# Final Exam Equation Sheet

Gaussian beams

$$\theta_0 = \frac{\lambda}{\pi\, w_0} \qquad z_0 = \frac{\pi w_0^2}{\lambda} \qquad R(z) = z\left[1 + \left(\frac{z_0}{z}\right)^2\right] \qquad w(z) = w_0\sqrt{1 + \left(\frac{z}{z_0}\right)^2}$$

$$w(z) = \sqrt{y_\Delta^2(z) + y_\Omega^2(z)}\, n(y_\Omega u_\Delta - y_\Delta u_\Omega) = \frac{\lambda_0}{\pi} \qquad \theta_0 = \sqrt{u_\Delta^2 + u_\Omega^2}$$

Wave equation and Fresnel equations

$$\nabla^2 E - k^2 E = 0 \qquad \mathrm{R} = |r|^2 = \left(\frac{n-1}{n+1}\right)^2 \qquad \theta_\mathrm{B} = \tan^{-1}\frac{n_2}{n_1}$$

System resolution

$$r_0(1D) = \frac{F}{D}\lambda = F_\#\lambda = 0.5\,\frac{\lambda}{NA}$$

$$f_0 = \frac{D}{2\lambda_0 t} = \frac{NA}{\lambda_0} \qquad r_0(2D) = 1.22\,\frac{F}{D}\lambda = 1.22\,F_\#\lambda = 0.6\,\frac{\lambda}{NA}$$

Lagrange Invariant

$H = n(u\bar{y} - y\bar{u})$ is conserved $\qquad N_{\mathrm{spots}} = \frac{2}{\lambda}H$

Radiometry

$$L' = TL$$

$$\Omega = \frac{A}{R^2} \qquad I = \frac{\phi}{\Omega} \qquad E = \frac{\phi}{A}$$

$L = \frac{\phi}{\Omega A} = \frac{\phi}{\Omega \cos\theta A}$ (for tilted surface)