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

DEPARTMENT OF PURE AND APPLIED SCIENCE

2020_2 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)List and explain the two types of coherence (6 marks)

(b) In Einstein's prediction of stimulated emission of radiation, using the rate of spontaneous emission, show that $\frac{N_2}{N_1} = \frac{B_{12}u(\nu)}{A_{21}+u(\nu)B_{21}}$ (4 marks)

(c) Briefly explain three applications of holography (6 marks)

(d) A step-index fibre 5 106.35 − × 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. (3 marks)

(ii) the acceptance angle. (3 marks)

QUESTION 2

(a) Derive the equation that establishes a relationship between visibility and coherence

in visibility of fringes. (4 marks)

(b) White light falls on a single slit 0.050 mm wide. A screen is placed 1.00 m away. A student first puts a blue-violet filter ($\lambda = 441\,nm$) over the slit, then a red filter $\lambda = 622\,nm$. The student measures the width of the central peak, that is, the distance between the two dark bands.

(i) Which filter produces the wider band? (4 marks)

(ii) Calculate the width of the central bright band for each of the two filters (4 marks)

QUESTION 3

(a) Write a short note on two (2) types of lasers (4 marks)

(b) Discuss briefly materials in the three states of matter as active medium for laser stimulation. (4 marks)

(c) A He-Ne laser operating at 6328 Å has a resonant cavity with plane mirrors spaced 0.5 m apart. Calculate the frequency separation between the axial modes of this laser. Estimate whether this laser would operate at one or at several axial frequencies given that the line width of the Ne 6328 Å line observed in spontaneous emission is typically 0.016 Å wide. (4 marks)

QUESTION 4

(a) Derive the expression for absorption coefficient in light beam amplification when it passes through an active medium using the process of population inversion.

(6 marks)

(b) Explain the principle of multiplexing. (6 marks)

QUESTION 5

(a)List and explain two (2) ways of pumping a laser to achieve the population inversion necessary for stimulated emission to occur. (6 marks)

(b) A spectrometer uses a grating with 12,000 lines/cm. Find the angles at which red light, 632 nm, and blue light, 421 nm, have first-order bright bands. (6 marks)

QUESTION 6

(a) What are the essential components of a general laser system? (4 marks)

(b) Give a brief description of two of the following:
Pumping Process, Active Medium and Resonator. (4 marks)

(c) In a general laser system stimulated emission is always the dominant process in which the Active Medium's excited particles decay to lower state. How do you compare the other two decaying processes: spontaneous and non-radioactive decays?

(4 marks)