Physical Optics

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Assignment : Fresnel & Fraunhofer Diffraction

Submission due date: 17/05/2020

Q.1) (a) In a double slit interferece pattern the 12^{th} order maximum is observed at a point when light of wavelength $\lambda_1 = 6000\mathring{A}$ is used. What order will be visible at the same point if the source is now replaced by light of wavelength $\lambda_2 = 4800\mathring{A}$?

(b) The central maximum of the envelop of the double-slit interferece pattern contains exactly 9 fringes. Determine the angles where fringes will appear between the first and second minima of envelop.

Q.2) (a) A plane transmission grating at normal incidence diffracts a line of wavelength $540nm$ for a certain order superposed on another line of wavelength $405nm$ of the next higher order. If the angle of diffraction be $30°$, find the grating element.

(b) Consider a grating with slit of width $a = 0.001mm$ separated by a distance of $0.002mm$. How many orders would be visible at $\lambda = 500nm$? *[Note: you must account for missing order.]*

(c) Find the least-width that a diffraction grating must have to resolve two Sodium D-lines ($\lambda_{D_1} = 5890\mathring{A}$ & $\lambda_{D_2} = 5896\mathring{A}$) in the second order. The number of lines per cm of the grating is 820.

(d) Sodium light is incident normally on a plane transmission grating having 3000 lines per cm. Find the direction of the first order for the D-lines and the width of the grating necessary to resolve them.

(e) A transmission grating is $4cm$ long and having 4000 lines/cm. Compute the resolving power of the grating for $\lambda = 5900\mathring{A}$ in the first order spectrum. Will this grating separate the sodium line doublet?

(f) You are given two plane transmission grating G_1 and G_2. The grating G_1 is of width $3cm$ and has 3000 lines, while G_2 is of width $2cm$ and has 2000 lines. Compare the resolving powers of these two gratings.

Q.3) (a) Find the separation of two points on the moon that can be resolved by a $500cm$ telescope. The distance of moon is 3.8×10^5km and eye is most sensitive to light of wavelength $5500\mathring{A}$.

(b) The resolving power of the human eye is about 1 minute of arc. Find (i) the diameter of human eye and (ii) angular separation in seconds of arc of the closest two stars resolvable by a reflecting telescope with $8cm$ objective, $1.5m$ focal length, $80X$ eyepiece. Assume that wavelength of light is $6000\mathring{A}$.

Q.4) A zone plate is constructed by drawing a concentric circles of radii equal to that of a dark Newton's rings formed by a equiconvex lens of radius of curvature $R = 2m$. Find the first focal length of the zone plate (for same λ).