PHYS 2610: Midterm Formula Sheet 2015

Current: $i = dq/dt = \int \vec{J}.d\vec{a}$ Steady state: $di/dt = 0; \quad \oint \vec{J}.d\vec{a} = 0$

Ohm's law: $\vec{J} = \sigma\vec{E} = \vec{E}/\rho \quad \Rightarrow V = iR, \quad \text{with } R = \rho\ell/A$ Current density: $\vec{J} = ne\vec{v}_d$

Gauss's law: $\oint \vec{E}.d\vec{a} = q_{enc}/\varepsilon_o$

Electrical potential and potential energy: $V = U/q; \quad dU = q\,dV$

Potential difference and EMF (DC): $\int_a^b \vec{E}.d\vec{\ell} = -(V_b - V_a); \quad \oint \vec{E}.d\vec{\ell} = 0$

Power: $P = Vi$

Capacitor: $q = CV, \quad U = q^2/(2C)$

Solution to DE of the form $\frac{dq}{dt} + \frac{q}{\tau} = const: \quad \rightarrow \quad q(t) = A\,e^{-t/\tau} + q(\infty)$

Faraday's Law for time varying fields: $\varepsilon_{ind} = \oint \vec{E}.d\vec{\ell} = -\frac{d}{dt}\int \vec{B}.d\vec{a} = -L\frac{di}{dt}$

Inductor: applied EMF $\varepsilon = L\frac{di}{dt}, \quad U = \frac{1}{2}Li^2$

Magnetic field, ideal solenoid: $B = \mu_o (N/\ell)\,I$

Euler's Formula: $e^{j\theta} = \cos\theta + j\sin\theta$

Complex Impedance: $Z = R + jX = |Z|e^{j\phi}; \quad \tilde{v} = Z\,\tilde{i}; \quad v = \mathrm{Re}(\tilde{v}) = v_o\cos\omega t$

Capacitor: $Z = 1/(j\omega C)$ Inductor: $Z = j\omega L$

Series configuration: $Z_{eff} = Z_1 + Z_2 + \ldots Z_N$

Parallel configuration: $1/Z_{eff} = 1/Z_1 + 1/Z_2 + \ldots 1/Z_N$