Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	MATERIAL TESTING AND EVALUATION
COURSE CODE	:	BWC 40403
PROGRAMME CODE	:	BWC
EXAMINATION DATE	:	DECEMBER 2019/ JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **FOUR (4)** PAGES

Q1 (a) Explain the basic principle of magnetic particle inspection.

(6 marks)

(b) Name a suitable testing method for each of the following properties:

(i) Strength
(ii) Ductility
(iii) Hardness
(iv) Toughness

(4 marks)

(c) Explain the importance of non-destructive testing in the industry. Include some examples of applications in your discussion.

(10 marks)

Q2 (a) The graph in **Figure Q2** shows the relationship between tensile stress and tensile strain for a specimen of metal. Copy the graph and label it with the following regions or points (i), (ii), (iii), (iv) in accordance to the shape of a ductile specimen in **Figure Q2**.

(4 marks)

(b) (i) Explain the significance of the slope S as shown in **Figure Q2.**

(4 marks)

(ii) Define toughness in the context as a property of materials.

(2 marks)

(iii) Demonstrate how toughness can be calculated through the tensile stress-strain curve.

(2 marks)

(c) A steel test specimen ($E = 30 \times 10^6$ lb/in^2) in a compression test has a starting height = 2.0 in and diameter = 1.5 in. The metal yields (0.2% offset) at a load = 140,000 lb. At a load of 260,000 lb, the height has been reduced to 1.6 in. Assuming that the cross-sectional area increases uniformly during the test.

Calculate:

(i) yield strength Y,
(ii) total strain at the offset yield point
(iii) True strain
(iv) True stress

(8 marks)

Q3 (a) Differentiate between Rockwell, Brinell, and Vickers hardness tests and name an application for each method.

(6 marks)

(b) Suggest a suitable hardness test for a rubber tire. Justify your suggestion and detail out how the test is undertaken for such purposes.

(8 marks)

(c) Brinell Hardness Number, *HB* is given by the following equation:

$$HB = \frac{2P}{\pi D\left[D - \sqrt{D^2 - d^2}\right]}$$

(i) If a 10-mm-diameter Brinell hardness indenter produced an indentation 1.62 mm in diameter in a steel alloy when a load of 800 kg was used, calculate the *HB* of this material.

(ii) Using the same indenter in **Q3(a)(i)**, calculate the diameter of an indentation that yield a hardness of 450 HB when a 800 kg load is used.

(6 marks)

Q4 Stress life testing is based on Wohler's work and requires multiple constant amplitude fatigue tests on identical samples to generate an S-N or Wohler diagram.

(a) Define what is the fatigue limit of a material.

(2 marks)

(b) A bicycle pedal is to be tested its endurance limit. Elaborate on the details of the steps taken in this test and how the endurance limit is computed.

(9 marks)

(c) **Figure Q4** shows the S-N diagram of steel and aluminium. If a sctructural element is to undergo a repeated cyclic stress of 35 ksi over its life time,

(i) Determine its fatigue life, if it is made of aluminium?

(3 marks)

(ii) Determine which material would you choose if the element is to endure 10^6 loading cycles during its life time. Justify your answer.

(6 marks)

Q5 (a) Describe and illustrate the data presentation available with ultrasonic testing method.

(6 marks)

(b) Explain the principle of ultrasonic transducer in producing ultrasonic waves.

(8 marks)

(c) Two important aspects of an ultrasonic system is sensitivity and resolution.

(i) Define sensitivity and resolution.

(2 marks)

(ii) Describe how sensitivity and resolution can be improved in the ultrasonic system.

(4 marks)

– **END OF QUESTIONS** –

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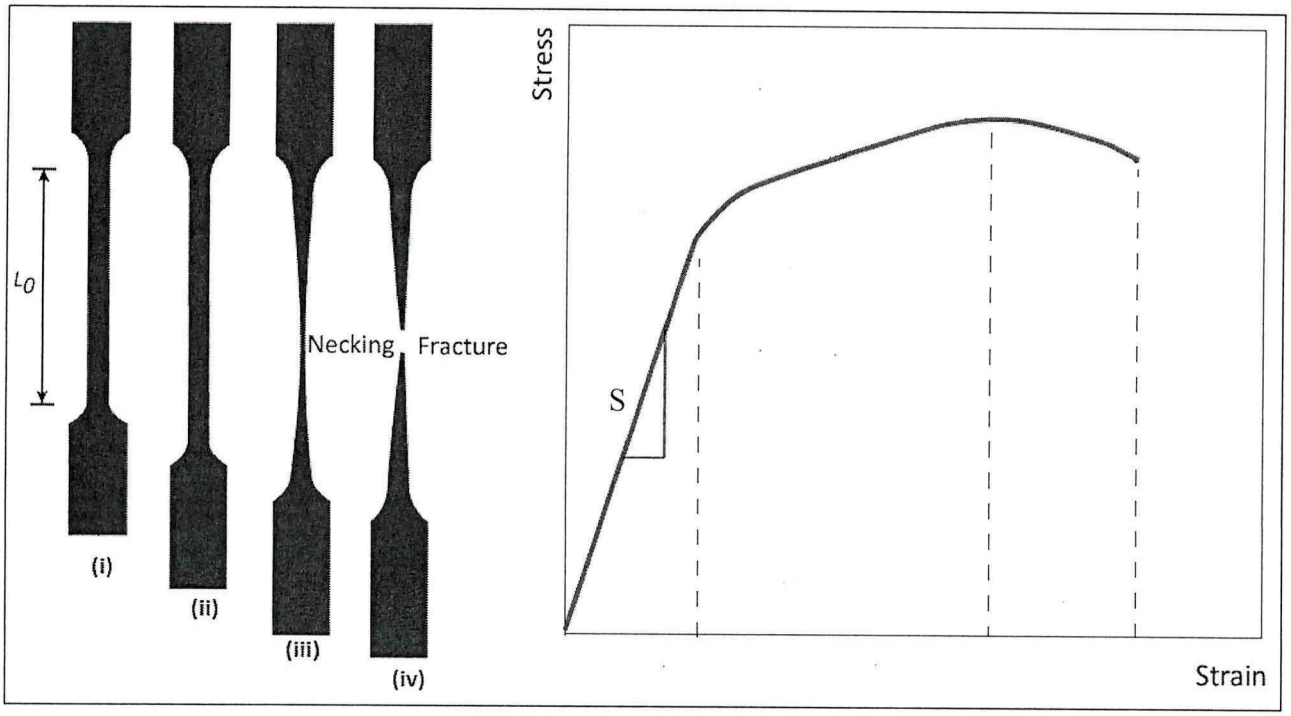

Figure Q2

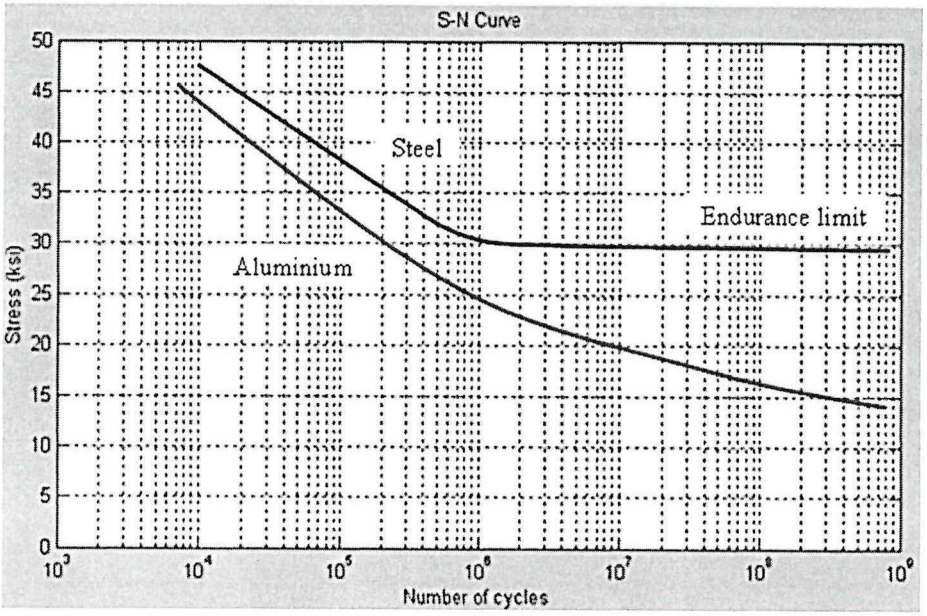

Figure Q4