PHYS 2610: Final Exam Formula Sheet 2017

Current: $i = \frac{dq}{dt} = \int \mathbf{J} \cdot \overrightarrow{da}$

Steady state: $\frac{di}{dt} = 0; \oint \mathbf{J} \cdot \overrightarrow{da}$

Ohm's law: $\mathbf{J} = \sigma \mathbf{E} = \frac{\mathbf{E}}{\rho} \Rightarrow v = iR$ with $R = \rho \ell / A$

Current density: $\mathbf{J} = ne\vec{v}_d$

Gauss's law: $\oint \mathbf{E} \cdot \overrightarrow{da} = q_{net}/\varepsilon_0$

Electric potential and potential energy: $V = U/q;\ dU = qdV$

Potential difference and emf: $\int_a^b \mathbf{E} \cdot \overrightarrow{dl} = -(V_b - V_a);\ \oint \mathbf{E} \cdot \overrightarrow{dl} = 0$

Power: $P = vi$

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

Solution to $\frac{dy}{dx} + ax = b$ has the form $y = Ae^{-ax} + b/a$

Faraday's law: $\mathcal{E}_{ind} = \int_a^b \mathbf{E} \cdot \overrightarrow{dl} = -\frac{d}{dt}\int \mathbf{B} \cdot \overrightarrow{da} = -L\frac{di}{dt}$

Inductor: $\mathcal{E} = L\frac{di}{dt}$

Magnetic field of ideal solenoid: $B = \mu_0 nI$

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

Complex impedance: $Z = R + jX = |Z|e^{j\phi}; \tilde{v} = Z\tilde{\imath}; v = \mathrm{Re}(\tilde{v}) = V cos\omega t$

Capacitive impedance: $Z_C = -jX_C = \frac{1}{j\omega C}$

Inductive impedance: $Z_L = jX_L = j\omega L$

Series impedance: $Z = \sum Z_i$

Parallel impedance: $\frac{1}{Z} = \sum \frac{1}{Z_i}$

Voltage gain: $a = \frac{v_{out}}{v_{in}}$

Gain in dB: $G_{dB} = 20\log\left|\frac{v_2}{v_1}\right|$

Q Factor: $Q = \omega_0 L/R$

Schockley diode equation: $I = I_s(e^{eV/\eta kT}$-1); η is the ideality factor ~ 2 for Si

Bipolar transistor current gains: $\alpha = \frac{I_C}{I_E}$; $\beta = \frac{I_C}{I_B}$

DeMorgan's theorems: $\overline{A + B} = \bar{A} \cdot \bar{B}$; $\overline{A \cdot B} = \bar{A} + \bar{B}$; $A \cdot B = \overline{\bar{A} + \bar{B}}$; $A + B = \overline{\bar{A} \cdot \bar{B}}$

Half adder: $S = A \oplus B$; $C = A \cdot B$

Full adder: $S_n = A_n \oplus B_n \oplus C_{n-1}$; $C_n = A_n \cdot B_n + C_{n-1} \cdot (A_n \oplus B_n)$

Ones' complement: complement each bit

Two's complement: one's complement plus 1