—48—

Total No. of pages : 3 *Roll. No............*

Fourth semester B.Tech. [Engg. Physics]

MID SEMESTER EXAMINATION (March 2019)

EP-204 OPTICS

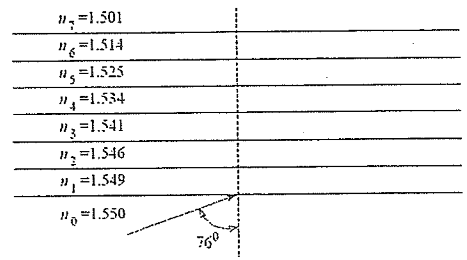
Time : 1:30 hours Max. Marks: 30

Answer all questions

1. (a) It is not possible to show interference effects between light from two separate sodium vapour lamps but you can show interference effects between sounds from loudspeakers that are driven by separate oscillators. Explain why it is so.

(b) Draw a neat diagram showing the optical arrangement of a Michelson interferometer.

(c) A light ray is incident on a dielectric stack of refractive indexes as shown below at angle 76° with respect to the normal. What is the exit angle of the ray?

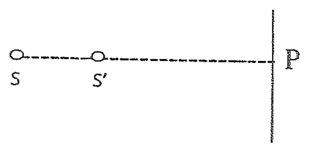


(d) Two light filters are used to transmit yellow light centered around 590 nm. One filter has a broad transmission width of 100 nm, whereas the other has a narrow pass band of 10 nm. Which filter would be better to use for an interference experiment? Compare the coherence lengths of the light from each.

(e) Plot the function '$\sin^2 N\gamma / \sin^2 \gamma$' for N = 5.

(f) A grating with 200 lines per millimetre and of width 2cm is fully illuminated by light consisting of wavelengths 600 nm and 600.1 nm. What is the lowest diffraction order where two wavelengths will be resolved?

(g) A pair of point sources , S, S' emitting a wavelength of 500nm with a spectral width of 500nm with a spectral width $\Delta\lambda$, and separated by distance of 1mm are placed as shown in figure. What is the condition on $\Delta\lambda$ so that one can observe an interference pattern around the point P, given that the screen is placed at a distance of 1 m from the midpoint of the sources?



[2*7 = 14]

2. In Newton's rings experiment, light containing two wavelengths λ_1 an λ_2 are used. The radius of the plano convex lens used is R. If the n^{th} dark ring due to λ_1 coincides with the $(n+1)^{th}$ dark ring due to λ_2, prove that the radius of the n^{th} dark ring of λ is $\sqrt{\left(\frac{\lambda_1 \lambda_2 R}{\lambda_1 - \lambda_2}\right)}$ [4]

3. A Fabry Perot interferometer has a 1cm spacing between mirrors and a reflection coefficient of r = 0.95. For a wavelength around 500nm, determine its mode number, its figure of merit, its minimum resolvable wavelength interval and its resolving power. [4]

4. Assume a Gaussian pulse of the form

$$\psi(x = 0, t) = E_0 \, exp\left(-\frac{t^2}{2\tau^2}\right) e^{i\omega_0 t}$$

Find the fourier transform A(ω). Show that the temporal coherence is ~ τ. Assume τ >> $(1/\omega_0)$, plot the Fourier transform A(ω) [as function of ω] and interpret it physically. Show that the frequency spread Δω ~ 1/τ.

Following standard integral can be used:

$$\int_{-\infty}^{\infty} \exp[-\alpha x^2 + \beta x] \, dx = \sqrt{\frac{\pi}{\alpha}} \exp\left(\frac{\beta^2}{4\alpha}\right); \quad \alpha > 0$$

[4]

5. Consider a plane wave incident normally on a rectangular aperture of width b (along the ξ axis) and width a (along the η axis) placed on the aperture plane. For such a case,

$$U(\xi, \eta, 0) = A \qquad |\xi| < b/2 \quad \text{and} \quad |\eta| < a/2$$
$$= 0 \qquad \text{else where}$$

for all values of η. Calculate the corresponding Fraunhofer diffraction pattern.

[4]