F IIQ – Anotações: Campo Elétrico & Potencial

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Conteúdo

1 The Electric Field I: Discrete Charge Distributions

1.1 Coulomb's Constant

$$\boldsymbol{k} = 8.99\,\mathrm{N\,m^2/C^2}$$

1.2 Coulomb's Law

$$\vec{\boldsymbol{F}} = \frac{\boldsymbol{k}\,\boldsymbol{q_1}\,\boldsymbol{q_2}}{\boldsymbol{r_{1,2}^2}}\hat{\boldsymbol{r_{1,2}}}$$

1.3 Electric Field

$$\vec{\boldsymbol{E}} = \frac{\vec{\boldsymbol{F}}}{\boldsymbol{q_0}} = \frac{\boldsymbol{k}\,\boldsymbol{q}}{\boldsymbol{r^2}}\hat{\boldsymbol{r}}$$

1.4 Dipole

$$\vec{\boldsymbol{p}} = \boldsymbol{q}\,\vec{\boldsymbol{L}}_{(-\rightarrow+)} \qquad \vec{\boldsymbol{\tau}} = \vec{\boldsymbol{p}} \times \vec{\boldsymbol{E}}$$
$$\boldsymbol{U} = -\vec{\boldsymbol{p}} \cdot \vec{\boldsymbol{E}} + \boldsymbol{U_0}$$

2 The Electric Field II: Continuous Charge Distributions

2.1 Fluxo Elétrico

$$\phi = \lim_{\Delta A_i \to 0} \sum_i \vec{E}_i \cdot \hat{n}\, \Delta A_i = \int_S \vec{E} \cdot \hat{n}\; \mathrm{d}A$$

2.2 Electric Constant (Permissivity of Free Space)

$$\varepsilon_0 = (4\,\pi\, k)^{-1} = 8.85 * 10^{-12}\ \mathrm{C}^2/\mathrm{N\,m}^2$$

2.3 Gauss's Law

$$\phi_{net} = \oint_S \vec{E} \cdot \hat{n}\; \mathrm{d}A = Q_{inside}/\varepsilon_0$$

2.4 Discontinuity of E_n

$$E_{n+} - E_{n-} = \sigma/\varepsilon_0$$

2.5 $\vec{E}$ just outside a Conductor

$$E = \sigma/\varepsilon_0$$

Acts like an infinite place surface

Electric Fields for Selected Uniform Charge Distributions

2.6 Of a line charge of infinite lenght

$$\vec{E} = 2\,k\,\lambda\,\hat{r}/R$$

2.7 On the axis of a charged ring

$$\vec{E} = k\,Q\,z\,\left(z^2 + a^2\right)^{-3/2}\,\hat{z}$$

2.8 On the axis of a charged disk

$$\vec{E} = \frac{\text{sign}\,(z)\,\sigma\,\hat{z}}{2\,\varepsilon_0}\left(1 - \left(1 + R^2/z^2\right)^{-1}\right)$$

2.9 Of a charged infinite plane

$$\vec{E} = \text{sign}\,(z)\sigma\,\hat{z}/2\,\varepsilon_0$$

2.10 Of a charged thin spherical shell

$$\vec{E} = \begin{cases} k\,Q\,\hat{r}/r & r > 0 \\ 0 & r < 0 \end{cases}$$

3 Electric Potential

3.1 Units and Constants

V and ΔV	$1\,\mathrm{V} = 1\,\mathrm{J/C}$
Electric Field	$1\,\mathrm{N/C} = 1\,\mathrm{V/m}$
Electron volt	$1\,\mathrm{eV} = 160.22 * 10^{-21}\,\mathrm{C\,V} = 160.22 * 10^{-21}\,\mathrm{J}$
Dielectric Strength	$\max E \approx 3.00 * 10^{6}\,\mathrm{MV/m}$

3.2 Potential Energy of Two Point Charges

$$U = q_0\,V = k\,q_0\,q/r$$

Potential Functions

3.3 On the axis of a uniformly charged ring

$$V = \frac{k\,Q}{\sqrt{z^2 + a^2}}$$

3.4 On the axis of a uniformly charged disk

$$V = 2\,\pi\,k\,\sigma\;|z|\left(\sqrt{1 + R^2/z^2} - 1\right)$$

3.5 For an infinite plane of charge

$$V = V_0 - 2\,\pi\,k\,\sigma\;|x|$$

3.6 For a spherical shell of charge

$$V = \begin{cases} k\,Q/r & r \geq R \\ k\,Q/R & r \geq R \end{cases}$$

3.7 For an infinite line of charge

$$V = 2\,k\,\lambda\,\ln\frac{R_{ref}}{R}$$

Electrostatic Potential Energy

3.8 Of point charges

$$U = \frac{1}{2}\sum_{i=1}^{n} q_i\,V_i$$

3.9 Of a conductor with charge Q at potential V

$$U = Q\,V/2$$

3.10 Of a system of conductors

$$U = \frac{1}{2}\sum_{i=1}^{n} Q_i\,V_i$$