Indian Institute of Technology Delhi
Department of Physics
Major Exam EPL105
24 November 2013

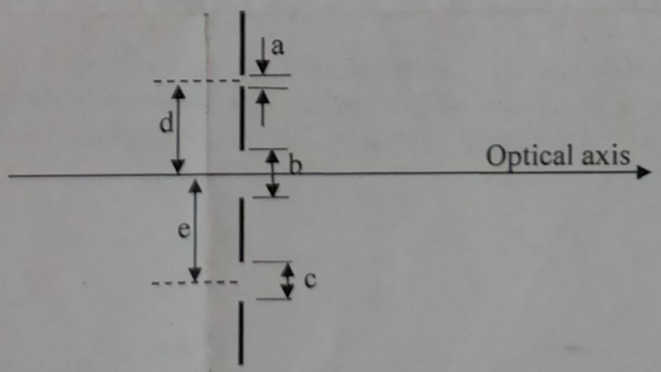
Max.Marks : 50 Duration 2hrs.

Please answer all the questions.

1. A zone plate consisting of 6 transparent rings, with the first ring being transparent, produces a bright spot at a distance of 30 cm when illuminated by a point source kept before the zone plate at a distance of 15 cm. What is the radius of the first and sixth transparent ring in the zone plate. Assume each ring occupies one half period zone. (6)

2. A Gaussian beam with wavelength λ is travelling along the z axis with its minimum waist located at z = 0 plane. What is the phase distribution $\phi(x,y)$ of the beam at a distance z equal to the Rayleigh length? (4)

3. Three slits each of widths a, b and c are arranged as shown in the figure below. What is the intensity observed in the Fraunhofer diffraction pattern? (6)



4. A complex filed of an optical wave given by $a\exp\left[-iB\left(x^2-y^2\right)+ikz\right]$. What is the local spatial frequency at the location given by (x_0,y_0) at $z=z_0$ plane. B is a constant whose unit is m^{-2}. (4)

5. A phased array antenna having N x N radiating elements, is kept vertical (say in xy plane). N x N elements occupy an area of A m^2. If the antenna has to look horizontally (i.e., in the xz plane) at an angle of 30° with respect to the z direction what should be the phase difference that should be given to the elements of the antenna. (4)

6. A glass plate with uniform thickness d is inserted into a Fabry-Perot interferometer cavity with its side parallel to the interferometer mirrors. In

doing so, what will happen to the free spectral range of the interferometer? Assume that the refractive index of the glass plate n is constant for a wide range of frequencies. (5)

7. Light with electric field $\vec{E} = (\hat{x} + i\hat{y})E_0 \exp(i(kz - \omega t))$ is incident normally on a quarter wave plate whose fast axis is oriented in $\frac{1}{2}[\sqrt{3}\hat{x} + \hat{y}]$ direction. Write the electric field of the emergent light. (5)

8. A half-wave plate placed between two crossed polarizers is rotated about the beam axis. When unpolarized light is incident on the system, sketch the output intensity as a function of angle θ between the pass plane of the first polarizer and the optic axis of the wave plate. (3)

9. When a single slit is normally illuminated by plane wave of wavelength $\lambda_1 = 400\,nm$, the minimum missing spatial frequency components are $\pm 0.3\ mm^{-1}$. If the same slit is illuminated by a light of wavelength 500nm, find the minimum missing spatial frequency component. (6)

$f = 15\,cm$ just behind slit Fraunhoffer.

10. For a wave propagating in a periodic structure for which $\omega(k) = 2\omega_0 \sin(kl/2)$, determine both the phase and group velocities. Write the former as a sinc function. (4)

11. Using the stellar interferometer, Michelson observed for the star Betelgeuse that the fringes disappear when the distance between the movable mirrors is 25 inch. Assuming $\lambda \approx 6 \times 10^{-5} cm$, calculate the angular diameter of the star. (3)