PHYS 354 – Midterm 1 Exam Cheat Sheet

Legendre Polynomials

$P_0(\cos\theta) = 1$

$P_1(\cos\theta) = \cos\theta$

$P_2(\cos\theta) = \frac{3}{2}\cos^2\theta - \frac{1}{2}$

$P_3(\cos\theta) = \frac{5}{2}\cos^3\theta - \frac{3}{2}\cos\theta$

Orthogonality

$$\int_0^a \sin\frac{k\pi y}{a}\sin\frac{n\pi y}{a}\,dy \;=\; \begin{cases} 0, & k\neq n \\ \frac{a}{2}, & k=n \end{cases}$$

$$\int_0^\pi P_l(\cos\theta)P_n(\cos\theta)\sin\theta\,d\theta \;=\; \begin{cases} 0, & l\neq n \\ \frac{2}{2n+1}, & l=n \end{cases}$$

Multipole Expansion

$$V(\vec{r}) \;=\; \frac{1}{4\pi\epsilon_0}\int \frac{\rho(\vec{r'})}{r}\,d\tau'$$

$$V(\vec{r}) \;=\; \frac{1}{4\pi\epsilon_0}\sum_{n=0}^{\infty}\frac{1}{r^{n+1}}\int (r')^n\,P_n(\cos\theta')\,\rho(\vec{r'})\,d\tau'$$

Coulomb's Law

$$V(\vec{r}) = \frac{1}{4\pi\epsilon_0}\int \frac{\rho(\vec{r'})}{r}\,d\tau'$$

Forces

$$\vec{F}_{elec} \;=\; \int \rho\vec{E}\,d\tau$$

Electric Flux

$$\Phi_E \;=\; \int \vec{E}\cdot d\vec{a}$$

Gauss' Law

$$\oint \vec{E}\cdot d\vec{a} = \frac{Q_{enc}}{\epsilon_0}$$