NATIONAL OPEN UNIVERSITY OF NIGERIA
PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI - ABUJA
FACULTY OF SCIENCES

DEPARTMENT OF PURE AND APPLIED SCIENCE

SEPTEMBER, 2020_1 EXAMINATIONS

COURSE CODE: **PHY 406**
COURSE TITLE: **OPTICS III**
CREDIT UNIT: **3**
TIME ALLOWED: **(2½ HRS)**

INSTRUCTION: ***Answer question 1 and any other four questions***

QUESTION 1

a Define the following terms

i Coherence **2 marks**

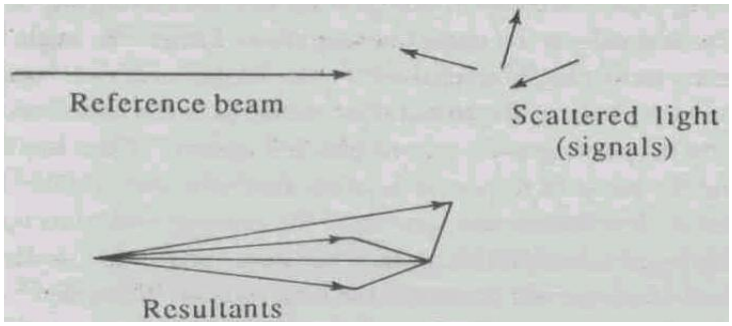
ii Interference **2 marks**

b If light of 660 nm wavelength has a wavetrain 20λ long, what is its

i coherence length and **3 marks**

ii coherence time. **3 marks**

c Using the size of the amplitude vectors drawn in Fig. below to calculate



Addition of a strong coherent reference beam (top left) with random-phase signals (top right) gives similar resultant (bottom)

i the ratio of intensities, and **8 marks**

ii the contrast resulting from these intensities. **4 marks**

QUESTION 2

a Explain the following terms

i Temporal coherence **3 marks**

ii Coherence time **1.5 marks**

iii Coherence length **1.5 marks**

b If laser action occurs by the transition from an excited state to the ground state and it produces light of 700 nm wavelength, what is the energy of the excited state. Take the energy of the ground state to be zero. **(6 marks)**

QUESTION 3

A The sodium line at λ = 5890 Å, produced in a low-pressure discharge, has spread in wavelength, $\Delta\lambda$ = 0.0194 Å. Calculate:

i the coherence length and **4 marks**

ii line width in hertz. **3 marks**

b If the visibility in an interference fringe pattern is 50 percent and the maxima receive 15 units of light, how much light does the minima receive? **5 marks**

QUESTION 4

a Assume that an atom has two energy levels separated by an energy corresponding to a frequency 5.4×10^{14} Hz, as in the He-Ne laser. Let us assume that all the atoms are located in one or the other of these two states. Calculate the fraction of atoms in the upper state at room temperature T = 300K **6marks**

b If laser action occurs by the transition from an excited state to the ground state and it produces light of 693nm wavelength, what is the energy of the excited state. Take the energy of the ground state to be zero. **6 marks**

QUESTION 5

a Assume that an atom has two energy levels separated by an energy corresponding to a frequency 4.7×10^{14} Hz, as in the He-Ne laser. Let us assume that all the atoms are located in one or the other of these two states. Calculate the fraction of atoms in the upper state at room temperature T = 300K. **6 marks**

b. A pulsed laser used for welding produces 100 W of power during 10 m. Calculate the energy delivered to the **6 marks**

QUESTION 6

6a Suppose you have two optical fibres *A* and *B*. The refractive indices of the core (n_1) and the cladding (n_2) materials is $(n_1)_A$= 1.52, $(n_2)_A$= 1.41, $(n_1)_B$= 1.53, $(n_2)_B$= 1.39
Which of the two fibres will have higher light gathering capacity? **6 marks**

b. A step-index fibre 6.35×10^{-5} m in diameter has a core of refractive index 1.53 and a cladding of refractive index 1.39. Determine

(i) the numerical aperture for the fibre; **3marks**

(ii) the acceptance angle (or maximum entrance cone angle). **3 marks**