PYL 115: APPLIED OPTICS

(Ist Semester, 2015-2016)

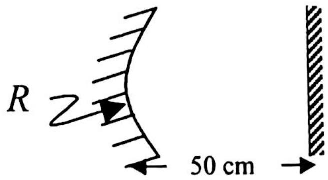
Minor-II

Duration: 1 hour **Max. Marks: 20**

Attempt ALL questions.

1. Using a Fabry-Perot interferometer, the spectrum of a source (central wavelength at 600 nm) is to be analyzed. The source has a spectral width of 5 nm. What should be the minimum reflectivity and largest mirror separation to obtain a resolution of 0.02 nm? (5)

2. Consider a resonator shown in the figure. What will be the spot size w_0 of the cavity mode? Assume $R = 250$ cm and $\lambda = 1$ μm. The plane mirror has a reflectivity of 50%, so that the beam is partially transmitted. What would be the intensity spot-size of the beam on a screen kept 100 cm away from the plane mirror? (5)



3. The f-number of a lens specifies the ratio of focal length to its diameter. One of the important specifications of a camera is its f-number. Consider a camera with a lens of f-number of 2.8 (usually written as $f/2.8$) and a focal length of 50 mm. What is the minimum spacing between the images of two point objects at infinity when they are just resolved? Assume wavelength = 500 nm. (3)

4. Consider a rectangular aperture ($20\mu\text{m} \times 10\mu\text{m}$) being illuminated normally by a plane wave of 0.4 μm wavelength. The diffraction pattern is observed on a screen placed (symmetrically on the axis) at the back focal plane of a lens of focal length 20 cm (assume the aperture of the lens to be very large). What would happen if
   (a) the aperture is shifted by 20 μm in its plane? (1)
   (b) the aperture is rotated by 30 degrees in its plane? (1)
   (c) the aperture is moved by 5cm away from the lens along the axis? (1)

5. The threshold population inversion in a laser cavity is given by (4)

$$(N_2 - N_1)_{\text{th}} = \frac{4\nu^2 n_0^2}{c^3} \frac{t_{sp}}{t_c} \frac{1}{g(\omega)}$$

where all symbols have their usual meanings. Discuss various conditions to have low threshold population inversion.

For multiple beam interference:

$$I = \frac{I_0}{1 + F \sin^2(\delta/2)} \qquad \delta = 4\pi n_t d \cos\theta_t / \lambda_0 \qquad F = 4R/(1-R)^2$$

Gaussian beam:

$$U(x,y,z) = \frac{a w_0}{w(z)} e^{-\left(\frac{x^2+y^2}{w^2(z)}\right)} e^{-ik\left(z+\frac{x^2+y^2}{2R(z)}\right)} e^{-i\tan^{-1}(\lambda z/\pi w_0^2)}$$

$$w(z) = w_0\sqrt{1+(\lambda z/\pi w_0^2)^2}$$

$$R(z) = z[1+(\pi w_0^2/\lambda z)^2]$$