Tutorial 4

Diffraction:

- Fraunhofer diffraction-single slit, double slit, diffraction grating,
- resolving power;
- Diffraction by a circular aperture and the Airy pattern;
- Fresnel diffraction: half-period zones and zone plates, circular aperture.

Q1:

Explain the physical significance of resolving power of a grating with relevant mathematical expression. *10*

2013

Q2:

Considering a plane transmission diffraction grating, where d is the distance between two consecutive ruled lines, m as the order number and 0 as the angle of diffraction for normal incidence, calculate the angular dispersion $\frac{d\theta}{d\lambda}$ for an incident light of wavelength λ. *10*

2014

Q3:

A convex lens of focal length 20 cm is placed after a slit of width 0·5 mm. If a plane wave of wavelength 5000 Å falls normally on the slit, calculate the separation between the second minima on either side of the central maximum. *10*

2015

Q4:

Can D_1 and D_2 lines of sodium light ($\lambda_{D_1} = 5890$ Å and $\lambda_{D_2} = 5896$ Å) be resolved in second-order spectrum if the number of lines in the given grating is 450? Explain. 10

2016

Q5:

Obtain an expression for the resolving power of a grating explaining the Rayleigh's criterion of resolution. 15

2016

Q6:

Show that the areas of all the half-period zones are nearly the same. Find the radius of 1st half-period zone in a zone plate whose focal length is 50 cm and the wavelength of the incident light is 500 nm. 15

2017

Q7:

A plane transmission grating has 3000 lines in all, having width of 3 mm. What would be the angular separation in the first order spectrum of the two sodium lines of wavelengths 5890 Å and 5896 Å ? Can they be seen distinctly ? *10*

2018

Q8:

Discuss the intensity distribution in Fraunhofer diffraction pattern due to a single slit. Obtain conditions for maxima and minima of the intensity distribution. Show that the intensity of the first maxima is about 4·95% of that of the principal maxima. *20*

2018

Q9:

What is a zone plate ? Give its theoretical description. Show that a zone plate has multiple foci. Differentiate a zone plate from a convex lens. Calculate the radius of the first half period zone in a zone plate behaving like a convex lens of focal length 60 cm for light of wavelength 6000 Å. *15*

2020

Q10:

Show that the phenomenon of Fraunhofer diffraction at two vertical slits is modulation of two terms viz. double slit interference and single slit diffraction. Obtain the condition for positions of maxima and minima. *20*

2021

Q11:

Discuss the phenomenon of Fraunhofer diffraction at a single slit and show that the intensities of successive maxima are nearly in the ratio

$$1 : \frac{4}{9\pi^2} : \frac{4}{25\pi^2} : \frac{4}{49\pi^2}$$ 20

2022

Q12:

(i) What is the difference between Fresnel diffraction and Fraunhofer diffraction ? *5*

(ii) What is resolving power of a telescope ? Why is the resolving power of microscope more with UV light than with visible light ? *10*

2023

Q13.

A telescope has an objective lens of diameter 10 cm. Determine whether this telescope can resolve two stars having an angular separation of 2·4 seconds of arc. (Assume the wavelength of starlight as 550 nm) 10

2024

Q14.

The diameter of central zone of a zone plate is 2·4 mm. If a point source of light of wavelength 600 nm is placed at a distance of 5·0 m from the zone plate, calculate the position of the first image. 10

2024

Q15.

In a double slit Fraunhofer diffraction experiment, the slit width is 0·12 mm and the spacing between the two slits is 0·48 mm. The distance of the screen from the slits is 1·5 m. If the wavelength of the light used is 600 nm, determine (i) the missing orders of the interference maxima, and (ii) the distance between the central maxima and the first minima. *10*

2025