SCHEME OF EVALUATION

Department of Physics, MIT Manipal University, Manipal

II Semester B.Tech. - Test 1 Engineering Physics [PHY102] Date 22-02-2014

Time: 8.00-9.00 am Max Marks: 20

Note: Answer all the questions.

1. Choose the most appropriate answer for the following out of the options given: [1x5]

HRK MCQ 41-3

(i) In a double slit interference experiment the slit separation is d and the slit-screen distance is D. Green light is used to form the interference pattern. The green light is then replaced by red light. Which of the following changes will allow the spacing of the bright bands on the screen to remain unaffected by the change of light colour?

(A) Increase D (B) Decrease d
(C) Increase d and / or decrease D
(D) Increase the brightness of the light source

Ans: C 1 mark

HRK MCQ 42-1

(ii) Which of the statements is most correct?

(A) Diffraction occurs only for transverse waves
(B) Red sunsets are a diffraction phenomena
(C) Diffraction explains rainbows
(D) Diffraction is proof that light can behave like a wave

Ans: D 1 mark

HRK MCQ 42-7

(iii) The intensity of the first secondary maximum in single-slit diffraction is approximately what percentage of the intensity of the central maximum?

(A) 50% (B) 25% (C) 5%
(D) It depends on the width of the slit

Ans: C 1 mark

HRK MCQ 44-1

(iv) A vertically oriented, ideal polarizing sheet transmits 50% of the incident unpolarized light. The polarizing sheet is now rotated through 45°. What fraction of the incident intensity now passes?

(A) 0% (B) 50% (C) 100%
(D) Either 0% or 100%

Ans: B 1 mark

HRK MCQ 44-7a

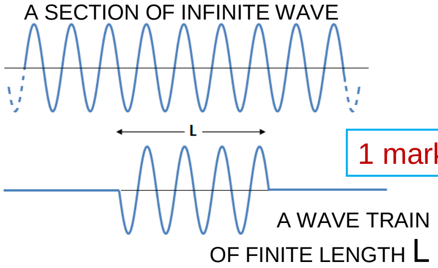
(v) Light reflected from the surface of a road is ⅓ vertically polarized and ⅔ horizontally polarized. At what angle should the polarization direction of polarizing sheet be oriented to provide the maximum reduction in light intensity?

(A) vertically (B) 30° from the vertical
(C) 30° from the horizontal (D) horizontally

Ans: A 1 mark

2. Explain the term coherence of light waves. [2]

½ mark for each main point. Max 2 marks



1 mark

Common sources of visible light emit light wave trains of finite length rather than an infinite wave. ½ mark

The degree of coherence decreases as the length of wave train decreases. ½ mark

Two waves are said to be coherent when they are of :

- mutually comparable amplitude
- same frequency
- same phase or are of a constant phase difference ½ mark

Laser light is highly coherent whereas a laboratory monochromatic light source (sodium vapor lamp) may be partially coherent. ½ mark

3. Obtain an expression for the width of the central maximum in diffraction pattern due to multiple slits. [3]

The pattern contains central maximum with minima on either side.
λ = wavelength of light.
N = total number of slits.
$\delta\theta_o$ = width of the central maximum.

ΔL = path difference between the light waves from the two adjacent slits separated by d at the position $\delta\theta_o$.
$\Delta\phi$ = phase difference between the light waves from the two adjacent slits separated by d at the position $\delta\theta_o$. 1 mark

At minima, the phase difference, $\Delta\phi = 2\pi / N$

$$\Delta L = \left(\frac{\lambda}{2\pi}\right)\Delta\phi = \frac{\lambda}{N}$$

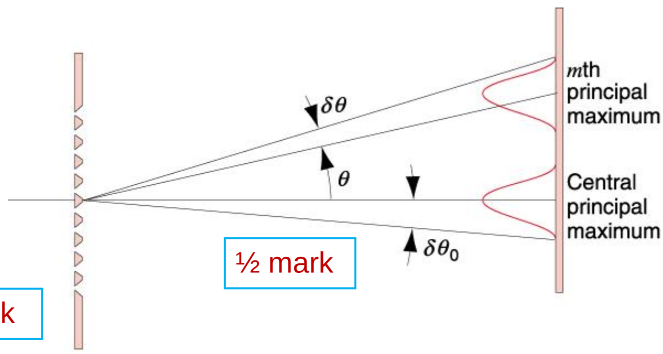
$$\Delta L = d\sin\delta\theta_0$$

$$\frac{\lambda}{N} = d\sin\delta\theta_0$$

$$\sin\delta\theta_0 = \frac{\lambda}{Nd}$$

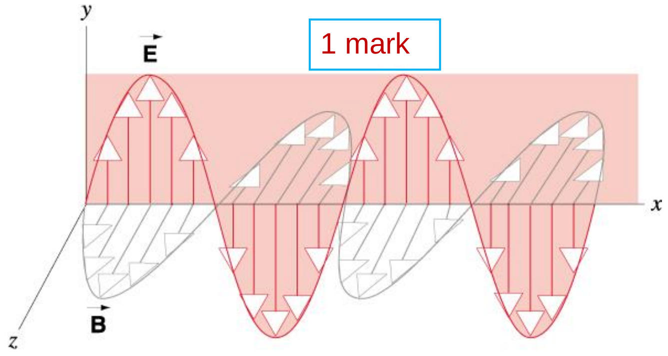
$$\delta\theta_0 \cong \frac{\lambda}{Nd}$$

1½ mark



½ mark

4. Sketch the schematic graph of a travelling electromagnetic wave showing the electric and magnetic vectors. [1]



$\vec{E}$ = electric vector

$\vec{B}$ = magnetic induction vector
x = direction of propagation of the wave
y = direction of polarization of the wave = direction of $\vec{E}$ vector

5. White light reflected at perpendicular incidence from a soap film (refractive index = 1.33) in air has, in the visible spectrum, an interference maximum at 600 nm and a minimum at 450 nm with no minimum in between. What is the film thickness, assumed to be uniform? [3]

HRK
E 41-28

λ_1 = 600 nm , λ_2 = 450 nm , n = 1.33 , d = ?

$2\,d + \lambda_n/2 = m\,\lambda_n$, for constructive interference

$2\,n\,d + \lambda_1/2 = m\,\lambda_1$, for constructive interference of λ_1

$2\,n\,d + \lambda_2/2 = (m+½)\,\lambda_2$, for destructive interference of $\lambda_2 < \lambda_1$ 1 mark

$\therefore$ $m\,\lambda_2 = (m-½)\,\lambda_1$, solving, $m = \lambda_1 / [2\,(\lambda_1 - \lambda_2)]$

Substituting, m = 2 1 mark

$\therefore$ $d = m\,\lambda_2 / (2\,n)$, Substituting, d = **338 nm** 1 mark

6. A slit 1.16 mm wide is illuminated by light of wavelength 589 nm. The diffraction pattern is seen on a screen 2.94 m away. Find the distance between the first two diffraction minima on the same side of the central maxima. [3]

HRK
E 42-9

$a = 1.16$ mm, $D = 2.94$ m, $\lambda = 589$ nm

$a \sin\theta = m\lambda$ FOR m^{TH} MINIMUM

$\tan\theta \cong \sin\theta = m\lambda / a$ FOR SMALL θ — 1 mark

$\tan\theta_1 = y_1 / D = \lambda / a$, $\tan\theta_2 = y_2 / D = 2\lambda / a$ — 1 mark

Subtract and simplify: $y_2 - y_1 = \lambda D / a$

Substitute: $y_2 - y_1 =$ 1.49 mm — 1 mark

7. A grating has 9600 lines uniformly spaced over a width 3 cm and is illuminated by mercury light. What is the expected dispersion in the first order, in the vicinity of intense green line (wavelength = 546nm)? [3]

HRK
SP 43-3a

$w = 3$ cm , $N = 9600$, $\lambda = 546$ nm , $m = 1$

$d = w / N = 3125$ nm — ½ mark

$d \sin\theta = m\lambda$, $\theta = \sin^{-1}(\lambda / d) = 10.06°$ — 1 mark

$D = m / (d \cos\theta) =$ 3.25×10^{-4} RAD/nm — 1½ mark

$= 0.0186°/\text{nm}$

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