MACHAKOS UNIVERSITY

University Examinations 2019/2020Academic year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

THIRD YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF EDUCATION (SCIENCE)

SPH 306: PHYSICAL OPTICS

DATE: 4/12/2019 **TIME: 2.00-4.0 PM**

INSTRUCTIONS TO CANDIDATES

Answer **QUESTION ONE** and **ANY OTHER TWO** questions.

Question 1 carries **30** marks) and the others carry **20** marks) each.

YOUMAYUSE:

You may need to use the following constants:

Plank's constant= $6.63 \times 10^{-34} m^2 kg/s$

Speed of light, c=$2.998 \times 10^8 m/s$

$\varepsilon_o = 8.85 \times 10^{-12} Nm^2C^2$, $\mu_o = 4\pi \times 10^{-7}$TmA

QUESTION ONE (30 MARKS)

a) Define an optical path and distinguish between guided and unguided waveguides. (3 marks)

b) Describe the two causes of phase change in wave propagation. (4 marks)

c) If in an experiment, there is destructive interference, the reflected wave goes away, where does the energy that would have been in the reflected wave go? (2 marks)

d) Distinguish between the two types of polaroids (4 marks)

e) Under what conditions do we say two or more sources are either coherent or incoherent? (4 marks)

f) In the white light spectrum obtained with a diffraction grating, the third order image of a wavelength coincides with the fourth order image of a second wavelength. Calculate the ratio of the two wavelengths. (4 marks)

g) With proper labelling, draw the wave profiles of an electromagnetic wave (4 marks)

h) State Huygens's principle (2 marks)

i) Identify the three classes of lasers (3 marks)

QUESTION TWO (20 MARKS)

a) Explain whether the Young's experiment is an experiment for studying interference or diffraction effects of light. (4 marks)

b) i Define resolving power of a laser (2 marks)

ii Rayleigh light source with a wavelength of 560nm has a numerical aperture (NA) of 0.9. Calculate its resolving power. (4 marks)

c) For an electromagnetic wave traveling in a vacuum, calculate the speed of light. (4 marks)

d) Describe the differences between Fraunhofer and Fresnel diffraction (6 marks)

QUESTION THREE (20 MARKS)

a) Using a diagram describe how the light signal is transmitted through an optical fibre? (5 marks)

b) Explain how the power is lost in an optical fibre by dispersion? (4 marks)

c) Define a laser and state how it emits a light signal (5 marks)

d) Describe how a laser can emits light in either transverse or longitudinal modes (6 marks)

QUESTION FOUR (20 MARKS)

a) Using diagrams, describe Young's double slit experiment (4 marks)

b) A Young's double-slit interference experiment is carried out with blue-green argon laser light. The interference pattern formed on a screen 3.3 m away contains the first-order (m = 1) bright fringe 3.4 mm from the center of the pattern as shown in figure 1. If the separation of the double slits is 0.50 mm, what is the wavelength of the argon laser light? (5 marks)

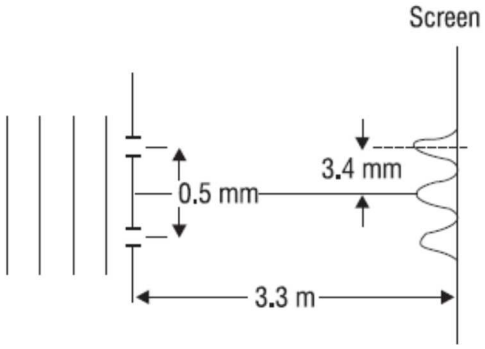

Figure 1

c) Michael has been handed a transmission grating by his supervisor who wants to know how widely the red light and blue light fringes—in *second* order—are separated on a screen one meter from the grating. Michael is told that the separation distance between the red and blue colors is a critical piece of information needed for an experiment with a grating spectrometer. The transmission grating is to be illuminated at *normal incidence* with red light at $\lambda = 632.8$ nm and blue light at $\lambda = 420.0$ nm. Printed on the frame surrounding the ruled grating, Michael sees that there are 5000 slits (lines) per centimeter on this grating.

i. Determine the distance between the slit centers. (3 marks)

ii. Determine the angular deviation θp in 2^{nd}-order for both the red and the blue light. (4 marks)

iii. Determine the separation distance on the screen between the red and blue fringes. (4 marks)

QUESTION FIVE (20 MARKS)

a) A HeNe laser in air emits light at 632.8nm. The beam passes into a glass substance of index 1.35. Calculate;

i. the speed (2 marks)

ii. wavelength (2 marks)

iii. and frequency of the laser light in the glass substance? (2 marks)

b) i Using a diagram, describe the laser feedback interferometry. (6 marks)

ii use a diagram to describe the operation of a fibre-based interferometric sensor (8 marks)