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**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
SEMESTER II  
SESSION 2022/2023**

COURSE NAME : METROLOGY AND MEASUREMENT

COURSE CODE : BNM 30203

PROGRAMME CODE : BNM

EXAMINATION DATE : JULY / AUGUST 2023

DURATION : 3 HOURS

INSTRUCTION : 1. ANSWER ALL QUESTIONS.  
2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK**.  
3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK.

THIS ANSWERING SCHEME CONSISTS OF FIVE (5) PAGES

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- Q1** (a) Legal metrology is acknowledged as pattern approval and verification of instruments used in legal enforcement. List **THREE (3)** examples of legal metrology. (6 marks)
- (b) Based on answers from **Q(1)(a)**, elaborate all these **THREE (3)** legal metrology listed are important in daily life. (6 marks)
- (c) Differentiate between Limit Tolerance, Plus Minus Tolerance and Bilateral Tolerance (6 marks)
- (d) Feature of Size (FOS) is known as one cylindrical or spherical surface or a set of two opposed elements or opposed parallel surfaces associated with a size of dimension. By using the aids of sketch, construct a part consisting of **FOUR (4)** FOS features in the drawing. (5 marks)
- (e) Based on the answer from **Q(1)(d)**, show **FOUR (4)** features in the sketched answer. (2 marks)
- Q2** (a) **Figure Q(2)(a)** shows the 2D technical drawing of a shaft. From this 2D drawing, all the types (tolerance symbols) and values of dimensional and GD&T tolerances are presented. Explain the meaning (from number 1 to 5) of all the tolerances in this shaft component. (10 marks)
- (b) Differentiate repeatability and reproducibility in measurement system. (2 marks)
- (c) **Figure Q(2)(c)(i)** and **Figure Q(2)(c)(ii)** show a situation given for repeatability and reproducibility during measurement. Based on repeatability and reproducibility in measurement theory, interpret both graphic:
- (i) The lines (represent gauges) in **Figure Q(2)(c)(i)** shows one operator with two gauges. (3 marks)
- (ii) The lines (represent operators) in **Figure Q(2)(c)(ii)** shows three operators with one gauge. (3 marks)
- (d) Choosing which repeatability and reproducibility (GR&R) study to perform depends on how much data are available and whether the measurement test is destructive. GR&R study is divided into **THREE (3)** types, list those studies. (3 marks)

- (e) Calling a product bad when it is good, or calling a product good when it is bad is a part of probabilities of misclassification. Probabilities of misclassification, repeatability and reproducibility is divided in **TWO (2)** types. Name both. (4 marks)
- Q3** (a) List **FOUR (4)** benefits of using digital calipers for manufacturing measuring parts. (4 marks)
- (b) **Figure Q(3)(b)** shows a measurement equipment known as micrometer. Name **SIX (6)** parts labelled from (i) to (iv). (3 marks)
- (c) Feeler gauges consists of thin blades of metal of various thicknesses, precision machined piece of metal that is flat or round. State **FOUR (4)** applications of feeler gauge (4 marks)
- (d) Dial Indicators and torque wrench are measuring instrument which to measure a physical quantity of an object. By using a table, analyses **TWO (2)** differences between dial indicators and torque wrench applications. (8 marks)
- (e) Comparators are classified into five various. Only two types of comparators which commonly used in industry known as mechanical and optical comparators. By using one example of mechanical comparators, explain the **SIX (6)** steps for its working principle. (6 marks)
- Q4** (a) Surface metrology is the measurement of small-scale features on surfaces and is a branch of metrology. Surface finishes are divided into **THREE (3)** forms, name and explain each form. (9 marks)
- (b) Terminology in surface finish measurement is classified into four approaches; direct measurement, comparison, non-contact and on-process. Direct measurement by means of stylus measurement system, is preferred due to its reliability. Explain **THREE(3)** features of stylus in measuring surface texture. (6 marks)
- (c) Inspection and assessment of surface roughness of machined piecework can be carried out by means of different measurement techniques. Classify **FOUR (4)** methods for surface finish measurement. (8 marks)
- (d) State **TWO (2)** disadvantages of direct measurement methods such as using a stylus. (2 marks)

- END OF QUESTION -

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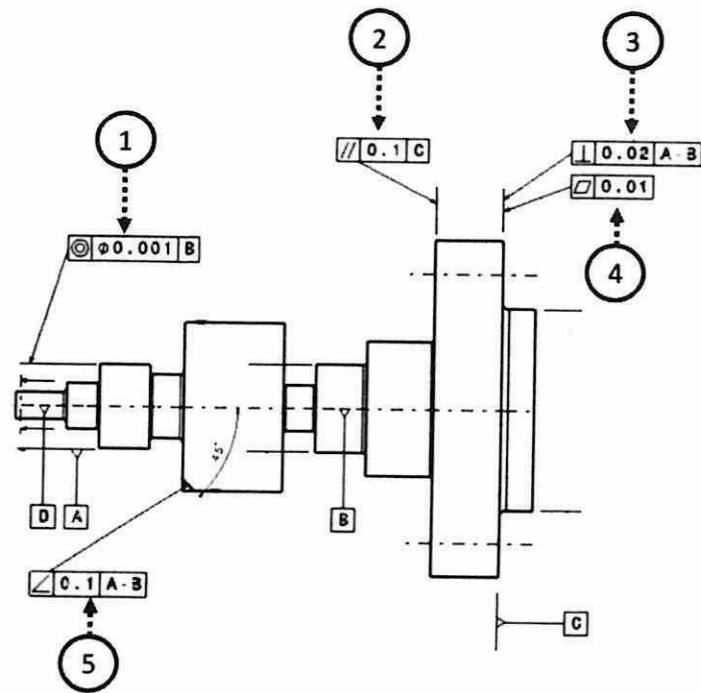


Figure Q(2)(a)

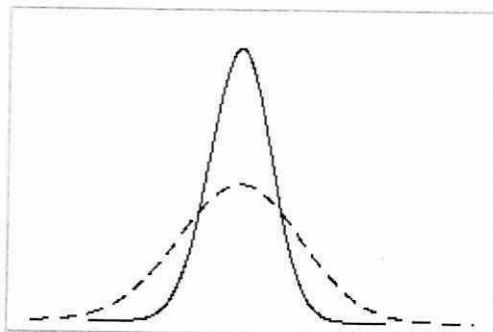


Figure Q(2)(c)(i)

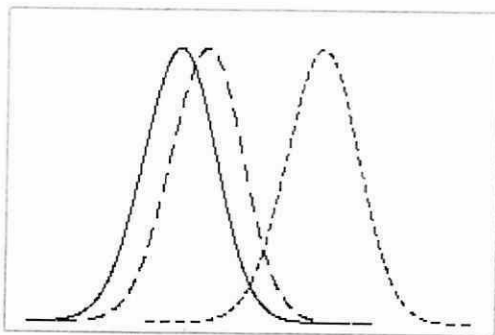


Figure Q(2)(c)(i)

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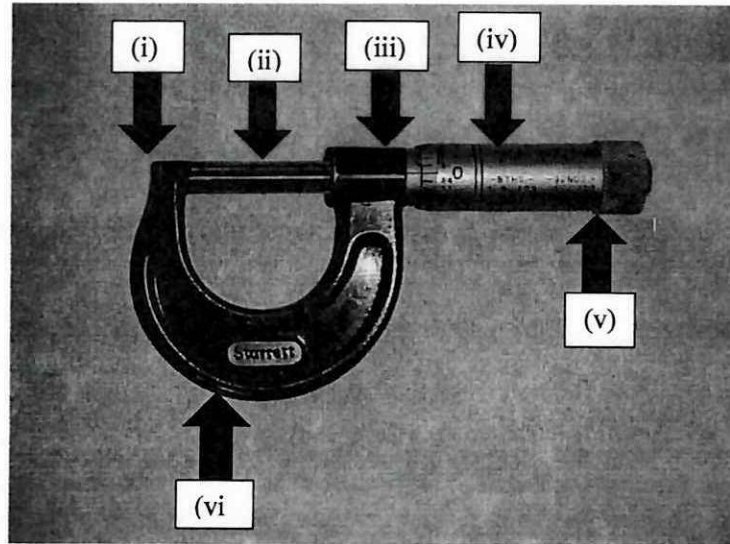


Figure Q(3)(b)

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