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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER II
SESSION 2021/2022**

COURSE NAME : MATERIALS TESTING
COURSE CODE : BDB 40203
PROGRAMME CODE : BDD
EXAMINATION DATE : JULY 2022
DURATION : 3 HOURS
INSTRUCTION :
1. ANSWER ALL QUESTIONS IN SECTION A AND THREE (3) QUESTIONS IN SECTION B
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 VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF SEVEN (7) PAGES

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SECTION A

- Q1** (a) Spectroscopy techniques are methods that use radiated energy to analyze the properties or characteristics of materials. Fourier Transform-Infrared (FTIR) spectroscopy reveals the composition of solids, liquids, and gases. Determine THREE (3) other applications of FTIR.
(6 marks)
- (b) X-ray diffraction (XRD) is an analytical technique based on the diffraction of X-rays by matter, especially for crystalline materials. Differentiate between two types of XRD method.
(4 marks)
- (c) Mr Amir needs to analyse a sample of the thin film. Recommend to him a suitable diffraction method that can be applied to analyse its phases and crystal structure.
(4 marks)
- (d) **Figure Q1 (d)** shows the different values of the incident angle used to evaluate ZnO thin film by X-ray diffraction. Evaluate the influence of incident angle on the output of X-ray spectra (sketch the spectra in your explanation).
(6 marks)
- Q2** (a) Thermal analysis is a series of techniques that provide physical property measurement as a function of temperature, time, and other variables. Determine THREE (3) thermal analysis methods that can be applied for the characterization of inorganic materials.
(3 marks)
- (b) Differentiate between a differential scanning calorimetry (DSC) and a differential thermal analysis (DTA) technique of thermal characterization.
(6 marks)
- (c) A glass transition temperature (T_g) of a polymer material is the temperature range where the polymer substrate changes from a rigid glassy material to a soft (not melted) material. Propose a thermal analysis technique that can be applied to measure T_g .
(5 marks)
- (d) **Figure Q2 (d)** displays three different profiles of differential thermal gravimetry (DTG) curves. Based on your knowledge of thermal analysis, interpret the DTG curves.
(6 marks)

SECTION B

- Q3** (a) Materials testing is a measurement of the characteristics and behaviour of such substances as metals, ceramics, or plastics under various conditions. Justify the main purpose of doing the materials testing.
(6 marks)

- (b) Eddy Current testing is NDT testing to evaluate surface and subsurface defects. Evaluate the THREE (3) types of eddy current probes on the basis of their applications. (9 marks)
- (c) Turbine blade normally exposed to cyclic loading at elevated temperature ($> 0.4T_m$) application. Estimate types of material failure that may occur on the metal turbine blade. (5 marks)
- Q4** (a) Justify how immersion transducer differ from other transducer in Ultrasonic testing. (4 marks)
- (b) Radiation sources can be divided into two types which are X-ray radiography and Gamma radiography. Differentiate the characteristics of X-ray radiography and Gamma radiography. (6 marks)
- (c) In microstructure observation of metal components under an optical microscope, sample preparation is very important to ensure a good quality microstructure image can be captured. Clearly justify the stages involved in the sample preparation. (10 marks)
- Q5** (a) A casting pipe component is suspected to have gas porosity or blow holes are caused by accumulated gas or air which is trapped by the metal during fabrication. Propose a suitable non-destructive testing (NDT) that can be carried out to detect the porosity. Clearly explain how the measurement is done. (10 marks)
- (b) **Figure Q5 (b)** shows the bacteria image that was observed via different types of microscopes. Give your comment on the basic principles of each microscope and different information that can be obtained from each image. (10 marks)
- Q6** (a) Chemical elements in a material can be identified through energy dispersive spectroscopy (EDS). Recommend other X-ray methods that can be used to analyse chemical elements of the material. Explain the basic principles of the recommended method and provide an example of a graph that can be obtained from this analysis. (10 marks)

- (b) You are required to construct a phase diagram of the unknown material. In your opinion, which method of thermal analysis can be applied. Justify your suggestion by using an appropriate phase graph and explanation to show the construction of the phase diagram.

(10 marks)

-END OF QUESTION-

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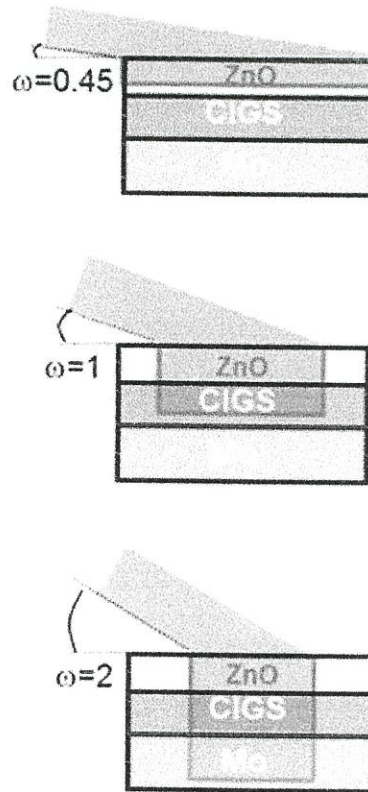


Figure Q1 (d)

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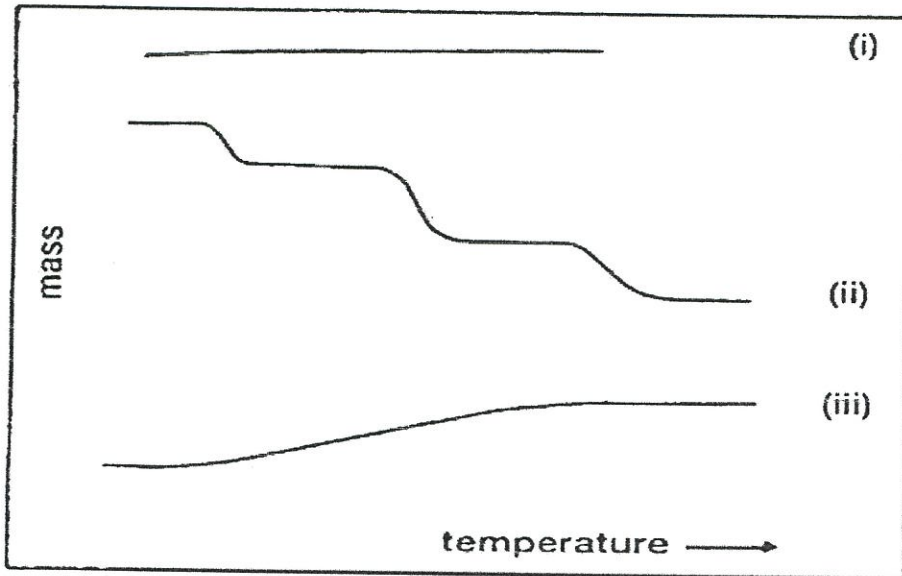
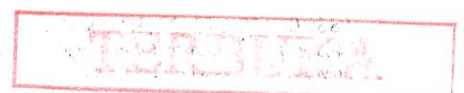


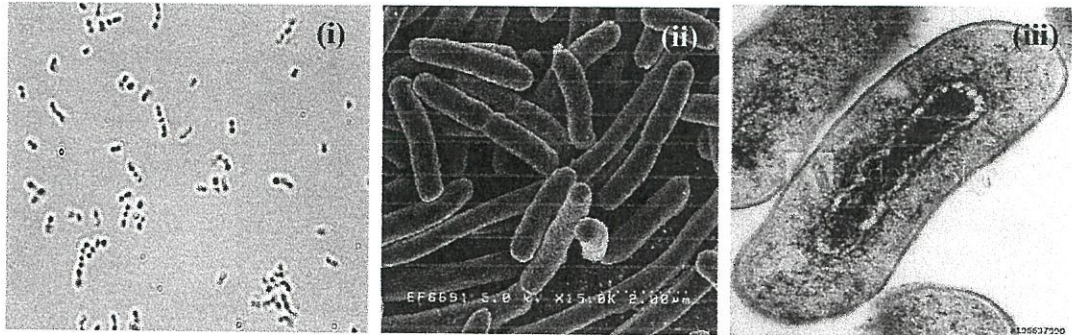
Figure Q2 (d)



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Images of bacteria observed by (i) Optical microscope (OM) (ii) Scanning electron microscope (SEM) and (iii) Transmission electron microscope (TEM)

Figure Q5 (b)