Faculty of Engineering Science

UNIVERSITY OF GHANA

FACULTY OF ENGINEERING SCIENCE

BSc. (Eng) FIRST SEMESTER EXAMINATIONS 2012/2013

MTEN 309 MATERIALS ANALYSIS TECHNIQUES (3 CREDITS)

TIME- 3HRS

ANSWER ALL QUESTIONS

1.

a) As a Materials Science Engineer in the research and development laboratory of a manufacturing company, state 4 reasons why you will undertake materials characterisation. **[4marks]**

b) Explain the term spectroscopy. **[2marks]**

c) In using UV-Vis-NIR spectroscopy as a characterisation tool, what material property will you be investigating on your samples? **[2marks]**

(i) In performing a full range UV-Vis-NIR spectroscopy, different light sources are activated at various stages in the electromagnetic spectrum. State the light sources and their corresponding wavelength ranges during a full-scale UV-Vis-NIR routine scans. **[6marks]**

(ii) With the aid of mathematical expressions briefly explain the Beer-Bouguer-Lambert law. **[5marks]**

d) Briefly describe the technique, Transmission electron microscopy. **[6marks]**

2.

a) Using copper radiation of wavelength $\lambda = 1.5405$ Å, Aluminium powder gives a diffraction pattern that yields the following five (5) d-spacings: 2.338 Å, 2.024 Å, 1.431 Å, 1.221 Å, and 1.169 Å. Aluminium has a cubic close packed structure and atomic weight of 26.98 g/mol.

(i) Index the diffraction data. **[10 marks]**

(ii) Calculate the unit cell parameter. **[5 marks]**

(iii) Calculate the density of aluminium. **[5 marks]**

b) Explain the term XPS and give 2 applications in which XPS is applied as a characterisation technique. **[5 marks]**

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3.

a) Briefly explain the term Thermal Analysis. **[2 marks]**

b) Discuss the following terms in relation to thermal analysis: TGA, DSC, and DTA.**[6 marks]**

c) In using thermal analysis as a characterisation tool, state and explain 4 physical limitations that can affect the heating process on your sample. **[8 marks]**

d) Briefly discuss the principles of Infrared spectroscopy in materials characterisation. Use diagrams where appropriate. **[9 marks]**

4.

a) Briefly discuss the 4 main categories of materials characterisation techniques. **[4 marks]**

b) State 3 analytical tools under each category of materials characterisation technique discussed above. **[3 marks]**

c) What are x-rays? Briefly explain how x-rays are produced **[6 marks]**

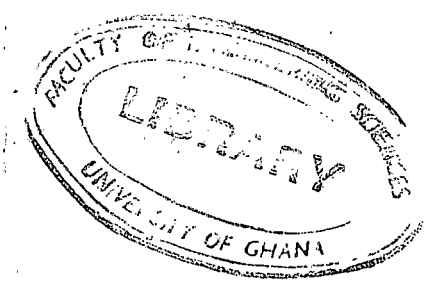
d) In materials science, x-ray diffraction is an important characterisation tool for microstructure analysis. The Bragg's law is the prominent underlining principle governing the diffraction by x-rays.

i. Briefly discuss the Bragg's law for x-ray diffraction. **[4 marks].**

ii. Using the equation of the Bragg's law and also given that the relation between the interplanar distance of a cubic crystal and its interatomic distance is $d_{Cubic} = \frac{a}{\sqrt{h^2 + k^2 + l^2}}$.

Show that $a^2 = \frac{\lambda^2}{4\sin^2\theta}(h^2 + k^2 + l^2)$

[8 marks]



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