SCHEME OF EVALUATION

Department of Physics **MIT** **Manipal University, Manipal**
II Semester B.Tech. - Test 1 **Engineering Physics [PHY1001]** Date 09-09-2017
Time: 1.45-2.45 pm Max Marks: 15

Note: Answer all the questions. Missing data may suitably be assumed.
Draw neat sketches wherever necessary with axes shown properly.

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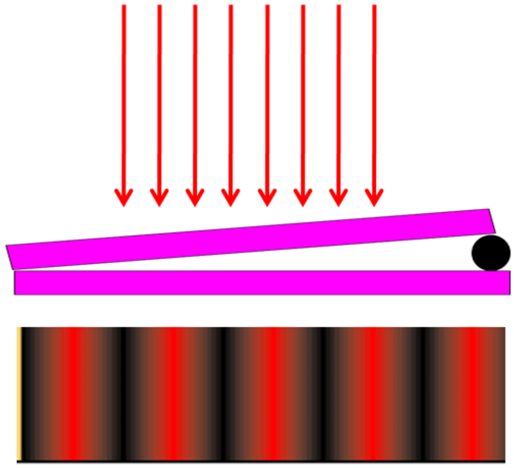
1. HRK E41-29

Explain the interference of light in the case of wedge-shaped thin films.
A broad source of light (wavelength = 680 nm) illuminates normally two glass plates 120 mm long that touch at one end and are separated by a wire 0.048 mm in diameter at the other end. How many bright fringes appear over 120 mm distance? [3]



When light falls on wedge shaped thin film, it undergoes partial reflections from upper and lower part of the film thereby producing coherent waves.

Since the film is thin, the reflected waves are close by and are in a position to interfere. Constructive interference occurs in certain part of the film [$2\,d + (½)\,\lambda_n = m\,\lambda_n$] and destructive interference in others [$2\,d + (½)\lambda_n = (m+½)\lambda_n$]. Then bands of maximum and minimum intensity appear, called fringes of constant thickness. The locus of the points having the same thickness is a straight line and hence straight (linear) fringes are formed.

1½ mark

d = 0.048 mm λ = 680 nm n = 1

$2\,d + (0)\,\lambda + (½)\,\lambda = m\,\lambda$ FOR m^{TH} BRIGHT FRINGE at the wire

$$m = \frac{2\,d}{\lambda} + \frac{1}{2} = 141.67 \qquad \therefore \qquad m_{MAX} = \boxed{141}$$

1½ mark

2. HRK E43-9

Explain: what is a diffraction grating.
Given a grating with 400 rulings/mm, how many orders of the entire visible spectrum (400-700 nm) can be produced? [3]

The diffraction grating, is a useful device for analysing light sources. It consists of a large number of equally spaced parallel slits. A typical grating might contain *N*= 10,000 slits distributed over a width of a few centimetres. They are of two kind: i) Transmission gratings ii) Reflection gratings. A transmission grating can be made by cutting parallel grooves on a glass plate with a precision ruling machine. The spaces between the grooves are transparent to the light and hence act as separate slits. A reflection grating can be made by cutting parallel grooves on the surface of a reflective material. The reflection of light from the spaces between the grooves is specular, and the reflection from the grooves is diffuse.

1½ mark

$\lambda = \lambda_{MAX} = 700$ nm

$$d = \frac{w}{N} = \frac{0.001\text{m}}{400} = 2.5 \times 10^{-6}\ \text{m}$$

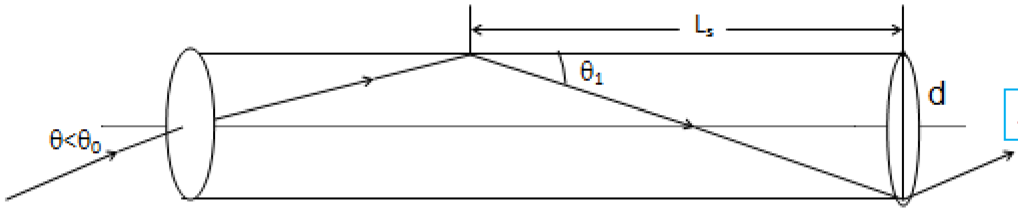
$d \sin\theta = m\,\lambda$

$$m = \frac{d\sin\theta}{\lambda} \qquad m_{MAX} < \frac{d}{\lambda} = 3.57 \qquad m_{MAX} = \boxed{3}$$

1½ mark

3. What is skip distance? With neat diagram, derive an expression for it. [2]

Skip distance is the distance between two successive reflections of the ray of light which propagates through the optical fiber. Consider a portion of the optical fiber through which a light signal is transmitted.



1 mark

From the Figure

$$L_s = d\cot\theta_1 = d\sqrt{\operatorname{cosec}^2\theta_1 - 1}$$

$$L_s = d\sqrt{\frac{n_1^2}{n_0^2\sin^2\theta} - 1} \qquad \because \sin\theta_1 = \frac{n_0}{n_1}\sin\theta$$

1 mark

4. A ruby laser emits light at a wavelength of 694.4 nm. If a laser pulse is emitted for 12.0 ps and the energy release per pulse is 150 mJ, what is the length of the pulse, and how many photons are there in each pulse? [2]

HRK E48-28

n = number of photons in each pulse

Δx = length of the pulse

Δt = 12.0 ps

λ = 694.4 nm

$c = 3.00\times10^8$ m/s

E_{PULSE} = 150 mJ

$\Delta x = (c)(\Delta t) = \boxed{3.6\text{ mm}}$ 1 mark

$E_{PHOTON} = hc/\lambda = 2.862\times10^{-19}$ J

$n = \frac{E_{PULSE}}{E_{PHOTON}} = \boxed{\mathbf{5.24\times10^{17}}}$ 1 mark

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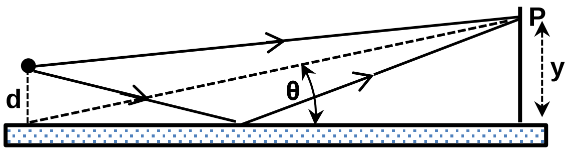
5. Choose the most appropriate answer for the following out of the options given.
WRITE THE FULL SENTENCE WITH THE RIGHT OPTION UNDERLINED: [1x5]

(A) An interference pattern is produced at point P on a screen as a result of direct rays and rays reflected off a mirror as shown in the figure. The source is 100 m to the left of the screen, 1 cm above the mirror, and the source is monochromatic (λ = 500 nm). The condition for minimum brightness on the screen in terms of λ, θ, m (=integer) and d is ....

SJ
MCQ37-16

- $2\, d \sin\theta = (m+½)\lambda$
- $2d \sin\theta = m\,\lambda$ ANS
- $d \sin\theta = (m+½)\lambda$
- $d \sin\theta = m\,\lambda$



(B) Bright and dark fringes are seen on a screen when light (λ = wavelength) from a single source reaches two narrow slits a short distance apart. The locations of bright and dark fringes can be interchanged if a thin film (n = refractive index) is placed in front of one of the slits. The minimum thickness (d) of this film must be ....

SJ
MCQ37-39

- $d = \lambda / 2$
- $d = \lambda / (2\,n)$
- $d = \lambda / (\,n - 1)$
- $d = \lambda / [2(\,n - 1)]$ ANS

(C) The centers of two slits of width a are a distance d apart. If the first minimum of the interference pattern occurs at the location of the first minimum of the diffraction pattern for light of wavelength λ, the ratio a/d is equal to ....

SJ
MCQ38-36

- ½
- 1
- $^{3}/_{2}$
- 2 ANS

(D) Photons in a laser beam are produced by ....

HRW
MCQ41-66

- transitions from a metastable state. ANS
- transitions from a state that decays rapidly.
- pumping.
- reflection from mirrors.

(E) Numerical aperture of an optical fibre ....

NEW

- increases with decrease in fractional index change.
- increases with increase in refractive index of the core. ANS
- increases with increase in refractive index of the cladding.
- is independent of refractive index of core and cladding.

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