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Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2016/2017

COURSE NAME	:	SOLID MECHANICS
COURSE CODE	:	BNJ10403 / BNJ20903
PROGRAMME CODE	:	BNG/BNH/BNK/BNL/BNM
EXAMINATION DATE	:	JUNE 2017
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

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Q1 (a) Differentiate between stress and strain, and provide the related formula.

(4 marks)

(b) A verticle force of **P = 1800 N** is applied to the bell crank as shown in **Figure Q1(b)**.

(i) Draw the free body diagram (FBD) at the bell crank.

(3 marks)

(ii) Determine the support reaction.

(4 marks)

(iii) Calculate the average normal stress developed in the 0.8 cm diameter rod CD.

(3 marks)

(iv) Draw the free body diagram (FBD) at pin B.

(2 marks)

(v) Calculate the average shear stress developed in 6 mm diameter pin B that subjected to double shear.

(4 marks)

Q2 Beam is one of the importance structural and mechanical elements in engineering, and classified as to how they are supported. In order to increase the strength for supporting loads, beams constructed of two or more different materials are referred to as composite beams.

(a) Explain **TWO (2)** assumptions made for composite beam analysis.

(4 marks)

(b) An L2 steel strap having a thickness of **5 mm** and a width of **5 cm** is bent into circular arc of radius **20 m**. Determine the maximum bending stress in the strap. (E = 200 GPa)

(5 marks)

(c) Draw the shear and moment diagrams for the beam as shown in **Figure Q2(c)**.

(11 marks)

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Q3 The gas pipe line is supported every **6 m** by concrete piers and also lays on the ground. If there are rigid retainers at the piers that hold the pipe is fixed. The gas within the pipe is at pressure of **4.8 MPa**. The pipe has inner diameter of **50 cm** and the thickness of **6 mm**. The material is A-36 steel with modulus o elasticity, **E= 200 GPa** and $\alpha = 12 \times 10^{-6}/^{0}C$. Determine:

(a) The longitudinal and hoop stress in pipe if the temperature rises **25 ^{0}C** from the temperature at which it installed.

(10 marks)

(b) Equivalent state of stress for the element oriented at angle $\theta = 50^{0}$ counter-clockwise.

(10 marks)

Q4 (a) An element of material subjected to plane strain as shown in **Figure Q4(a)** has strains as follows: $\epsilon_x = 220 \times 10^{-6}$, $\epsilon_y = 480 \times 10^{-6}$ and $\gamma_{xy} = 180 \times 10^{-6}$. Calculate the strains for an element oriented at angle $\theta = 30^{o}$ clockwise.

(10 marks)

(b) **Figure Q4(b)** shows the steel shaft is made from two segments: AC has a diameter of **10 mm**, and CB has a diameter of **20 mm**. If it is fixed at its ends A and B and subjected to a torque of **500 Nm**, determine the maximum shear stress in the shaft. **(G=75 GPa)**

(10 marks)

Q5 (a) Explain briefly the theories of elastic failures for each theory.

(i) Rankine theory.

(2 marks)

(ii) Tresca Yield Criterion.

(2 marks)

(iii) Von Misses theory.

(2 marks)

(b) **Figure Q5(b)** shows the wood column has a square cross section with dimensions (**100 mm** x **100 mm**). It is fixed at its based and free at its top. Determine the load P that can be applied to the edge of the column without causing the column to fail either by buckling or by yielding. Given $E_w = 12$ **GPa** and $\sigma_y = 55$ **MPa**.

(14 marks)

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Q6 **Figure Q6** shows the cantilevered aluminum alloy rectangular beam with **G = 26 GPa** and **E = 68.9 GPa**.

(a) Calculate the Internal loadings

(4 marks)

(b) Determine the Shearing Strain Energy

(4 marks)

(c) Determine the Bending Strain Energy

(4 marks)

(d) Determine external work or external force

(4 marks)

(e) Calculate the Conservation of Energy.

(4 marks)

-END OF QUESTION-

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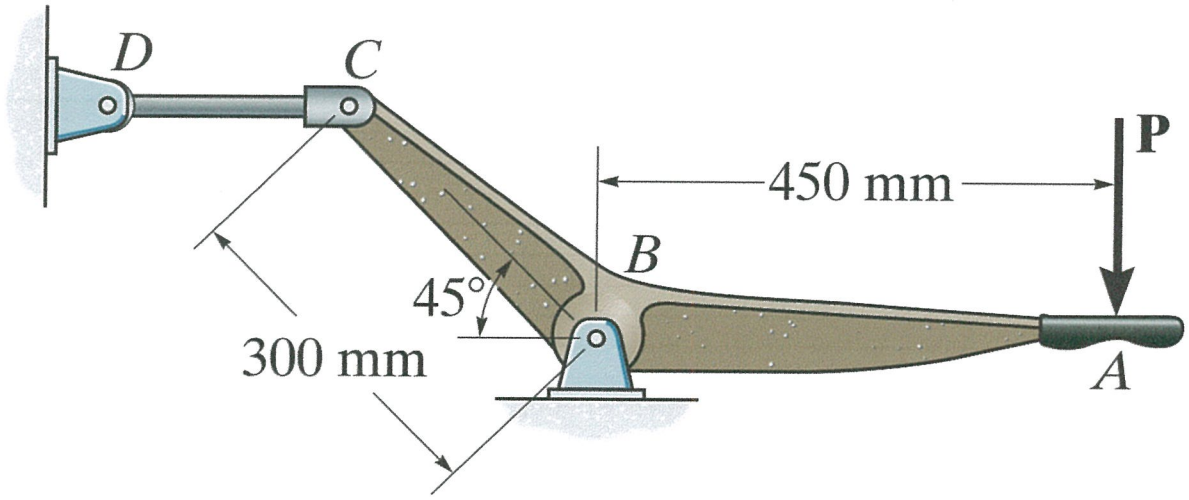

Figure Q1(b)

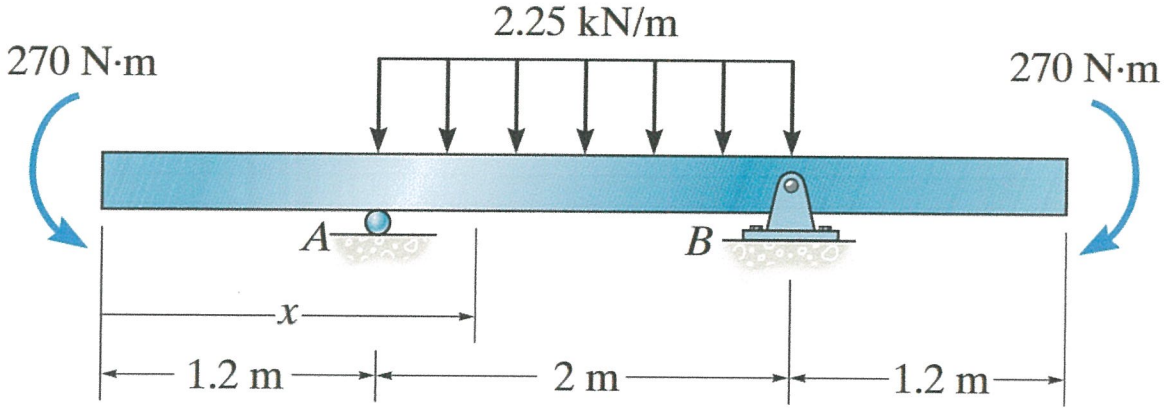

Figure Q2(c)

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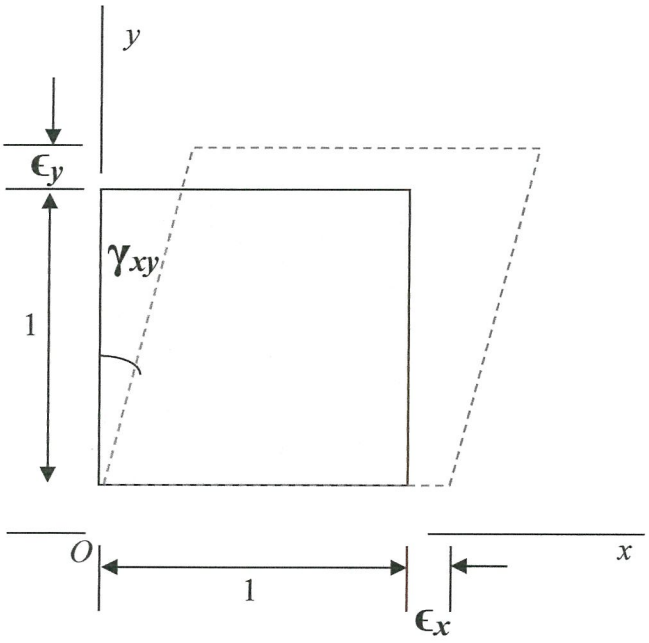

Figure Q4(a)

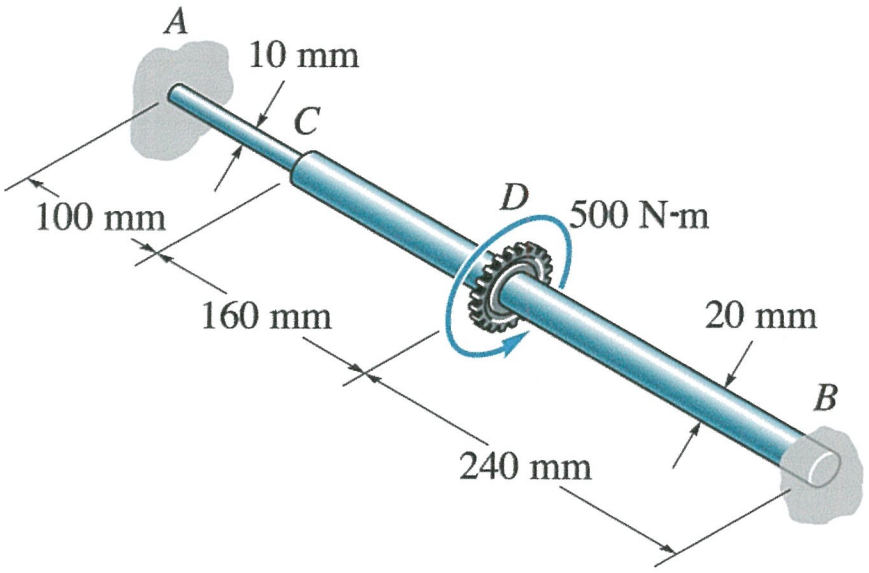

Figure Q4(b)

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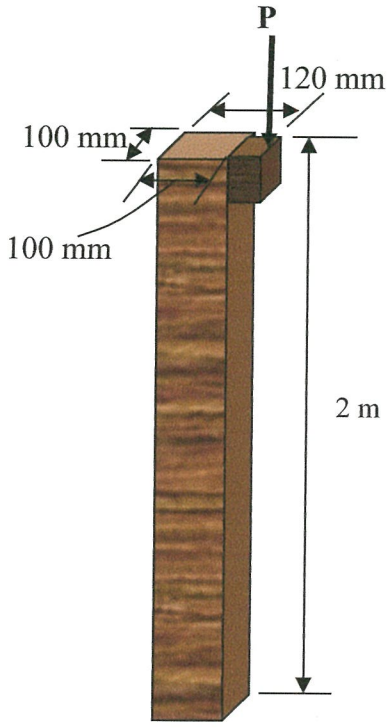

Figure Q5(b)

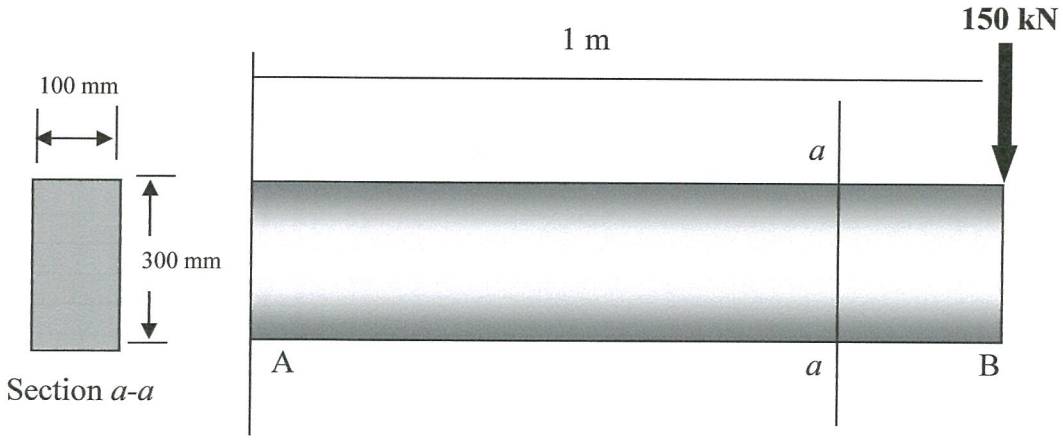

Figure Q6