



UNIVERSITY EXAMINATIONS
THIRD YEAR EXAMINATION FOR THE AWARD OF
THE DEGREE OF BACHELOR OF SCIENCE IN EDUCATION AND
BACHELOR OF SCIENCE

SECOND SEMESTER 2021/2022
(FEBRUARY – JUNE, 2022)

PHYS 321: PHYSICAL OPTICS

STREAM: Y3 S2

TIME: 2 HOURS

DAY: FRIDAY, 9:00 AM – 11:00 AM

DATE: 20/05/2022

INSTRUCTIONS

- 1. Do not write anything on this question paper.***
- 2. Answer Question ONE (Compulsory) and any other TWO questions.***

QUESTION 1 COMPULSORY (30 MARKS)

- a) Define the following terms as used in optics
- Beats (1mark)
 - Polarization. (2 marks)
 - Space quantization (1mark)
- b). Calculate the thickness of soap film resulting in a constructive interference of first order fringe given $n = 1.33$ and light of wavelength 440nm .
(5mks)
- c). Two strong lines in the spectrum of sodium have wavelengths of 27.00nm and 27.62nm . What must be the resolving power of the grating be in order to distinguish these wavelengths? (5 marks)
- d). Michelson interferometer is used to measure a distance of 600nm . During this displacement, 400 fringe shifts are counted. Calculate wavelength of light being used. (5 marks)

e).Distinguish between constructive and destructive interference (6 marks)

f). The mirror on one arm of a Michelson interferometer is displaced a distance Δx . During this displacement, 50 fringe shifts are counted. The light being used has a wavelength of 567nm. Calculate the displacement Δx . (5 marks)

QUESTION 2 ELECTIVE, 20 MARKS

(a). (i) Explain the formation colors on a pool of water. (2mks)

(ii) Unpolarized light passes through two polaroid sheets. The axis of the first is vertical and the second is at 20° to the vertical axis. What fraction of the initial light is transmitted? (3 marks)

(b). Light beam is incident on a heavy flint glass ($n = 1.5$) at the polarizing angle. Calculate the angle of refraction for the transmitted ray. (5 marks)

(c) Use diagrams to briefly distinguish polarization by selective absorption, reflection, double refraction and scattering. (10 marks)

QUESTION 3 ELECTIVE, 20 MARKS

a) (i) Define newton's rings. (2 marks)

c) When Newton's rings are formed using sodium light ($\lambda=340\text{nm}$), the diameters of two successive dark rings are 5mm and 5.89mm. Calculate the radius of curvature of the convex lens surface. (5 marks)

d) A plane polarized light incident on a single polarizing disk with the direction of E_0 parallel to the direction of transmission axis. Through what angle should the disk be rotated so that the intensity in the transmitted beam be reduced by a factor of 2. (5 marks)

e) By use of appropriate diagram explain double slit diffraction (8 marks)

QUESTION 4 ELECTIVE, 20 MARKS

a) A coherent light of wavelength 300nm is incident on a slit of width 0.6mm. The observing screen is placed 1m from the slit. Find

i) Position of the second dark fringe (4 marks)

ii) Width of the central bright fringe (2 marks)

iii) Width of the second order bright fringe. (4 marks)

b) A sinusoidal wave travelling in the positive x-direction has an amplitude of 10cm, a wavelength of 50cm and frequency of 20Hz. The displacement of the wave at $t = 0$ and $x = 0$ is also 10cm.

- (i). Determine the wave number and angular frequency. (4 marks)
- (ii). Determine its phase velocity. (2 marks)
- (iii). Determine the general expression of the wave function. (4 marks)

QUESTION 5 ELECTIVE, 20 MARKS

a) (i) Define diffraction (1 mark)

(ii) Two strong lines in the spectrum of sodium have wavelengths of 40.60nm and 41.0 nm. What must be the resolving power of the grating be in order to distinguish these wavelengths? (3 marks)

b) Use diagrams to explain the following:

i) Single slit diffraction (3 marks)

ii) Fraunhofer diffraction (4 marks)

c) Use appropriate diagrams and equations to explain the plane, circular and elliptical polarization. (9 marks)