



**UTHM**  
Universiti Tun Hussein Onn Malaysia

**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
SEMESTER 2  
SESSION 2015/2016**

**COURSE NAME** : **SOLID MECHANICS 2**  
**COURSE CODE** : **BDA20903 / BDA30303**  
**PROGRAMME** : **BDD**  
**EXAMINATION DATE** : **JUNE / JULY 2016**  
**DURATION** : **3 HOURS**  
**INSTRUCTION** : **ANSWER FIVE (5) FROM SIX (6)  
QUESTIONS**

**THIS QUESTION PAPER CONSISTS OF SIX (6) PAGES**

**Q1** A 45° strain rosette is firmly attached on the surface of a structure under loading. The following readings are recorded:

Strain gauge A,  $\epsilon_a = +450\mu$  at 0°

Strain gauge B,  $\epsilon_b = +200\mu$  at 45°

Strain gauge C,  $\epsilon_c = -200\mu$  at 90°

Determine:

- (a) The normal strains, (5 marks)
- (b) The principal strains and angles by calculation method, (5 marks)
- (c) The principal strains and angles by Mohr's circle, and (5 marks)
- (d) The equivalent strains when similar element is oriented 20° counter-clockwise (solve this problem using Mohr's circle obtained from (c)). (5 marks)

**Q2** (a) Define the following terms:

- (i) The elastic curve of a beam, (1 marks)
- (ii) Positive and negative internal moment, and (1 marks)
- (iii) Inflection point. (1 marks)

(b) Proof that the relationship between the moment and the curvature of an elastic curves of beam is given by:

$$\frac{1}{\rho} = \frac{M}{EI}$$

(7 marks)

(c) Determine the equation of the elastic curve for the cantilevered beam using Macaulay's Function as shown in **Figure Q2**.

(10 marks)

- Q3** (a) Define the following terms:
- (i) Columns, (1 mark)
  - (ii) Strut, (1 mark)
  - (iii) Slenderness ratio, (1 mark)
  - (iv) Buckling factor, and (1 mark)
  - (v) Buckling load.
- (b) The effective-length factor,  $K$  is vary depends on the column end support. There are four different values of  $K$ . For each value of  $K$ , draw the diagram of the column with their different end supports. (5 marks)
- (c) The A-36 steel bar  $AB$  as shown in **Figure Q3** has a square cross section. If it is pin-connected at its ends, determine the maximum allowable load  $P$  that can be applied to the frame. Use a factor of safety with respect to buckling of 2. Use  $E = 210$  GPa and  $\sigma_y = 250$  MPa. (10 marks)

- Q4** An overhanging beam  $ABC$  shown in **Figure Q4** is subjected to concentrated force,  $P$  at point  $A$  and uniformly distributed force,  $w$  across points  $B$  to  $C$ . Considering the Castigliano's theorem, prove that the slope at mid-point (saying point  $D$ ) between  $B$  and  $C$  is:

$$\theta_D = \left( \frac{dy}{dx} \right)_D = -\frac{wL^3}{360EI}$$

(20 marks)

- Q5** (a) Derive the expression of longitudinal stress,  $\sigma_L$  for a closed thick cylinder which has inner radius,  $R_1$  and outer radius,  $R_2$  and subjected to internal pressure only. (3 marks)
- (b) A set of same material compound cylinder having similar wall thickness of 25mm with first tube internal diameter of 250mm and second tube wall thickness of 250mm external diameter. Due to shrinkage, the stress set up between the two mating material is 10MPa with internal pressure of 80MPa. Using graph paper provided, sketch stress distribution graph due to:
- (i) Internal pressure only assuming the compound cylinder as a single cylinder as a single cylinder, and (6 marks)
- (ii) Shrinkage pressure acting on the two separate cylinders, (6 marks)
- (iii) Once the stresses are completely sketch, find the resultant hoop stresses occur across the cylinder wall. (5 marks)
- Q6** (a) Compare the difference between brittle and ductile material and give one example for each material. (6 marks)
- (b) A steel tube has a mean diameter of 100 mm and a thickness of 3mm. The elastic limit of the steel in tension is 225 MN/m<sup>2</sup> with Poisson's ratio of 0.3. Calculate the torque,  $T$  which can be transmitted by the tube with a factor of safety of 2.25 if the criterion of failure is:
- (i) Maximum shear stress. (5 marks)
- (ii) Maximum strain energy. (5 marks)
- (iii) Maximum shear strain energy. (5 marks)

- END OF QUESTION -

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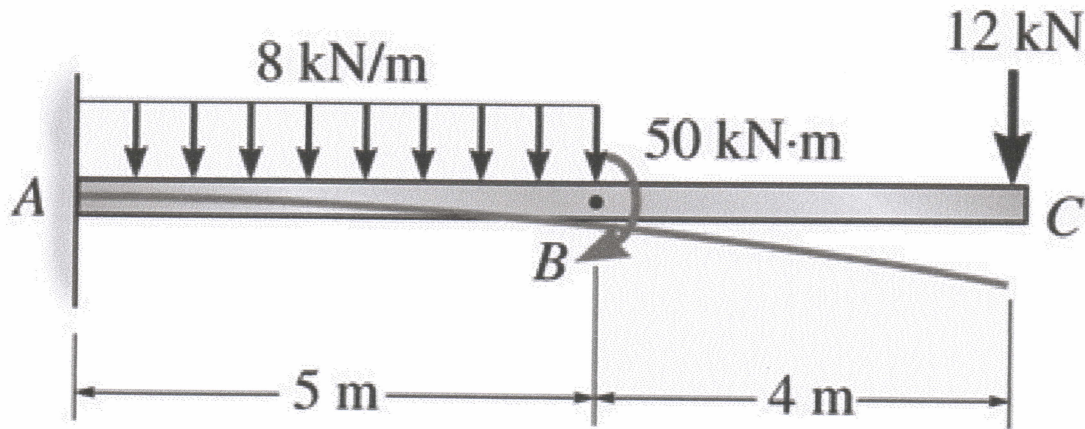


Figure Q2

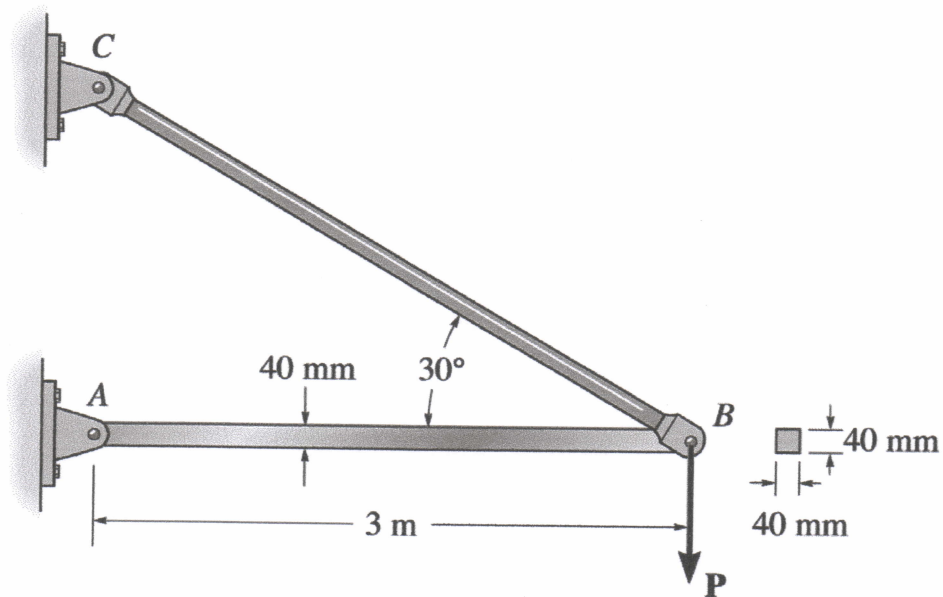
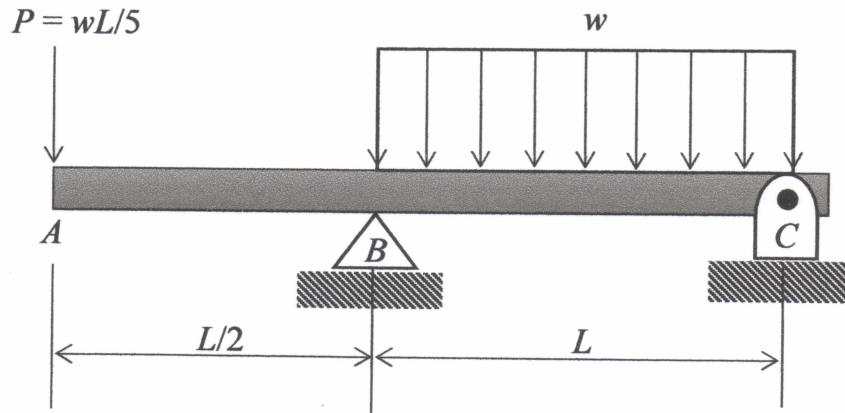


Figure Q3

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**Figure Q4**