



**GWANDA STATE UNIVERSITY**  
**FACULTY OF ENGINEERING AND THE ENVIRONMENT**  
**DEPARTMENT OF GEOMATICS AND SURVEYING**

**WAVES AND OPTICS (EGS 1109)**

**Final Examination Paper**

**June 2023**

**EPOCH MINE CAMPUS**

**Time Allowed:** 3 hours  
**Total Marks:** 100  
**Examiner's Name:** Mr. C.W Ndlovu  
Mr P. Sigwegwe

**INSTRUCTIONS**

1. Answer **ALL** question in SECTION A.
2. Answer any **THREE** questions from SECTION B.
3. Use of calculators is permissible.

**MARK ALLOCATION**

<b>Section A</b>	<b>40</b>
Question 1	20
Question 2	20
<b>Section B</b>	<b>60</b>
Question 3	20
Question 4	20
Question 5	20
Question 6	20
<b>Total Attainable</b>	<b>100</b>

## **SECTION A**

### **ANSWER ALL QUESTIONS IN THIS SECTION (40 Marks)**

#### **Question 1**

- (a) What is a mirror? [2]
- (b) What is the difference between a real image and a virtual image? [4]
- (c) With aid of a diagram state and explain the laws of reflection and refraction. [6]
- (d) Suppose you have an unknown clear substance immersed in water, and you wish to identify it by finding its index of refraction. You arrange to have a beam of light enter it at an angle of  $45, 0^{\circ}$ , and you observe the angle of refraction to be  $40, 3^{\circ}$ . What is the index of refraction of the substance? The index of refraction of water is 1.33. [4]
- (e) How far from the lens must the film in a camera be, if the lens has a 35.0 mm focal length and is being used to photograph a flower 75.0 cm away? [4]

#### **Question 2**

- a) A wave traveling along a string is described by  $y(x, t) = (0.00327\text{m})\text{Sin}(72.1x - 2.72t)$ ,

Determine the following characteristics of the wave motion

- i) Amplitude
  - ii) Wave constant k
  - iii) Wavelength
  - iv) Period
  - v) Frequency
  - vi) Speed of the wave [12]
- b) Briefly describe how sound waves are used ships navigation and medical imaging [8]

## **SECTION B (60 marks)**

**Answer ANY THREE questions from this section.**

### **Question 3**

- (a) With aid of a diagram explain how an image is formed in a
- (i) Converging lens. [6]
- (ii) Diverging lens. [6]
- (b) What is the use of cladding in optical fibres? [2]
- (c) What is dispersion? [2]
- (d) An optical fibre cable has a refractive index of 1.5. Calculate the angle at which total internal reflection occurs. [4]

### **Question 4**

- (a) With aid of a diagram differentiate between a concave and a convex mirror, taking into account the center of curvature (C), the field view, and distance of the image to the mirror and the height of the image. [12]
- (b) With the aid of a diagram explain how a signal is transmitted in an optical fibre. [5]
- (c) An optical fibre is manufactured using glass of refractive index of 1.5. Calculate the speed of light travelling through the optical fibre. Speed of light in air =  $3 \times 10^8 \text{ m/s}$  [3]

### **Question 5**

- a) State the principle of superposition for waves [3]
- b) Two separate waves traveling along a stretched string superpose and their individual progressive wave equation are given below.

$$y_1(x, t) = y_m \sin(kx - \omega t) \quad y_2(x, t) = y_m \sin(kx - \omega t + \phi).$$

Show that the overall equation of the combined wave form is

$$y'(x, t) = [2y_m \cos \frac{1}{2}\phi] \sin(kx - \omega t + \frac{1}{2}\phi). \quad [7]$$

c) Describe Maxwell's rainbow, for each segment state the functions and applications [10]

### Question 6

a) Give the three main types of waves and give a brief description of each type [6]

b) A string has a linear  $\mu=525\text{g/m}$  and is under tension  $\tau=45\text{N}$ . We send a sinusoidal wave frequency  $f=120\text{Hz}$  and amplitude  $y= 8.5\text{mm}$  along the string.

i) At what average rate does the wave transport energy [4]

c) The general differential equation that governs the travel of waves of all types is

$$\frac{\partial^2 y}{\partial x^2} = \frac{1}{v^2} \frac{\partial^2 y}{\partial t^2}.$$

Derive the above wave equation and show all the necessary steps [10]

**End of Question Paper.**