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**University Examinations 2016/2017**

THIRD YEAR, FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE PHYSICS AND BACHELOR OF EDUCATION

**SPH 3306: PHYSICAL OPTICS**

**DATE: December, 2016 TIME: HOURS**

**INSTRUCTIONS:** *Answer questions* ***one*** *and any other* ***two*** *questions.*

***Constants***

*Permeativity of free space****;*** $\in \_{0}=8.85 x 10^{-12} F/m$

*Electron charge :* $e= -1.6 x 10^{-19}C$

*Acceleration due to gravity:* $g = 9.8N/kg$

*Speed of light in vacuum:* $C=3.0 x 10^{8}$*m/s*

**QUESTION ONE - (30 MARKS)**

1. (i) What is the relationship between the electric field amplitude of a beam of light to its irradiance? (2 Marks)

(ii) What is the effect of the interference term experiment on the appearance of the interference fringes? (2 Marks)

1. (i) What is fringe visibility? (2 Marks)

(ii) State the condition for maximum fringe visibility and that for minimum fringe visibility. (2 Marks)

1. What is the difference between wave front division interferometers and amplitude division interferometers? Give an example in each case. (4 Marks)
2. Consider the interference between two light beams represented by the electric fields  and , Show that the resultant irradiance of the individual beams $I\_{12}$ is the interference term. (4 Marks)
3. Define the following terms encountered in optical interferometry.
4. Finesse (1 Mark)
5. Free spectral range (1 Mark)
6. Distinguish between spartial coherence and temporal coherence. State a scenario in which each of the aspects play a role. (3 Marks)
7. Distinguish between phase velocity and group velocity. Under what circumstances are the two velocities equal? (3 Marks)
8. Distinguish between Fresnel diffraction and Fraunhoffer diffraction. (2 Marks)
9. State any two differences between optical holography and photography. (2 Marks)
10. Determine the line width in hertz for laser light whose coherence length is 10 km. The mean wavelength is 632.8nm. (2 Marks)
11. What do you understand by the following?
12. Phase retarder (1 Mark)
13. Linear Polarizer (1 Mark)

**QUESTION TWO (20 MARKS)**

1. Consider the electric fields of four light beams defined as follows;

$Ε\_{1}$= $Ε\_{01}Sin (wt+ ∝\_{1}$), $Ε\_{2}=Ε\_{02}Sin (wt+ ∝\_{2}$), $Ε\_{3}= Ε\_{03}Sin (wt+ ∝\_{3})$,

 $Ε\_{4}= Ε\_{04}Sin (wt+ ∝\_{4})$

The parameters in the equations have their usual meaning. Show on a phaser diagram how to super pose the four beams. (5 Marks)

1. Two interfering beams with parallel electric fields are given by  and 

Determine;

1. The irradiance contributed by each beam acting alone. (4 Marks)
2. The irradiance due to their mutual interference. (3 Marks)
3. The fringe contrast. (4 Marks)
4. Show that if one beam of a two bean interference set-up has an irradiance of N times that of the other beam, the fringe visibility is given by;

 (4 Marks)

**QUESTION THREE (20 MARKS)**

1. Draw a typical Michelson interferometer and describe its principle of operation. Explain how the interference fringes are realized. (5 Marks)
2. The irradiance due to the resultant of the transmitted beams in a Fabry Perot interferometer is given by;

 

where r = reflection coefficient, = irradiance of transmitted beam. Using this expression, obtain an equation for the Airy function T, in terms of the finesse.(5 Marks)

1. A Fabry Perot interferometer has a 1.5cm spacing and a reflection coefficient of

 $r=0.95.$ For a wavelength of 632.8nm, determine;

1. Its maximum order of interference. (2 Marks)
2. Its coefficient of finesse (3 Marks)
3. Its minimum resovable wavelength interval (3 Marks)
4. Its resolving power. (2 Marks)

**QUESTION FOUR (20 MARKS)**

1. Two plane waves of the same frequency and with vibrations in the Z-direction are given by;

 and  write the resultant wave equation expressing their superposition at the point $x=3 $and $y=2$. (5 Marks)

1. Explain the effect of the following optical elements on an incident light beam.
2. Linear polarizer (2 Marks)
3. Phase retarder (2 Marks)
4. Rotator (2 Marks)
5. Analyze the Jones vector given by to show that it represents elliptically polarized light. (5 Marks)
6. Show that the group velocity can be expressed as  (4 Marks)