P214 Formula Sheet: Final/Prelim III

Complex numbers

$$e^{ix} = \cos(x) + i\sin(x)$$
$$|\underline{A}|^2 = A_r^2 + A_i^2 = \underline{A}^*\underline{A}$$
$$|\underline{A} \cdot \underline{B}| = |\underline{A}| \cdot |\underline{B}|$$
$$|\underline{A}/\underline{B}| = |\underline{A}|/|\underline{B}|$$

Basic wave relationships

$$f = 1/T \qquad \omega = 2\pi f$$
$$\omega = 2\pi/T \quad k = 2\pi/\lambda$$
$$c = \lambda f \qquad c = \omega/k$$

Wave equation and solutions

$$c^2 \frac{\partial^2 y}{\partial x^2} = \frac{\partial^2 y}{\partial t^2}$$
$$\mp c \frac{\partial y}{\partial x} = \frac{\partial y}{\partial t} \quad \text{(pulse Eq.)}$$
$$y(x,t) = f(x - ct) + g(x + ct)$$
$$y(x,t) = h(x+ct) - h(-(x-ct)) \quad \text{reflection from fixed BC}$$
$$y(x,t) = h(x+ct) + h(-(x-ct)) \quad \text{reflection from free BC}$$

Electromagnetic (Plane) Waves in Vacuum

Relative Field strengths: $|\vec{E}| = c|\vec{B}|$

Direction of propagation: $\vec{E} \times \vec{B}$

Wave physics

Quantity	String	Sound	E&M
Dynamics	$F_y = -\tau \frac{\partial y}{\partial x}$	$P = P_o - B\frac{\partial s}{\partial x}$	$\begin{cases} \frac{\partial}{\partial x}\left(\frac{B_y}{\mu}\right) = \frac{\partial}{\partial t}\left(\epsilon_0 E_z\right) \\ \left(\frac{\partial E_y}{\partial x} = -\frac{\partial B_z}{\partial t}\right) \end{cases}$
Equation	$\tau\frac{\partial^2 y}{\partial x^2} = \mu\frac{\partial^2 y}{\partial t^2}$	$B\frac{\partial^2 s}{\partial x^2} = \rho\frac{\partial^2 s}{\partial t^2}$	$\frac{1}{\mu_0}\frac{\partial^2 E_y}{\partial x^2} = \epsilon_0\frac{\partial^2 E_y}{\partial t^2}$
k.e.	$\frac{1}{2}\mu\left(\frac{\partial y}{\partial t}\right)^2$	$\frac{1}{2}\rho\left(\frac{\partial s}{\partial t}\right)^2$	$\frac{1}{2}\epsilon_0 E^2$
p.e.	$\frac{1}{2}\tau\left(\frac{\partial y}{\partial x}\right)^2$	$\frac{1}{2}B\left(\frac{\partial s}{\partial x}\right)^2$	$\frac{1}{2\mu_0}B^2$
Power	$-\tau\frac{\partial y}{\partial x}\frac{\partial y}{\partial t}$	$-B\frac{\partial s}{\partial x}\frac{\partial s}{\partial t}$	$\frac{1}{\mu_0}\vec{E} \times \vec{B}$

Interference

Multiple Narrow Slit Interference

Intensity: $I(\theta) = I_0 \dfrac{\sin^2(Nk\Delta R/2)}{\sin^2(k\Delta R/2)}$ where $\Delta R = d \sin\theta$, $N = \#$ of slits

Minima: $\Delta\Phi/(2\pi) = \dfrac{d}{\lambda}\sin\theta = \dfrac{n}{N}, \quad n = \pm 1, \pm 2, \ldots, \pm(N-1), \pm(N+1), \ldots$

Principal Maxima: $\Delta\Phi/(2\pi) = \dfrac{d}{\lambda}\sin\theta = n, \quad n = 0, \pm 1, \pm 2, \ldots$

Lessor maxima: $\Delta\Phi/(2\pi) = \dfrac{d}{\lambda}\sin\theta = \pm\dfrac{n+1/2}{N}, \quad n = 1, 2, \ldots, N-2, N+1, \ldots$

Single Finite Slit Diffraction

Intensity: $I(\theta) = I_0 \dfrac{\sin^2(\beta/2)}{(\beta/2)^2}$ where $\beta = 2\pi a \sin\theta/\lambda$

Quantum Mechanics

$$eV_0 = hf - \phi$$

$$E = \hbar\omega \quad \mathbf{p} = \hbar\mathbf{k}$$

$$E\psi(x) = -\frac{\hbar^2}{2m}\frac{\partial^2\psi(x)}{\partial x^2} + U(x)\psi(x)$$