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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020**

COURSE NAME : METROLOGY AND MEASUREMENT
COURSE CODE : BNG 31803
PROGRAMME CODE : BNG
EXAMINATION DATE : DECEMBER 2019 / JANUARY 2020
DURATION : 3 HOURS
INSTRUCTION : ANSWER ALL QUESTIONS

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THIS QUESTION PAPER CONSISTS OF SEVEN (7) PAGES

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- Q1** (a) The most widely used line-graduated measuring instrument in metal working industry comprises of vernier caliper and micrometer.
- (i) Specify the value of measurement reading on vernier caliper as shown in **Figure 1 (a) (i)**. The measurement range and sensitivity of the instrument is 0 - 150 mm and 0.02 mm, respectively. The arrow indicates the position of vernier scale to coincide with main scale.
(1 mark)
- (ii) Specify the value of measurement reading on micrometer as shown in **Figure 1 (a) (ii)**. The measurement range and sensitivity of the instrument is 0 - 25 mm and 0.01 mm, respectively.
(1 mark)
- (iii) Specify the value of measurement reading on micrometer as shown in **Figure 1 (a) (iii)**. The measurement range and sensitivity of the instrument is 0 - 25 mm and 0.01 mm, respectively.
(1 mark)
- (b) Height gauge and bevel protractor are basic measuring instruments used for dimensional metrology.
- (i) Point out the similarity of height gauge and bevel protractor.
(2 marks)
- (ii) Differentiate the function of height gauge and bevel protractor.
(2 marks)
- (c) **Figure 1 (c)** shows an automotive component, namely spark plug. Formulate your plan to perform measurement of electrode gap of spark plug, which include the followings:
- (i) Instrument to be used with a brief description.
(2 marks)
- (ii) Method of measurement to be employed.
(4 marks)
- (d) Optical metrology is the science and technology of measurement, which operate with the assistance of light and magnification. Briefly explain the concept of optical system applied by the following instruments:
- (i) Profile Projector
(1 mark)
- (ii) Microscope
(1 mark)

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- (iii) Laser Scanner (1 mark)
- (e) Among the main components of a typical profile projector are inclusive of viewing screen and overlay chart. Distinguish the difference between viewing screen and overlay chart. (4 marks)
- Q2** (a) Distinguish the terms tolerance and fit in metrology application. (2 marks)
- (b) There are several types of fit associated with the identification of actual size of hole and shaft, including clearance fit, transition fit, and interference fit. Discover the difference between clearance fit and interference fits, with the aid of sketch. (8 marks)
- (c) Using the following equation and referring to **Table 2 (c) (i)** and **Table 2 (c) (ii)**, calculate the limits, tolerances, and allowances on a 50 mm shaft and hole pair designated as $\text{Ø } 50 \text{ H7/d9}$ to get a precision fit. The pair lies between 30 mm and 50 mm diameter.
- $$i = 0.453 \sqrt[3]{D} + 0.001D$$
- (10 marks)
- Q3** (a) Define engineering drawing in metrology application. (2 marks)
- (b) Coordinate tolerancing (CT) is a system used before geometrical dimensioning and tolerancing (GD&T) was introduced. Briefly explain **TWO (2)** limitations of coordinate tolerancing (CT). (4 marks)
- (c) **Figure 3 (c)** displays a feature control frame, which consists of several boxes or compartments. Produce the appropriate interpretation of each of these boxes. (4 marks)
- (d) Differentiate the geometric characteristics of straightness and circularity. (4 marks)
- (e) Datum refers to as a theoretically exact plane, point or axis from which measurements are made. In many situations, however, the exact point, axis or plane do not exist, thus a simulated datum is introduced. Analyse simulated datum with the aid of diagram. (6 marks)

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- Q4** (a) Discover the interpretation of repeatability and reproducibility in measurement system. (2 marks)
- (b) Below are the situation given for repeatability and reproducibility during measurement. Point out the representation of both situations using graphic.
- (i) Operator 1 measures a single part with gauge A 20 times, and then measures the same part with gauge B. (2 marks)
- (ii) Operators 1, 2, and 3 measure the same part 20 times with the same gauge. (2 marks)
- (c) Distinguish the interpretation of both graphic illustrated in Q4 (b) (i) and (ii). (4 marks)
- (d) Investigate **TWO (2)** benefits of gauge reproducibility and repeatability (GR&R) in measurement system. (4 marks)
- (e) **Figure Q4 (e)** shows a gauge run chart of three operators (operator A, B, C) measuring ten parts, three time each. Produce **THREE (3)** points of interpretation of the chart. (6 marks)
- Q5** (a) The common classification of gauging devices in the industry include ring gauge and snap gauge.
- (i) Point out the similarity of ring gauge and snap gauge in terms of function in measurement. (2 marks)
- (ii) Differentiate ring gauge and snap gauge in terms of their shape. (2 marks)
- (b) Produce a complete list of **FOUR (4)** basic characteristics of plug gauge. (4 marks)
- (c) Surface metrology refers to the geometry and texture of surface, such as roughness, waviness, and roundness. Discover **TWO (2)** points of differences in surface texture affects the selection of material in certain application. (4 marks)
- (d) Analyse the stylus measurement system by producing **FOUR (4)** features of stylus in measuring surface texture. (8 marks)

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- END OF QUESTIONS -

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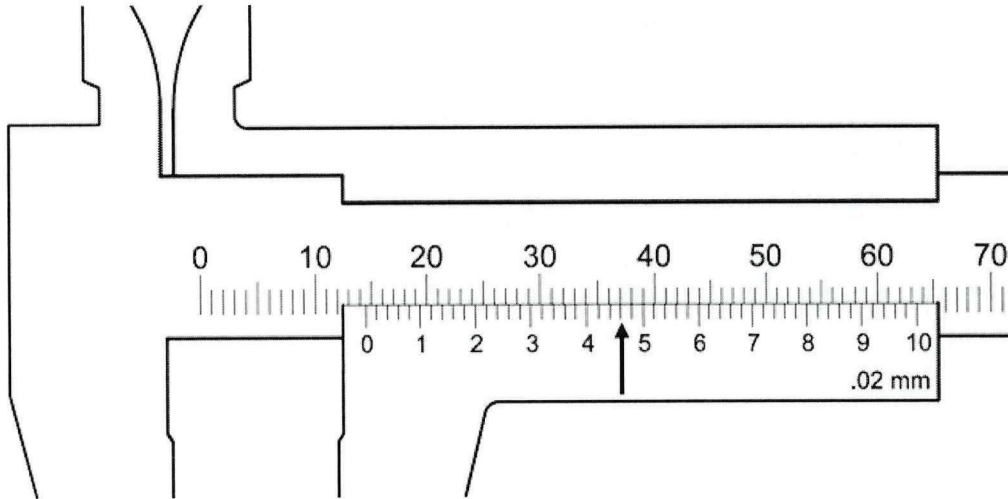


Figure Q1 (a) (i)

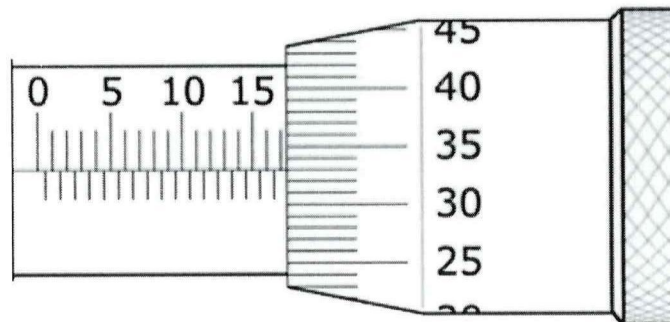


Figure Q1 (a) (ii)

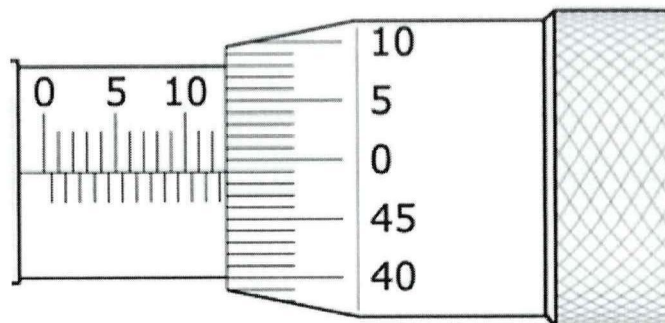


Figure Q1 (a) (iii)

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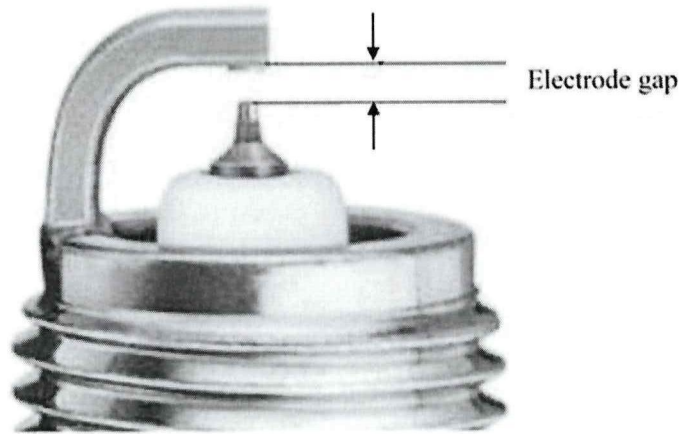


Figure Q1 (c)

Table 2 (c) (i)

Tolerance Grade	IT6	IT7	IT8	IT9	IT10	IT11	IT12	IT13	IT14	IT15	IT16
Standard Tolerance Unit, <i>i</i>	10	16	25	40	64	100	160	250	400	640	1000

Table 2 (c) (ii)

Shafts			Holes			Formula for Deviation in μm
Type	Fund Deviation	Sign	Type	Fund Deviation	Sign	D in mm
d	s	-	D	EI	+	$16D^{0.44}$
e	s	-	E	EI	+	$11D^{0.41}$
f	s	-	F	EI	+	$5.5D^{0.41}$
g	s	-	G	EI	+	$2.5D^{0.34}$
h	s	No Sign	H	EI	No Sign	0

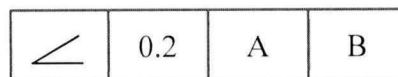


Figure Q3 (c)

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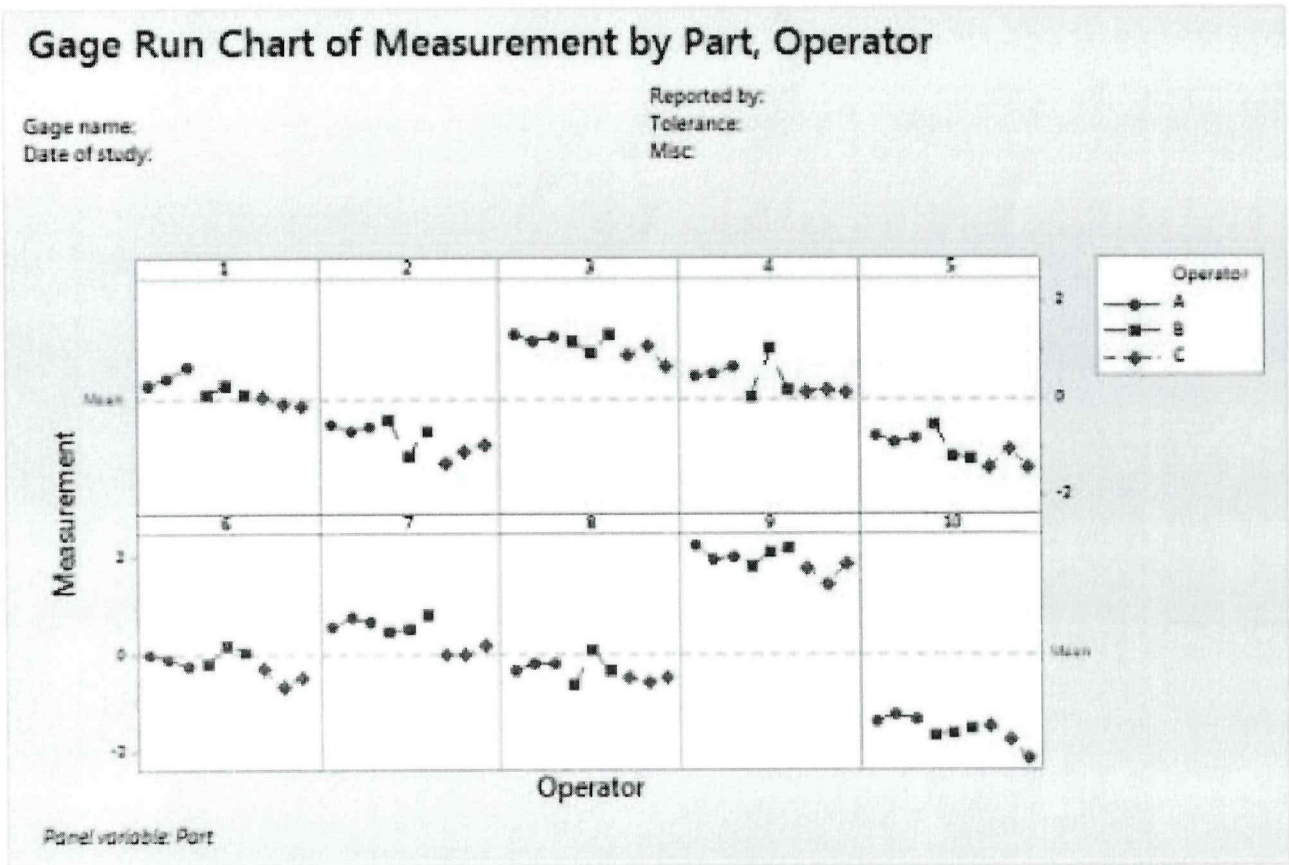


Figure Q4 (e)

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