University of Technology
Laser& Optoelectronics Eng. Dept.
Final Exam 2011/2012

Subject:Optical Design | ***Class:4th year***
Branch:Optoelectronics | ***Time:3 hr***
Examiner:Dr.Mohamed Saleh Ahmed | ***Date: 7-6-2012***

Attempt four questions only

Q.1.a- Drive a formula for the longitudinal chromatic aberration for a thin positive lens of index μ in air. (15)

b- Starting up with a Taylor's series, put down the wave aberration polynomial for a rotationally symmetric optical system. (10)

Q.2.a- What is meant by the sine condition .Put down all the appropriate formulae. (15)

b- Draw a diagram showing two systems in tandem for achieving pupil matching . (10)

Q.3.a- Drive formulae expressing the relation between wave and transverse ray aberrations. (15)

b- If the spherical aberration of an optical system is 0.2 λ for full aperture ,what would it be when the aperture is reduced by 50%. (10)

Q.4.a- What is the significance of the Y parameter , illustrate that diagrammatically . (15)

b- Given two identical thin positive lenses and a diverging one. How is it possible to use all of them to obtain a laser beam expander. (10)

Q.5. Suppose an optical system with f =+5cm ,find the position and size of the image formed of an object 2.5 cm in high which is located 20 cm to the left of the first focal point of the system. (25)

أ.د.محمد

الاجوبه النموذجيه للسؤال (١)
نظم بصريه/ الجزء الثاني
د. حسين احمد

Q.1 a- $C_L = Ah\Delta\left(\frac{\partial n}{n}\right)$, where $A_1 = hc_1 - u_1$ and $A_2 = hc_2 - u_2'$ and $hK = u_2' - u_1$ and $K = (\mu - 1)(c_1 - c_2)$

$$\Sigma C_L = \frac{h^2 K}{V} \quad \text{where} \quad V = \frac{\mu - 1}{\partial \mu}.$$

[25]

b- $W(\sigma, \tau; X, Y)$
$W = a_{0000} + a_{1000}\sigma + a_{0100}\tau + a_{0010}X + a_{0001}Y + a_{110}\sigma\tau + a_{1010}\sigma X$
$+ a_{0110}\tau X + a_{0101}\tau Y + a_{0011}XY + D(3)$

$(\sigma X + \tau Y)$, $X^2 + Y^2$, $\sigma^2 + \tau^2$

$W = W(\sigma^2 + \tau^2, X^2 + Y^2, \sigma X + \tau Y)$

$W = W(\tau^2, X^2 + Y^2, \tau Y)$

or $W = W(\tau^2, r^2, \tau r \cos\phi)$

$$W = \sum_i \sum_j \sum_k {}_{(2i+k)}W_{(2j+k),k} (\tau^2)^i (r^2)^j (\tau r \cos\phi)^k$$

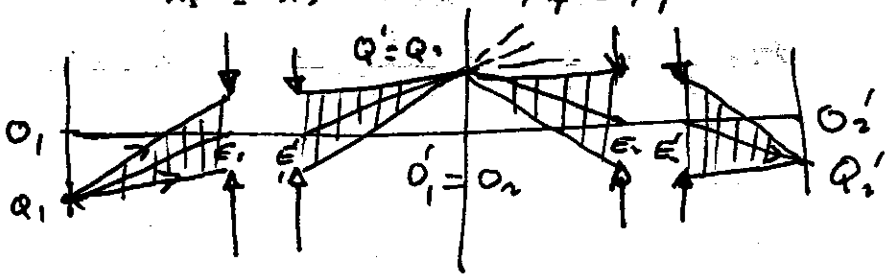
${}_l W_{m,n}$ where i, j, k. run $0, 1, 2, \ldots$

Q.2 a. The sine condition is satisfied when $\frac{\sin U'}{n'} = \frac{\sin U}{n}$ (15)

or $Y' = Y$

$X_s' = X_s$, $Y_T' = Y_T$

[25] b-



(10)

Q.3 a- $W = n'(B_x' B')$ (15)

$W = n'(B_s' B')$

Now $(B'\bar{Q}')^2 = \left(\bar{R}' - \frac{W}{n'}\right)^2 = (X')^2 + (Y' - \bar{\eta})^2 + (Z' - D')^2$

[25]

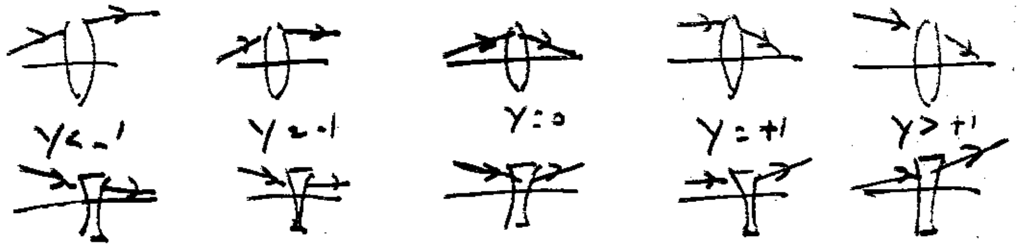
$$\frac{X' - \delta\xi'}{X' + \frac{\bar{R}'}{n'}\frac{\partial W}{\partial X'}} = \frac{Y' - (\bar{\eta}' + \delta\eta')}{Y' - \bar{\eta}' + \frac{\bar{R}'}{n'}\frac{\partial W}{\partial Y'}} = 1$$

$$\delta\xi' = -\frac{\bar{R}'}{n'}\frac{\partial W}{\partial X'}, \quad \delta\eta' = -\frac{\bar{R}'}{n'}\frac{\partial W}{\partial Y'}$$ (10)

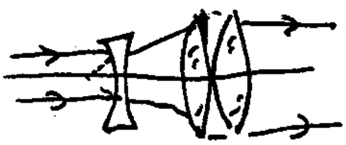
b- $W = {}_0W_{40} r^4 = (\ldots\lambda)(.5)^4 = (0.2\lambda)(0.0625) = 0.0125\lambda$

Q.4 a/ $Y = \frac{u' + u}{u' - u} = \left[\frac{1}{[illegible]}\right](u' - u)$

[25]



b/



Q.5 $x' = \frac{-f^2}{x} = \frac{-5^2}{-20} = +1.25$, $m = \frac{h'}{h} = \frac{f}{x} = \frac{5}{-20} = -0.25$

[25] $h' = mh = (-0.25)(2.5) = -0.625$ cm

or $\frac{1}{s'} = \frac{1}{f} + \frac{1}{s} = \frac{1}{5} + \frac{1}{(-25)} = 0.2 + (-0.04) = 0.16$

$s' = 6.25$ cm

$m = \frac{h'}{h} = \frac{s'}{s} = \frac{6.25}{-25} = -0.25$, $h' = mh = (-0.25)(2.5) = -.625$ cm