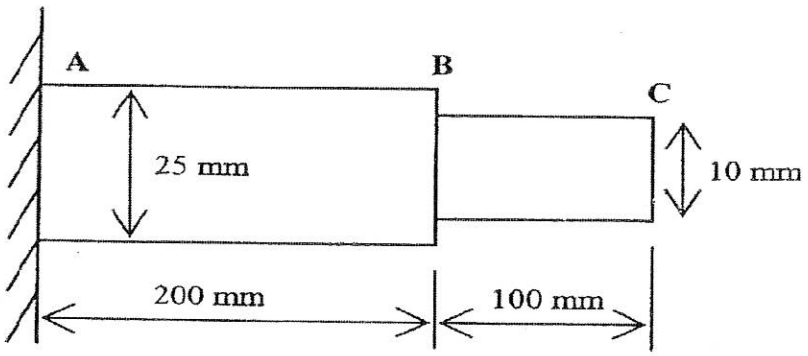

Figure 6