December 09, 2013
(9:00 am – 12:00 pm)

FINAL EXAMINATION

COURSE NO.: PHYS 2260

TIME: 3 hours

EXAMINATION: Introductory Optics

EXAMINER: P. W. Zetner

FORMULAE

1. Spherical Refracting Surface

$$\frac{n}{s}+\frac{n'}{s'}=\frac{n'-n}{R}$$

$$m=-\frac{ns'}{n's}$$

2. Thin Lens

$$\frac{1}{s}+\frac{1}{s'}=\frac{1}{f}$$

$$xx'=f^2$$

$$m=-\frac{s'}{s}=-\frac{f}{x}=-\frac{x'}{f}$$

$$\frac{1}{f}=(n-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right) \text{ where } n=\frac{n_{lens}}{n_{medium}}$$

3. Ray Transfer Matrices

$$\tilde{R}=\begin{pmatrix}1 & 0\\ \frac{n-n'}{n'R} & \frac{n}{n'}\end{pmatrix} \qquad h=\frac{D-1}{C}$$

$$\tilde{T}=\begin{pmatrix}1 & d\\ 0 & 1\end{pmatrix} \qquad h'=\frac{A-1}{C}$$

$$\tilde{M}^{thin}=\begin{pmatrix}1 & 0\\ -\frac{1}{f} & 1\end{pmatrix} \qquad f=-\frac{1}{C}$$

$$\tilde{M}=\begin{pmatrix}A & B\\ C & D\end{pmatrix}$$

4. Focal length of a 2 lens system

$$\frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2}-\frac{d}{f_1 f_2}$$

5. Condition for Zero Chromatic Aberration

$$\frac{\Delta_1}{f_1}+\frac{\Delta_2}{f_2}-\frac{d}{f_1 f_2}(\Delta_1+\Delta_2)=0 \qquad \text{with} \qquad \Delta=\frac{n_F-n_c}{n_D-1}$$

6. Magnifier (Relaxed Eye)

$$\gamma=\frac{25\,\text{cm}}{f}$$

7. Microscope

(i) Angular magnification (virtual final image)

$$\gamma=m_{objective}\left(\frac{25\ cm}{s_e}\right)$$

(ii) Angular magnification (virtual final image at infinity)

$$\gamma=-\frac{L}{f_{objective}}\bullet\frac{25\text{ cm}}{f_{eyepiece}}$$

(iii) Transverse magnification (real image)

$$m=m_{objective}m_{eyepiece}$$

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8. Harmonic Plane Wave

$$\vec{E} = \vec{E}_0 e^{i(\vec{k}\cdot\vec{r}-\omega t+\phi_0)}$$

$$I = \frac{\varepsilon_0 c n}{2}\vec{E}\cdot\vec{E}^*$$

For points A and B along the propagation path:

$$\vec{E}_B = \vec{E}_A\, e^{i\vec{k}\cdot(\vec{r}_B-\vec{r}_A)}$$

Wave vector in a medium:

$$\vec{k} = n\,\vec{k}_0 \qquad (\text{and } \lambda = \frac{\lambda_0}{n})$$

9. General 2 Beam Interference Formula

$$I = I_1 + I_2 + 2(I_1 I_2)^{1/2}\cos\Delta\phi$$

10. N Slit Interference/Diffraction

(i) Infinitesimal width slits:

$$I(\theta) = I_0\left(\frac{\sin N\alpha}{\sin\alpha}\right)^2$$

(ii) Finite width slits:

$$I(\theta) = \frac{I(0)}{N^2}\left(\frac{\sin\beta}{\beta}\right)^2\left(\frac{\sin N\alpha}{\sin\alpha}\right)^2$$

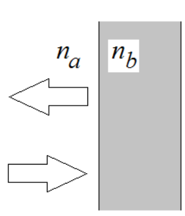
where $\alpha = \dfrac{\pi a}{\lambda_0}\sin\theta$ (a: slit separation)

$\beta = \dfrac{\pi b}{\lambda_0}\sin\theta$ (b: slit width)

11. Interference in a Dielectric Layer

$$\Delta\phi = 2k_0 n_f t\cos\theta_t + \delta_{fs} - \delta_{if}$$

$$\rho_{ab} = \frac{n_a - n_b}{n_a + n_b}$$



12. Michelson Interferometer

$$\Delta\phi = 2k_0 nd\cos\theta + \pi$$