Lecture 33

Exam 3 Review

(review checkpoint problems, homeworks, sample exams)

Important concepts:

Ch 33.

EM waves

- direction of propagation for wave
- oscillation direction for E-field, for B-field
- speed of EM wave
- energy transport + intensity of EM wave
- variation of intensity w/ distance

Law of reflection & Laws of refraction (Snell's law)

definition of index of refraction

index of refraction for multiple materials, i.e., changing interfaces

total internal reflection & critical angle (for angles of incidence larger than θ_c, there is only reflection)

real vs. virtual image

for real image, physical rays intersect to make the image

for virtual image, ~~it is only~~ physical rays do not intersect & instead image appears to form where virtual rays intersect.

Image distance versus object distance

convex & concave spherical mirrors

spherical mirror equation:

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{i}$$

↑ focal length

mirror magnification: $m = \frac{-i}{p}$

Thin lenses:

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{i}$$

review take-home quiz!

magnification of image

$$m = \frac{-i}{p}$$

multiple rounds of magnification

real vs. virtual image

upright vs. inverted image

interference of light (light as a wave)

Huygens' principle

phase difference of light going through different materials :

difference in terms of # of wavelengths $N_2 - N_1 = \frac{L}{\lambda}(n_2 - n_1)$

written on formula sheet as ΔN

in terms of radians $2\pi \cdot (N_2 - N_1)$

Young's double-slit experiment

path length differences + constructive + destructive interference

$\Delta L = d \sin\theta$ (path length difference)

$d \sin\theta = m\lambda$ for $m = 0, 1, 2, 3,$

bright fringes or maxima

$d \sin\theta = (m + 1/2)\lambda$ for $m = 0, 1, 2, \ldots$

for minima or dark fringes

intensity in double-slit experiment

$I(\theta) = 4 I_0 \cos^2\left(\frac{2\pi d}{\lambda} \sin\theta\right)$

- Interference from thin films

interference of reflected waves

Approximate $\theta \approx 0$ in this situation

+ path length difference is $2L$ plus additional phase due to reflection off material w/ different index + refraction single-slit diffraction & intensity

$$a \sin\theta = m\lambda \quad \text{(dark fringes)}$$

↑ slit width (a) ↑ $m = 1, 2, 3, \ldots$

intensity in single-slit diffraction

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

$$\alpha = \frac{\pi a}{\lambda} \sin\theta$$

minima, dark fringes @

$$a \sin\theta = m\lambda$$

for $m = 1, 2, 3, \ldots$

Problem 1 Spring 2018

a) relative phase shift between rays 3 & 4:

rule to apply:

if reflection occurs @ surface w/ higher index, n_2 ~~the~~ phase change is $\frac{1}{2}\lambda_{n_2}$

If reflection occurs @ surface w/ lower index, then no phase change occurs

in both cases reflection is off surface w/ lower index, & so no phase change.

What should the third min. thickness of film be if we see a bright spot?

use $2L +$ "other" $= m \lambda_{n_2}$

"other" $= 0$ from 1st part

third minimum thickness $\Rightarrow m = 3$

$$2L = 3 \frac{\lambda}{n_2}$$

$$\Rightarrow L = \frac{3}{2} \frac{450\,nm}{1.8} = 375\,nm$$

path length diff.

r_4 goes across 3 times, while r_3 goes across once

$$\Rightarrow 3L - L = 2L = 2 \cdot 375\,nm = 750\,nm$$

second minimum thickness if we see a ~~~~ dark spot?

$$2L + \text{"other"} = \left(m+\frac{1}{2}\right)\frac{\lambda_{vac}}{n_2}$$

↖ 0 from before

$m=0$ is min. thickness

& so $m=1$ is 2nd min.

$$\Rightarrow 2L = \left(1+\frac{1}{2}\right)\frac{\lambda_{vac}}{n_2}$$

$$L = \frac{3}{4}\cdot\frac{450\,nm}{1.8}$$

$$= 187.5\ nm$$

Ability of a telescope to distinguish two objects can be increased by

increasing lens diameter

$$\theta_R = 1.22 \frac{\lambda}{d}$$

point is that they can be closer & still resolved for θ_R

so θ_R becomes smaller as diameter d is increased.