COLLEGE OF ENGINEERING ROORKEE, ROORKEE
Autumn Semester 2014-2015

Subject: Physics **Subject Code: TPH101**
Diffraction **Tutorial Sheet: 7**

Numerical Problems:

1. Light of wavelength $5500A^0$ falls normally on a slit of width $2.2x10^{-4}$cm. Calculate the angular positions of first two minima on either side of central maxima. Ans. 14.48^o, 30^o

2. A screen is placed 1m away from a narrow slit which is illuminated by sodium light of wavelength 589nm. If the first minima lie 1mm on either side of the central maxima, find the width of the slit.
Ans. $5.89x10^{-4}$m

3. Diffraction pattern of a single slit of width 0.5mm is formed by a lens of focal length 40cm. Calculate the distance between first dark fringe and the next bright fringe on either side of central maxima. The wavelength of light used is $5890A^0$. Ans. 0.236mm

4. In a double slit fraunhofer diffraction pattern, the screen is placed 180cm away from the slits. The width of the slits is 0.1mm and they are separated 0.3mm apart. Calculate the wavelength of light if the fringe width is 0.3cm. Also find the missing orders. Ans. 6666.66A, 4,8,12,..

5. Two slits, each of width 0.05mm are placed parallel with a separation equal to the width of the slit. They are illuminated by a light of wavelength $6x10^{-5}$cm and the light emerging from them are focused by a lens of focal length 80cm. Deduce the positions of first three maxima on one side of central maximum.
`
Ans. 0.48cm, 1.44cm, 2.4cm

6. A diffraction grating used at the normal incidence gives a green line of wavelength 5400 A, in a certain order n superposed on a violet line of wavelength 4050 A, of the next higher order (n+1). If the angle of diffraction is 30^o, calculate spacing between the grating lines. Also find hoe many lines are there per cm in the grating.
Ans $3.24\ x10^{-4}$ cm, 3086
7. A grating with 15000 rulings per inch is illuminated normally with white light extending from 400-700nm. Show that only the first order spectrum is isolated and the second and the third orders overlap.

8. A grating has 6000 lines per cm. Calculate the angular separation of two lines of mercury having wavelengths 577nm and 579.1nm in the second order. Ans. $2.52x10^{-3}$ radian

9. Calculate the least width of the grating that can resolve the D lines of sodium in the third order if the grating has 1000 lines per inch. The wavelengths of the D lines are 5890A and 5896A. Ans. 8.3mm

10. A plane transmission grating produces an angular separation of 0.01 radian between two wavelengths observed at an angle 30^o. If the mean wavelength is 540nm and the spectrum observed is the II order, calculate the difference in the wavelengths. Also calculate the number of lines per cm on the grating.
Ans. 9.35nm, 4629.6/cm

11. Examine whether the two lines of helium at 5016A and 5048A be clearly resolved in the (i) first order, (ii) second order by a grating with grating element 0.2mm and width 1inch. Ans. (i) no, (ii) yes

12. A plane transmission grating has 30,000 lines in all with a grating element $1.25x10^{-4}$cm. Calculate the maximum resolving power it can give with the wavelength 600nm. Ans.60,000

13. A diffraction grating having 4000 lines per inch is used at normal incidence. Calculate the dispersive power of the grating in the second order spectrum in the 500nm wavelength range. Ans. 3189.4

Theoretical Questions:

1. Derive the expression for intensity distribution due to single slit diffraction under Fraunhofer condition and show that the relative intensities of successive maxima are nearly 1: $4/(9\pi^2)$: $4/(25\pi^2)$: $4/(49\pi^2)$: ……

2. What do you mean by missing orders of spectra in grating? Show that only first order will be visible if the width of the grating element is less than the wavelength of light.

3. What is meant by resolving power of an optical instrument? Explain the Rayleigh criterion of resolution.

4. What do you mean by dispersive power of a grating? Derive the necessary expression.

5. Explain the Fraunhofer diffraction due to a double slit. How does its intensity curve differ from that due to single slit? What is the effect of (i) increasing the slit width, (ii) increasing the slit separation and (iii) increasing the wavelength of light?

6. Give the theory of plane transmission grating and the formation of spectra by it. Hence describe the method to determine the wavelength of light.

7. Derive expression for the resolving power of a grating.

8. Differentiate between the resolving power and dispersive power of a grating.

.