FEDERAL UNIVERSITY OF TECHNOLOGY, OWERRI
SCHOOL OF PHYSICAL SCIENCES
DEPARTMENT OF PHYSICS
HARMATTAN SEMESTER EXAMINATIONS, 2018/2019 SESSION

PHY 409: OPTICS

Date: 17/06/19. **Time:** 3 hrs

Answer any FIVE questions.

1. (a) When is two waves said to be coherent?
(b) Given the electric field components of two waves arriving at a point p as $E_A = E_1 \sin\omega t$ and $E_B = E_2 \sin(\omega t + \delta)$ where δ is the phase difference between them that the square of the resultant and electric field $\hat{E}$ is given as $E^2 = E_1^2 + E_2^2 + 2E_1E_2 \cos\delta$.
(c) A Thin sheet of a transparent material (N = 1.60) is placed in the path of one of the interfering beams in a bi-prism experiment, using Sodium light, λ = 5990A°. The central fringe shift to a position originally occupied by the 12th bright fringe, Calculation the thickness of the sheet.
2. (a) Define a Thin film.
(b) With a diagram show the geometric path difference for interference in thin film. Hence derive the expression for optical path difference Δa for a plane parallel thin film.
(c) A glass wedge of angle 0.01 radian is illuminated by monochromatic light of wavelength 6000A° falling normally on it. At what distance from the edge of the wedge will the 10th image be observed by the reflected light?
3. (a) Explain the terms, coherence length and coherence time for light wave. Derive an expression for the coherence length of a wave train that has a frequency bandwidth $\Delta\gamma$.
(b) Explain in brief the terms (i) Temporal Coherence (ii) Spatial Coherence.
(c) Calculate the coherence length for Co_2 Laser whose line width is 1.0×10^{-5} nm at IR emission of wavelength 10.6nm.
4. (a) (i) what is diffraction of light? (ii) Using illustrative diagrams explain the difference between the Fraunhoffer diffraction and Fresnel diffraction patterns of a single- slit.
(b) Explain with a neat diagram how the phasors could be used to determine the intensity of the single - slit diffraction pattern.
(c) Red light of wavelength λ_r =750nm passes through a slit 1.5x10-3mm wide. (i) How wide is the central maximum [1] in degrees, [2] in centimeters, on a screen of 30cm away? (ii) If yellow light of wavelength λ_y =575nm was used instead, would the central maximum be wider or narrower?
5. (a)(i) What is Rayleigh's criterion? (ii) Explain the resolution of light when two point sources are placed from a small aperture [1] at a large angle and [2] when the angle between the two sources is small.
(b) Explain why it is theoretically impossible to see an object as small as an atom regardless of the quality of light microscope being used.
(c) Light of wavelength 579nm is used to view an object under a Microscope. If the aperture of the objective has a diameter of 0.85cm (i) determine the limiting angle of resolution. (ii) Using visible light of wavelength 560nm, find the maximum limits of resolution for this Microscope. (iii) When water of refractive index n = 1.33 fills the space between object and Objective lens, what effect would this have on resolution power?
6. (a) Explain the diffraction grating with respect (i) Optics (ii) Glass plate.
(b) Explain the uses of diffraction grating.
(c) A beam of white light is sent to a diffraction grating with 10,000 lines/cm through to a screen 2.0m away. (i) find the angle for the first- order diffraction of the shortest and longest wavelength of visible light (380nm and 760nm respectively). (ii) What is the distance between the ends of the rainbow of visible light produced on the screen for first-order interference? [Rainbow of colours are produced on the screen at a distance x= 2.0m from the grating] (iii) What is the significance of your result?