Sharjah Institute of Technology

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Electrostatics:

- **Force:**

$$\vec{F} = \frac{1}{4\pi\varepsilon}\frac{q\,Q}{r^2}\,\hat{u}_r$$

$$\varepsilon = \kappa\,\varepsilon_o$$
$$\varepsilon_o = 8.85\times10^{-12}\left[\frac{\text{C}^2}{\text{N m}^2}\right]$$

- **Field:**
-

$$\vec{E} = \frac{\vec{F}}{q} \quad [\text{N/C}]$$
$$= \frac{1}{4\pi\varepsilon}\frac{Q}{r^2}\,\hat{u}_r \rightarrow \text{point charge}$$

$$E = \frac{\sigma}{2\varepsilon} \rightarrow \text{plate}$$

$$E = \frac{\sigma}{\varepsilon} \rightarrow \text{capacitor}$$

$$\varepsilon\oint_A \vec{E}\cdot d\vec{A} = q_{enc} \rightarrow \text{Gauss' Law}$$

$$\Phi = \int_A \vec{E}\cdot d\vec{A} \rightarrow \text{Flux}$$

- **Voltage:**

$$V = V_{fi} = V_f - V_i \quad [\text{V}]$$
$$= -\frac{W}{q}$$
$$= -\int_i^f \vec{E}\cdot d\vec{S}$$

$$V = \frac{1}{4\pi\varepsilon}\frac{Q}{r} \rightarrow \text{point charge}$$

$$V = \frac{\sigma\,d}{2\varepsilon} \rightarrow \text{plate}$$

$$V = \frac{\sigma\,d}{\varepsilon} \rightarrow \text{capacitor}$$

Current and Resistance:

$$i = \frac{dq}{dt} \quad [\text{A}]$$

$$i = \int_A \vec{J}\cdot d\vec{A}$$

$$\vec{J} = \sigma\vec{E} = \frac{\vec{E}}{\rho} \quad [\text{A/m}^2]$$

$$\rho = \frac{E}{J} \quad [\Omega\text{ m}]$$

$$\rho = \rho_o[1+\alpha(T-T_o)]$$

$$R = \frac{V}{i} \quad [\Omega]$$

$$R = \rho\,\frac{L}{A} \rightarrow \text{wire}$$

$$P = V\,i = \frac{V^2}{R} = R\,i^2 \quad [\text{W}]$$

Magnetic Fields:

- **Bio-Savart's law:**

$$d\vec{B} = \frac{\mu}{4\pi}\,i\,\frac{d\vec{S}\times d\vec{r}}{r^3}$$

$$\mu = \mu_r\,\mu_o$$
$$\mu_o = 4\pi\times10^{-7}\,\frac{\text{T m}}{\text{A}}$$

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Capacitance:

$C = \frac{Q}{V}$ [F]

$C = \varepsilon \frac{A}{d} \rightarrow \parallel$ plates

$C = \sum_{j=1}^{n} C_j \rightarrow$ parallel

$\frac{1}{C} = \sum_{j=1}^{n} \frac{1}{C_j} \rightarrow$ series

$Energy = \frac{1}{2} C V^2$

TRANSFORMERS

$\frac{N_p}{N_S} = \frac{V_p}{V_S} = \frac{I_S}{I_p}$ 1 phase

$\frac{N1}{N2} = \frac{V_p 1}{V_p 2} = \frac{I_p 2}{I_p 1}$ 3 phase

Ampere's Law:

$\oint_S \vec{B} \cdot d\vec{S} = \mu \, i_{enc}$

$B = \frac{\mu \, i}{2\pi R} \rightarrow$ wire

$B = \mu \, i \frac{N}{l} \rightarrow$ selenoid

- **Force:**

$\vec{F} = q \, \vec{v} \times \vec{B} \rightarrow$ charge

$\vec{F} = i \, \vec{L} \times \vec{B} \rightarrow$ wire

$F_{ba} = \frac{\mu \, L \, i_a \, i_b}{2\pi d} \rightarrow \parallel$ wires

ALTERNATING CURRENT MOTORS

4.1 $\eta = \frac{Pout}{Pin}$

4.2 $Pout = \sqrt{3} \; V_L I_L \cos \phi \; \eta$

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ALTERNATING CURRENT THEORY

1.1 $e = Blv\sin\phi$

1.2 $e = E_m \sin\phi$

1.3 $E_m = 2\Pi BanN$

1.4 $360° = 2\Pi$ radians

1.5 $\omega = 2\Pi f$

1.6 $e = \sin(\omega t + \phi)$

1.7 $E_{rms} = 0.707Em$

1.8 $E_{ave} = 0.637Em$

1.9 $Ns = \frac{60f}{p} \qquad S = \frac{Ns - N_R}{N_S}$

1.10 $E_{rms} = \sqrt{\frac{e_1^2 + e_2^2 + e_3^2 + \ldots\ldots e_n^2}{n}}$

1.11 $E_{ave} = \frac{e_1 + e_2 + e_3 + \ldots\ldots e_n}{n}$

1.12 $formfactor = \frac{E_{rms}}{E_{ave}} \qquad crestfactor = \frac{Em}{0.707\,Em}$

1.13 $X_L = 2\Pi fL$

1.14 $Xc = \frac{1}{2\Pi f C}$

1.15 $Z = \sqrt{R^2 + (X_L - X_C)^2}$

1.16 $\cos\phi = \frac{R}{Z} = \frac{P}{S}$

1.17 $\tan\phi = \frac{X}{R}$

1.18 $P = VI\cos\phi$

1.19 $fr = \frac{1}{2\Pi\sqrt{LC}}$

1.20 $Vc = IXc$

$V_L = IX_L$

1.21 $I_{ACTIVE} = I\cos\phi$