Andrew Gorobetz
Chapter 26 Review
Wave Optics
Physics 513 – Jim Williams

I. Wave Properties of Light
    A. Polarization
        i. The simplest kind of light wave is a plane, monochromatic wave, which is linearly polarized
        ii. Linear polarization means that the electric field vector is always directed parallel to a single line
    B. Frequency Bandwidths
        i. There is a range or band of frequencies, which may be wide or narrow
            1. The narrower the band, the more nearly the wave approximates a monochromatic wave
    C. Diffraction
        i. A property common to all waves to bend or diffract around an obstacle
        ii. The amount of bending depends on the wavelength of the wave and the dimensions of the obstacle
        iii. The longer the wavelength, the greater the diffraction
        iv. The narrower we make the slit, the more the light bends outward
    D. Interference
        i. Like sound waves or waves on a string, light waves can interfere constructively or destructively

II. Interference
    A. Constructive Interference
        i. Occurs when two light waves are in phase at a certain point in space over a period of time
    B. Destructive Interference
        i. Occurs when two light waves are 180° out of phase over a period of time
    C. Young's Double Slit
        i. If a monochromatic plane wave is incident on a pair of thing, closely spaced slits, the two slits serve as sources of coherent light
        ii. The slits must be narrow enough and close enough that there is a significant amount of diffraction and overlap of the two wavefronts

D. Thin Films
    i. When light is incident on a partially reflecting surface (for example, a glass surface), part of the incident light is reflected and part is transmitted into the second medium
    ii. If the two light waves again come together, after having followed paths of somewhat different length, they will interfere

III. Diffraction
A. Single Slit
    i. Each section of a wavefront in the diffracting aperture is the source of a spherical wavelet
    ii. The amplitude of the light wave at any point beyond the aperture is the superposition of all these wavelets
B. Rayleigh Criterion for Resolution
    i. When a point source of light is imaged by an optical system with a circular aperture, the image is an Airy disk
    ii. Two points are barely resolved when the center of one's Airy disk is at the edge of the other's Airy disk
    iii. If one light source's maxima falls on the second light source's minima, then the two sources resolve (can distinguish between the two)
C. Diffraction Gratings
    i. A diffraction grating consists of thousands of very narrow, closely spaces slits, made by etching precisely spaced grooves n a glass plate
    ii. The slits are the transparent spaces between the groves

IV. Polarization
A. Polarization by Absorption
    i. Most light sources produce unpolarized light, as opposed to the polarized light produced by some lasers
    ii. However, there are ways to polarize light that is initially unpolarized, or to change the direction of polarization of polarized light
    iii. One way is to pass the light through a Polaroid sheet (a synthetic material)
    iv. There is a direction along each Polaroid sheet called its "transmission axis"
    v. If the incident light is linearly polarized at some angle θ relative to the transmission axis, the light will be partially absorbed and partially transmitted

B. Polarization by Reflection
    i. When light is reflected from the surface of a dielectric, such as water, or glass, the intensity of the reflected light depends on the angle of incidence and on the polarization of the incident light
    ii. Light polarized parallel to the reflecting surface is always more strongly reflected than light polarized in a perpendicular direction
C. Polarization by Scattering
    i. When an electromagnetic wave is incident on an atom, the atom's electrons oscillate in response to the oscillating electric field
    ii. The electrons behave like tiny antennas; they emit their own radiation with the same frequency as the incident electromagnetic wave, but scatter the radiation in various directions
    iii. The intensity of this scattered radiation depends on the light's frequency
    iv. Blue light is scattered much more effectively than red light
    v. Radiation scattered along the yz plane, perpendicular to the incident beam, must be polarized