



STAMFORD COLLEGE SCHOOL OF ENGINEERING

FOUNDATION STUDIES IN ENGINEERING

KE 005: WAVES & OPTICS

Date : 4 September 2007 (Tuesday)

Time: 9.30 am – 11.40 am

Duration: 2 hours + 10 minutes reading time

Instructions to Candidates:

- Instructions:
1. SIX questions set.
 2. Answer Any FOUR questions.
 3. All questions carry equal marks.
 4. Maximum marks attainable: 100

Please ensure that this examination paper contains SIX questions on TWO printed pages before you start the examination.

Books, papers or any other written materials are not allowed to be brought into the examination hall. A candidate who violates the examination rules of Stamford College or commits a malpractice will be disqualified from the examination.

Write your Examination Index Number on each page of your answer booklet.

Answer FOUR question only.

Question 1

- (a) With the aid of diagrams, distinguish between a transverse wave and a longitudinal wave. (2 marks)
- (b) (i) What is a progressive wave? (3 marks)
- (ii) Give any two equations for a progressive wave. (2 marks)
- (iii) List any five characteristics of a progressive wave. (5 marks)
- (c) Define 'period' and 'amplitude' of a wave. Derive $v = f\lambda$. (3 marks)

- (d) The equation of a sinusoidal wave travelling along positive x -axis is

$$y(x, t) = 0.3 \sin 10\pi(2x - 3t),$$

where x and y are in metre and t in seconds. Find the following:

- (i) amplitude,
(ii) wavelength,
(iii) period,
(iv) frequency and
(v) wave velocity

(10 marks)

(Total = 25 marks)

Question 2

- (a) List down five characteristics of a stationary wave. (5 marks)
- (b) Explain the following terms:
(i) Node and Antinode in standing wave
(ii) Coherent source
(iii) Superposition of waves (6 marks)
- (c) What is interference? List down any three conditions for observable interference. (5 marks)
- (d) List down five applications of radiowaves. (5 marks)

- (e) (i) What is polarisation of light?
- (ii) Calculate the polarising angles for water of refractive index 1.33 and glass of refractive index 1.56.

(4 marks)

(Total = 25 marks)

Question 3

- (a) Explain the laws of reflection with the aid of a diagram.
- (b) Sketch a diagram showing the formation of a real magnified image using the concave mirror.
- (c) An object of height 0.1 m is placed 0.2 m in front of a concave mirror whose radius of curvature is 0.25 m. Find the position and describe the nature of the image.
- (d) A convex mirror whose radius of curvature is 30 cm forms an image of a real object which has been placed 20 cm from the mirror. Calculate the position of the image and the magnification produced.

(5 marks)

(6 marks)

(8 marks)

(6 marks)

(Total = 25 marks)

Question 4

- (a) Sketch and explain the formation of a real magnified inverted image using the convex lens.
- (b) An object is placed 20 cm from a converging lens of focal length 30 cm. Calculate the position of the image. What is the nature of the image ?
- (c) (i) Explain the phenomenon of total internal reflection and state the conditions for total internal reflection
- (ii) A ray of light passes through a diamond of RI 2.3 into air. If the angle of incidence in the diamond is 20° , what is the angle of refraction of the diamond ?
- (d) Critical angle for glass is $41^\circ 48'$. Calculate the velocity of light in glass, if the velocity of light in air is 3×10^8 m/s.

(8 marks)

(4 marks)

(5 marks)

(4 marks)

(4 marks)

(Total = 25 marks)

Question 5

(a) Explain the following terms:

- (i) Photoelectric effect.
- (ii) Threshold frequency.

(6 marks)

(b) Sodium has a work function of 2.3eV. Calculate :

- (i) its threshold frequency
- (ii) the maximum velocity of the photoelectrons produced when the sodium is illuminated by light of wavelength $5 \times 10^{-7} \text{m}$
- (iii) the stopping potential with light of this wavelength.

Given $h = 6.6 \times 10^{-34} \text{J}$, $C = 3.0 \times 10^8 \text{ms}^{-1}$, $1 \text{eV} = 1.66 \times 10^{-19} \text{J}$,
the mass of an electron, $m = 9.1 \times 10^{-31} \text{kg}$.

(12 marks)

(c) (i) What is a photoelectric cell?

(2 marks)

(ii) Explain briefly any five applications of photoelectric .

(5 marks)

(Total = 25 marks)

Question 6

(a) State the conditions for constructive and destructive interference.

(10 marks)

(b) Derive an expression for the fringe width .

(10 marks)

(c) Two narrow and parallel slits $8 \times 10^{-4} \text{m}$ apart are illuminated with light of frequency $8 \times 10^{14} \text{Hz}$. It is desired to have the fringe width equal to $6 \times 10^{-4} \text{m}$. At what distance should the screen be placed from the slits?

(5 marks)

(Total = 25 marks)

– END OF PAPER –