1. (10%) Determine the focal length of a plano-convex surface lens having a radius of curvature 10 cm and the glass refractive index 1.5.

2. (10%) Define Numerical Aperture of a microscope objective and explain why immersion type microscope objective always have Numerical Aperture (N.A.) larger than 1.

3. (10%) A thick lens has the same surface curvatures at both sides (*i.e.* front and rare surfaces).　Prove that the optical power of the thick lens is positive.　That is, it can converge collimated beams.

4. (10%) There are two unknown optical glasses on hand and both glass refractive indices (Nd) and Abbe numbers (V) are known:
   A type glass Nd = 1.5 , V = 30 ;
   B type glass Nd = 1.8 , V = 40.
   Which glass has larger dispersion between blue light and red light?　Write down the necessary derivation process to earn credits.

5. (10%) The primary surface of a mirror-type telescope is designed to reflect and converge an incoming collimated beam into a perfectly focused spot.　Given the radius of curvature of the primary surface *r*, use Fermat's principle to prove that the primary surface of a mirror telescope is a parabolic surface.

6. (10%) Explain how a Fresnel lens works?　Sketch the structure of Fresnel lens and compare it with a normal lens.

7. (10%) Suppose that an ideal polarizer is rotated at a rate ω between a similar pair of stationary crossed polarizers.　The emergent flux density will be modulated according to the rotational frequency.　Plot the relationship of the output flux density with the rotational frequency ω.　Assume the input flux density is 1.

參考用

注意：背面有試題

8. A monochromatic point source is used with a Young's two-slit interferometer. The interfered fringes are observed on a screen with a distance from the slits. Answer the questions below:

   (a) (2%) The point source is replaced by a shorter-wavelength point source. Does the spacing of the fringes increase or decrease?

   (b) (2%) The spacing of the two slits is decreased. Does the spacing of the fringes increase or decrease?

   (c) (2%) The width of the two slits is decreased to the same width. Does the spacing of the fringes increase or decrease?

   (d) (2%) The distance between the slits and the screen is increased. Does the spacing of the fringes increase or decrease?

   (e) (2%) The surrounding medium between the slits and the screen is replaced by a medium with higher refractive index. Does the spacing of the fringes increase or decrease?

9. (10%) Explain what "Coherence" is? What is "temporal coherence"? What is "spatial coherence"?

10. (10%) Rayleigh's criterion defines the situation that two similar diffraction patterns can just be separated. The minimum angular resolution is $\Delta\theta = 1.22\lambda/D$, where λ and D are the wavelength and the aperture diameter respectively. A spy satellite with a camera of focal length 50 mm and f-number 2 is observing a car at the 100-km height. The distance of the two head lights on the car is 1.5 m. Can the satellite tell the two head lights apart? Assume the wavelength is 500 nm.

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