PHYS 333

Information for Exam II

Time: In-class exam, Friday, October 17, 11:00–11:52

Office Hours: Wednesday 10/15, 9:00–10:30, 3:00–5:00; Thursday 10/16, 8:00–9:30, 11:00–12:00, 2:00–4:00

This will be a closed book examination. I will provide you with copies of the inside covers of your text, photocopies of the figures representing differential volume elements in cylindrical and spherical coordinates, and the attached equation sheet. The exam will cover material from Griffiths 2.3–2.5, 3.4, 4.1–4.3, and 4.4.1. (You are still responsible for the "old" material that is necessary to solve problems in the listed sections.) The exam questions will be similar to the homework problems you have already done and to the worked examples in the text. You should be able to:

- calculate potential differences between points in known electric fields;
- calculate electric fields from known potentials;
- calculate potentials from known localized charge distributions;
- calculate the work it takes to assemble a given charge configuration;
- use the properties of electric conductors in calculations of fields and potentials;
- use the boundary conditions for electric fields and potentials at surfaces;
- calculate electric monopole and dipole moments for given charge distributions;
- determine the electric potential and electric fields at various points given an electric dipole moment of known magnitude, position, and orientation;
- calculate forces and torques on electric dipole moments in known electric fields;
- determine bound charge densities from known polarizations;
- determine polarization, electric displacement, and electric field for simple configurations of charges, conductors, and dielectric materials;

- use integration by parts to simplify calculations with fields and potentials;
- use the binomial expansion (Taylor's series) to determine approximate expressions in powers of small quantities.

Equations

$$V(\mathbf{r}) = -\int_{\mathcal{O}}^{\mathbf{r}} \mathbf{E}\cdot d\mathbf{l}$$

$$V(\mathbf{r}) = \frac{1}{4\pi\epsilon_0}\int \frac{\rho(\mathbf{r}')}{\mathscr{r}}\,d\tau' \longrightarrow \frac{1}{4\pi\epsilon_0}\int \frac{\sigma(\mathbf{r}')}{\mathscr{r}}\,da' \longrightarrow \frac{1}{4\pi\epsilon_0}\int \frac{\lambda(\mathbf{r}')}{\mathscr{r}}\,dl' \longrightarrow \frac{1}{4\pi\epsilon_0}\sum_{i=1}^{n}\frac{q_i}{\mathscr{r}_i}$$

$$\mathbf{E} = -\vec{\nabla} V$$

$$\mathbf{E}_{\text{above}} - \mathbf{E}_{\text{below}} = \frac{\sigma}{\epsilon_0}\hat{\mathbf{n}} \qquad \& \qquad \frac{\partial V_{\text{above}}}{\partial n} - \frac{\partial V_{\text{below}}}{\partial n} = -\frac{1}{\epsilon_0}\sigma$$

$$W = \frac{1}{4\pi\epsilon_0}\sum_{i=1}^{n}\sum_{j=1,j>i}^{n}\frac{q_i q_j}{\mathscr{r}_{ij}} = \frac{1}{8\pi\epsilon_0}\sum_{i=1}^{n}\sum_{j=1,j\neq i}^{n}\frac{q_i q_j}{\mathscr{r}_{ij}}$$

$$W = \frac{1}{2}\sum_{i=1}^{n} q_i V(\mathbf{r}_i) \longrightarrow \frac{1}{2}\int \rho V\,d\tau$$

$$W = \frac{\epsilon_0}{2}\int_{\text{all space}} E^2\,d\tau$$

$$C \equiv \frac{Q}{\Delta V}$$

$$(1+x)^n = 1 + nx + \frac{n(n-1)}{2!}x^2 + \frac{n(n-1)(n-2)}{3!}x^3 + \cdots$$

$$V(\mathbf{r}) = V_{\text{monopole}}(\mathbf{r}) + V_{\text{dipole}}(\mathbf{r}) + \cdots$$

$$V_{\text{monopole}} = \frac{1}{4\pi\epsilon_0}\frac{Q}{r}$$

$$V_{\text{dipole}} = \frac{1}{4\pi\epsilon_0}\frac{\mathbf{p}\cdot\hat{\mathbf{r}}}{r^2}$$

$$\mathbf{E}_{\text{dip}}(\mathbf{r}) = \frac{p}{4\pi\epsilon_0 r^3}(2\cos\theta\,\hat{\mathbf{r}} + \sin\theta\,\hat{\theta}) = \frac{1}{4\pi\epsilon_0}\frac{1}{r^3}\left[3(\mathbf{p}\cdot\hat{\mathbf{r}})\,\hat{\mathbf{r}} - \mathbf{p}\right]$$

$$Q = \sum_{i=1}^{n} q_i \longrightarrow \int \rho(\mathbf{r}')\, d\tau'$$

$$\mathbf{p} = \sum_{i=1}^{n} q_i \mathbf{r}_i \longrightarrow \int \mathbf{r}' \rho(\mathbf{r}')\, d\tau'$$

$$\mathbf{N} = \mathbf{p} \times \mathbf{E}$$

$$\mathbf{F} = (\mathbf{p} \cdot \nabla)\mathbf{E}$$

$$\sigma_b = \mathbf{P} \cdot \hat{\mathbf{n}}$$

$$\rho_b = -\nabla \cdot \mathbf{P}$$

$$\rho = \rho_b + \rho_f$$

$$\mathbf{D} = \epsilon_0 \mathbf{E} + \mathbf{P}$$

$$\nabla \cdot \mathbf{D} = \rho_f \longrightarrow \oint \mathbf{D} \cdot d\mathbf{a} = Q_{f_{\text{enc}}}$$

$$\mathbf{P} = \epsilon_0 \chi_e \mathbf{E} \quad \text{(linear dielectrics)}$$

$$\mathbf{D} = \epsilon_0 (1 + \chi_e)\mathbf{E} \equiv \epsilon \mathbf{E} \quad \text{(linear dielectrics)}$$

$$\epsilon_r \equiv 1 + \chi_e = \frac{\epsilon}{\epsilon_0}$$