

KIBABII UNIVERSITY

**UNIVERSITY EXAMINATIONS
2020/2021 ACADEMIC YEAR**

**THIRD YEAR SECOND SEMESTER
SPECIAL/SUPPLEMENTARY EXAMINATIONS**

FOR THE DEGREE OF BSc (PHYSICS)

COURSE CODE: SPM 312

COURSE TITLE: MATERIAL TESTING AND EVALUATION

DATE: 14/1/2022

TIME: 8-10AM

INSTRUCTIONS TO CANDIDATES:

TIME: 2 HOURS

ANSWER QUESTION ONE AND ANY TWO OF THE REMAINING

KIBU OBSERVES ZERO TOLERANCE TO examination cheating

QUESTION ONE (30 marks)

(COMPULSORY)

- (a) Explain two reasons why testing and evaluation of materials is important [2 marks]
- (b) Differentiate between destructive and non-destructive testing techniques [2 marks]
- (c) Using clearly labelled diagram illustrate the following types of defects lack of root penetration, undercut, lack of fusion, porosity [4 marks]
- (d) State two limitations of radiographic inspection [2 marks]
- (e) What is the principle behind the Acoustic testing technique? [2 marks]
- (f) Write short notes on the following
- (i) visual examination methods [2marks]
 - (ii) safety in industrial radiography [2marks]
 - (iii) Tomography [3 marks]

QUESTION TWO (20 marks)

- (a) One condition for a dye to be used in the liquid penetrant testing is that it must wet the surface. Consider a liquid in contact with a solid surface such that the contact angle is θ , derive the Young-Dupre equation and show that the condition for wetting is given by

$$\theta < 90^\circ \quad [4 \text{ marks}]$$

Show further that the height through which the liquid rises through the crack is

$$h = \frac{2\gamma_l \cos\theta}{r\rho g} \quad [5 \text{ marks}]$$

- (b) Describe the procedure of Liquid Penetrant Testing, LPT [8marks]
- (c) What is the meaning of the term 'dwell time' as used in LPT? [1mark]
- (d) State two properties of a liquid to be used as a dye in the LPT [2marks]

QUESTION THREE (20 marks)

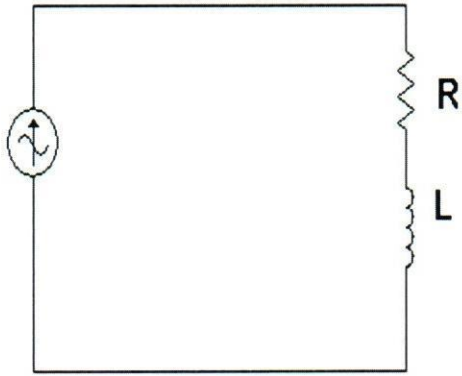
- (a) What is the principle behind radiographic testing? [2 marks]
- (b) State two sources of x rays [2 marks]
- (c) Explain how radiographic testing is carried out. Use clearly labelled diagrams where necessary [8 marks]
- (d) Explain the consequences of the inverse law of x-rays in radiographic testing [2 marks]
- (e) Apart from the fact that x-rays obey the inverse square law $I \propto \frac{1}{r^2}$, state two other properties of x-rays that make them suitable for radiographic testing of materials [2 marks]
- (f) Differentiate between microradiography and autoradiography [4 marks]

QUESTION FOUR (20 marks)

- (a) Explain the principle behind magnetic testing [2 marks]
- (b) What are the steps followed when conducting magnetic particle inspection with the help of neat and suitable diagrams? [4 marks]
- (b) Explain how magnetic testing is carried out using each of the following
- (i) Yokes [2 marks]
 - (ii) Prods [2 marks]
 - (iii) Coils [2 marks]
 - (iv) Heads [2 marks]
 - (v) Central conductor [2 marks]
- (c) State two limitations of magnetic particle testing [2 marks]
- (d) Would you regard magnetic testing as a bulk or surface testing method? Explain your answer [2 marks]

QUESTION FIVE (20 marks)

- (a) Define the term 'lift off' as used in eddy current testing [1 mark]
- (b) Consider the RL circuit shown below



Suppose that a sinusoidal current flowing through the circuit is given by

$i = i_0 \sin \omega t$ show that the impedance in the circuit Z is given by

$|Z| = \sqrt{R^2 + X_L^2}$ where $X_L = \omega L$ and all other symbols have their usual meanings [4 marks]

(c) Using the information in(b) above, define the impedance plane and use it to explain how it is utilized in eddy current testing to detect flaws in materials. Use well labelled diagrams [10 marks]

(d) Use a diagram to illustrate the time of flight diffraction NDT method [5 marks]