CHUKA UNIVERSITY

UNIVERSITY EXAMINATIONS

FIRST YEAR EXAMINATION FOR THE AWARD OF MASTER OF SCIENCE IN PHYSICS

PHYS 821: LABORATORY TECHNOLOGY I

STREAMS: MSC (PHYS) **TIME: 3 HOURS**

DAY/DATE: WEDNESDAY 07/04/2021 **2.30 P.M. – 5.30 P.M.**

INSTRUCTIONS:

- Answer ALL questions
- Do not write anything on the question paper
- This is a closed book exam, no reference materials are allowed in the examination room
- There will be No use of mobile phones or any other unauthorized materials
- Write your answer legibly and use your time wisely

QUESTION ONE (15 MARKS)

(a) What is X-ray Powder Diffraction (XRD)? [1 mark]

(b) Explain the basic principles of X-ray Powder Diffraction (XRD) [4 marks]

(c) Outline the working of an X-ray diffractometer [4 marks]

(d) Answer the following questions about body-centered cubic (bcc) structure with the lattice parameter "a".

(i) Obtain the volume of void, supposing the case where the spherical atoms of radius r_A are arranged in each lattice point. Calculate also the porosity and packing fraction [3 marks]

(ii) The position of the maximum void in this body centered cubic lattice is known to be corresponding to the tetrahedral site (½, ¼, 0), and to equivalent position. Obtain the radius of maximum sphere that fits to this space [3 marks]

QUESTION TWO (15 MARKS)

(a) With an aid of Jablonski diagram, explain the basic principles of Fluorescence spectroscopy. Discuss the following in your explanation; [12 marks]

(i) Absorption, emission and stokes shift

(ii) Spectroscopic Transition Strengths and Quantum yields

(iii) Lambert-Beer Law and Absorption Spectroscopy

(iv) Temperature Effects on Absorption and Emission Spectra

(b) Mention how Forster Resonance Energy Transfer Technique (FRET) can be used. What makes FRET useful in *vivo* experiments? [3 marks]

QUESTION THREE (15 MARKS)

(a) What is the Hall effect and what is the significance of a positive Hall coefficient? [4 marks]

(b) Derive the Hall Constant relation $R_H = \frac{1}{nq}$ [5 marks]

(c) A potential difference is applied between the ends of a strip of copper and a current of 100 A flows along its length. The strip is 20 cm long in the x-direction of a rectangular system of coordinates, 2 cm wide in the y direction and 1mm thick in the z-direction. A uniform magnetic field of 10 Wb/m^2 is applied across the strip in the positive y- direction and the hall EMF is found to be 5μV. Derive;

(i) The magnitude and direction of the Hall field when the current flows in the positive x-direction

(ii) The concentration of free electrons [3 marks]

(d) The hall coefficient and electrical conductivity of an n-type silicon are $\frac{-7.3x10-5m^3}{C}$ and $2x10^7 mho/m,$ respectively. Calculate the magnitude of the mobility of the electrons. [3 marks]

QUESTION FOUR (15 MARKS]

(a) What is in-situ ellipsometry? [2 marks]

(b) What kind of sample preparations are required before doing ellipsometry? [3 marks]

(c) Can spectroscopic Ellipsometers measure absorbing films? [2 marks]

(d) What factor should be considered when choosing a spectroscopic Ellipsometers? [2 marks]

(e) How does spectroscopic ellipsometry compare to spectrophotometric measurements? [2 marks]

(f) What is depolarization and how can it be measured? [2 marks]

(g) What is Mueller-matrix? [2 marks]
