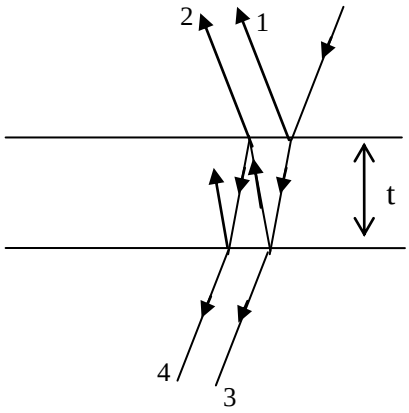
Q- Determine the minimum nonzero thickness of soap film (n=1.33) that will result in (a) constructive interference of the red H_a line (λ= 656.3nm), (b) destructive interference of the blue Hγ line (λ= 434.0nm)

When light is incident on a thin film then multiple refraction and reflections creating path difference between beams and produces interference on either side of the film.

On the same side of incidence, directly reflected 1 and wave refracted and then reflected from lower surface and again refracted from upper 2 will interfere to give interference.

The interference will be destructive if the net path difference is odd multiple of λ/2, and constructive if integer multiple of λ



After normal incidence second wave 2 has to cross the film twice before refraction hence path difference due to reflection is 2*n*t where t is the thickness of the film and n is the refractive index.

When a wave is reflected from a denser medium, its phase is changed by π and hence an additional path difference of ($\pm$: we will adjust value of m accordingly) λ/2 is to be introduced due to reflection at the top surface and hence the net equivalent path difference will be

$$2*n*t + \lambda/2$$

Hence the thickness of the film for constructive interference is given by the equation

$$2*n*t + \lambda/2 = m\lambda$$

And for it to be minimum m = 1 gives

$$2*n*t = \lambda/2$$

Or
$$t_{\min} = \frac{\lambda}{4n} = \frac{656.3*10^{-9}}{4*1.33} = 1.23*10^{-7} m$$

b)

For destructive interference of blue

$$2*n*t + \lambda/2 = (2m-1)\,\lambda/2$$

Hence for minimum non zero thickness substituting m = 2 we have

$$2*n*t + \lambda/2 = 3\lambda/2$$

Or
$$t_{\min} = \frac{\lambda}{2n} = \frac{434.0*10^{-9}}{2*1.33} = 1.63*10^{-7} m$$