Homework 16.

Interference.

Last time we discussed ***interference***. This phenomenon is related to the superposition principle for the waves:

If two or more waves are propagating in a medium, the displacement, produced by these waves in any point of the medium is a sum of displacements produced in this point by each wave.

If two waves are traveling through the same region in space they can overlap in such a way that crest meets crest and through meets through. In this case the resulting wave will have amplitude which is twice higher than this of the overlapping waves. Waves overlapping like this are said tc be *in phase* and to undergo ***constructive interference***.

If the crest of one wave meets the through of the other the resulting displacement will be zero – the wave are cancelling each other. In this case, the waves are said to be 180° out of phase and undergo ***destructive interference***.

One of the examples of interference is the interference of the light waves in a thin transparent film – say a thin oil film on the surface of water of thin wall of a soap bubble. In this case the interfering waves are the waves reflected from two sides of the film (Figure 1)

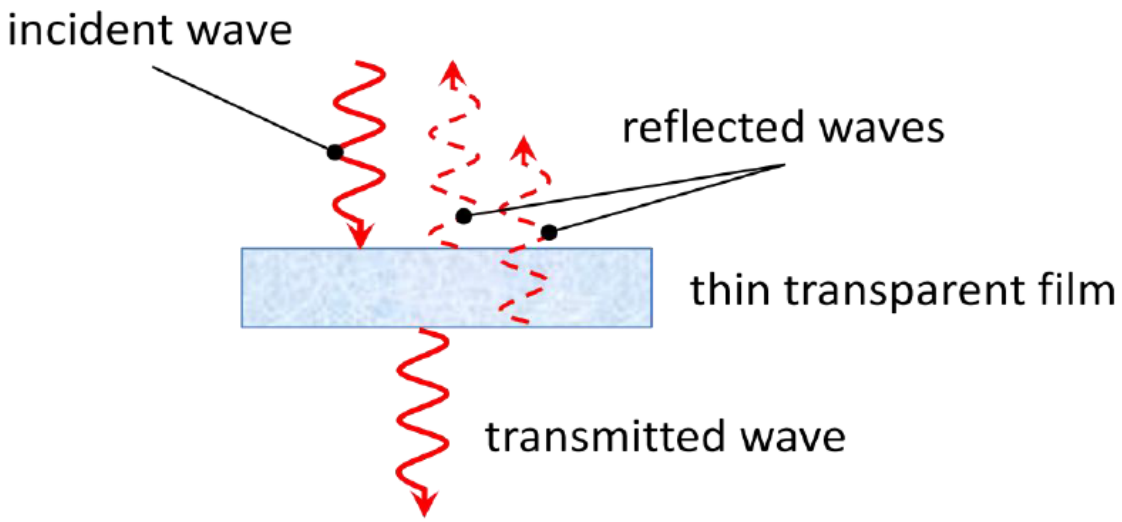

Figure 1. Interference in a thin film.

So, depending on the wavelength, certain waves being reflected from both sides of the film will interfere constructively. Waves with other wavelength will be partially or completely cancelled

when reflected. Since the color of the object is related to the wavelength of the light reflected by the object, thin transparent films are colored.

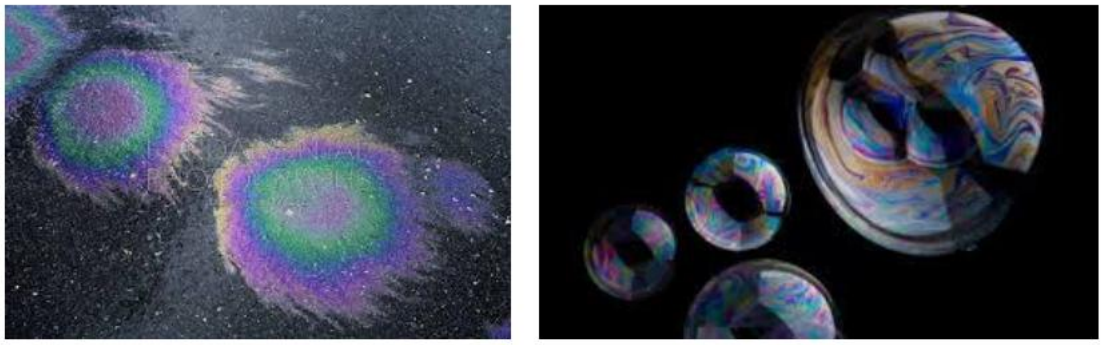

Figure 2. Oil spots on water (www.fphoto.com, left) and soap bubbles (www.sparticle.org, right).

If the waves reflecting from both sides of the film interfere destructively (cancel each other), then most of the incident light goes through the film. So thin transparent film can reduce light reflection from, say, objective of the camera, which makes the camera more sensitive. Such film is called antireflection (AR) coating.

Figure 3. AR coating (www.harisingh.com)

Problems.

1. Find the thickness of oil film in the place where the film is blue (it is known that the thickness is less than 10^{-6}m). Take the wavelength of blue light as 5×10^{-7}m. For simplicity assume that the wavelength of the light does not change inside the film and the wave experience same phase change when reflected from top and bottom side of the film.

2. The light with the wavelength of 6.3×10^{-7}m, being reflected from a thin soap film produces constructive interference. The nearest wavelength which produces destructive interference is 4.5×10^{-7}m. Find the thickness of the film. Again let us assume that the wavelength does not change inside the film