TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Applied & Health Sciences

DEPARTMENT OF MATHEMATICS & PHYSICS

UNIVERSITY EXAMINATION FOR DEGREE OF:

BACHELOR OF TECHNOLOGY IN APPLIED PHYSICS
BACHELOR OF TECHNOLOGY IN RENEWABLE ENERGY

APS 4203: PHYSICAL OPTICS

END OF SEMESTER EXAMINATION
SERIES: DECEMBER 2014
TIME ALLOWED: 2 HOURS

Instructions to Candidates:
You should have the following for this examination
- *Mathematical tables*
- *Scientific Calculator*

This paper consist of **FIVE** questions
Answer question **ONE (COMPULSORY)** and any other **TWO** questions
Maximum marks for each part of a question are as shown
This paper consists of **THREE** printed pages

Question One (Compulsory)

a) Define the following terms as applied to waves:
- **(i)** Standing wave **(1 mark)**
- **(ii)** In phase **(1 mark)**

b) Differentiate between:
- **(i)** The fringes formed by the Michelson interferometer and the Fabry-Pevot interferometer
- **(ii)** Coherent light source and in coherent light source **(2 marks)**

c) Show that for constructive interference, the intensity of the resulting wave is greater than the sum of the two individual wave intensities. **(4 marks)**

d) (i) Define diffraction gravity **(2 marks)**

(ii) Write down the expression that gives maximas for a grafing, and how does it compare to the condition for constructive interference in Young's double slit experiment. **(3 marks)**

e) Light from a blue laser (wavelength 440nm) passes through a diffraction gravity and then produces 7 bright spots on a screen (a central spot and three spots on each side) The two bright spots furthest $\theta = \pm 72^o$ from the central spot occur at

(i) How far are the lines in the diffraction gravity? **(3 marks)**

(ii) Light from a red laser (wavelength 680mm) is passed through the same grating. How many spots will be formed? **(4 marks)**

f) (i) What is the main difference between a hologram and a photograph? **(2 marks)**

(ii) Define a pseudoscopic image **(1 mark)**

(iii) A thin transmission hologram is recorded with a HeNe laser of wavelength 632.8nm, with the object and reference beams being inclined at $\pm 30^o$ to the normal to the surface respectively. What is the average fringe spacing in the emulsion? **(3 marks)**

Question Two

a) Describe Huygens's principle **(3 marks)**

b) Use Huygens's principle of waves to derive Snell's law of reflection. **(9 marks)**

c) Using two point sources of light, S_1 and S_2 separated by about 2cm (on paper) draw a clear and neat diagram describing how constructive and destructive interferences can be observed on a nearby screen (in form of a flat line) placed (on paper) about 10cm away from S_1 and S_2 **(8 marks)**

Question Three

a) Define the following:

(i) A Polaroid **(2 marks)**

(ii) Linearly polarized light **(2 marks)**

b) Describe the transmission of unpolarized light when incident on a vertical polarizer and then to a analyzer (in the form of horizontal polarizer) **(6 marks)**

c) Unpolarized light of intensity 0.4KW/m^2 is incident on "crossed polarizers" A and B (ones with their axes at 90^o to each other.)

B

(i) What is the intensity of the light after passing through the second polarizer (polarizer B in the diagram) **(3 marks)**

(ii) Now a third polarizer (C, not shown is placed between the first two, with its axis at 30° to A's and 60° to B's axis. What is the final intensity of light emerging from polarizer B?

(7 marks)

Question Four

a) Differentiate between interference and diffraction. **(4 marks)**

b) Describe interference by division of wave front and interference by division of amplitude. **(4 marks)**

c)

eye

The diagram above shows the set up for the Michelson Interferometer:

(i) Explain the use of the beam splitter in the setup. **(2 marks)**

(ii) Explain how bright and dark fringe's are formed/defected. **(3 marks)**

(iii) How can the Michelson Interferometer be used to make precise measurements of wavelength?

(3 marks)

(iv) How far must the mirror (M_1) in the set up be moved if 850 fringes of 589nm light are to pass by a reference line? **(4 marks)**

Question Five

a) Differentiate between Fraunohoffer diffraction and Fresnel diffraction. **(4 marks)**

b) Explain the criterion for observing Fraunohoffer or Fresnel diffraction **(4 marks)**

c) Illustrate using a clear drawing how the condition for Fraunhoffer diffraction can be satisfied through the use of focusing lenses on both sides of the aperture **(4 marks)**

d) Monochromatic light shines through a slit 4.5×10^{-3}mm wide, making a diffraction pattern on a distant screen. The angle between the first dark fringes on either side of the central maximum is 12.0° (dark fringe to dark fringe)

(i) What is the wavelength of the light? **(4 marks)**

(ii) If red light of wavelength 685mm is passed through the same slit, what is the angular width of the central maximum (dark fringe to dark fringe)? **(4 marks)**