EASTERN UNIVERSITY, SRI LANKA

SECOND EXAMINATION IN SCIENCE - 2010/2011

SECOND SEMESTER (April/May 2013)

PH 203 PHYSICAL OPTICS II

Time: 01 hour.

Answer ALL Questions

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1) Explain how diffraction causes limitation in the resolution of optical instruments and hence introduce *Rayleigh's Criterion* for just-resolved, not-resolved and well-resolved limits.

The two blinking lights on both wings of an aeroplane are 6 m apart. When the aeroplane is flying very far, these two lights are seen as one. Explain why?

(i). What is the maximum limiting distance for the observer to differentiate the two lights of the aeroplane with naked eye?

(ii). What should be the minimum objective diameter D_{min} of a telescope to resolve the two lights of the aeroplane when it is 100 km away from the observer? For a telescope with objective diameter D_{min}, what should be the *useful magnification*?

Consider that the pupil diameter of the human eye when looking at night sky is 3 mm and the wavelength of light of aeroplane bulbs is 0.6 μm. Take the angular resolution limit of an objective of diameter D of an image forming instrument is given by $1.22\lambda/D$.

2) The Fraunhofer diffraction intensity distribution due to N number of parallel slits, each of width b, and separated by distance d is given by

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

, where θ is the diffraction angle.

(i) If the condition for m^{th} order principal maxima of the 'interference term' is $\frac{\pi}{\lambda} d \sin\theta = m\pi$, (where $m = \frac{p}{N}$ is an integer) and the condition for the adjacent minima is $\frac{\pi}{\lambda} d \sin\theta = \left(\frac{p+1}{N}\right)\pi$, then by applying Rayleigh criterion show that the chromatic resolving power of a grating is given by $|m|N$.

(ii) Obtain the conditions for Principal maxima and minima of the 'diffraction term'.

(iii) A grating having 200 lines per cm and b=0.001 cm is illuminated normally by light in a spectrometer arrangement. If a square area (edges parallel to the grating edges) of 1 cm^2 of the grating is illuminated,

a) Find the minimum order at which the following spectral line doublets can be resolved?
- λ_1=5992 Å and λ_2=6000 Å
- λ_1=5892 Å and λ_2=5896 Å

b) The intensity of spectral lines would be sufficient to view only if it falls within the principal maxima of the diffraction term. Then show numerically which of the above doublets can be resolved in this experimental arrangement.

c) Show numerically how you could modify the experiment so that you can resolve both set of doublets.