Useful Formulae and Constants
(electric physics)

Coulomb Force

$$F = k\frac{Q_1 Q_2}{r^2} \text{ (vector)}$$

Electric Field

$$\mathbf{E} = \mathbf{F}/q, \quad E = k\frac{Q}{r^2} \text{ (vector)}$$

Gauss's Law

$$\oint \vec{E} \cdot d\vec{A} = Q_{enclosed} / \varepsilon_0$$

Electric Potential

$$V_{\mathbf{BA}} = -\int_A^B \vec{E} \cdot d\vec{l}$$

$$V = k\frac{Q}{r}, \quad PE = qV$$

Capacitors

$$Q = CV,$$

$$U = \frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C}$$

$$u = \frac{1}{2}\varepsilon_0 E^2$$

$$\text{dielectrics } \varepsilon_0 \rightarrow \varepsilon = \mathrm{K}\varepsilon_0$$

Parallel-Plate Capacitor

$$C = \varepsilon_0 \frac{A}{d}, \quad V = Ed, \quad E = \frac{Q}{\varepsilon_0 A}$$

Resistors

$$\text{Ohm's Law } V = IR$$

$$P = IV = I^2 R = \frac{V^2}{R}$$

$$R = \rho\frac{L}{A}$$

$$j = E/\rho = \sigma E = -nev_d$$

Resistors and Capacitors in Series

$$R_{Total} = \sum R$$

$$\frac{1}{C_{Total}} = \sum \frac{1}{C}$$

Resistors and Capacitors in Parallel

$$C_{Total} = \sum C$$

$$\frac{1}{R_{Total}} = \sum \frac{1}{R}$$

Circuits

$$\mathrm{V_{ab}} = \varepsilon - Ir$$

$$\mathrm{V} = \mathrm{V_0}\sin\omega t, \quad \mathrm{V}_{rms} = \mathrm{V_0}/\sqrt{2}$$

$$\text{junction rule } \sum \mathrm{I_{in}} = \sum \mathrm{I_{out}}$$

$$\text{loop rule } \sum_{\text{loop}} \mathrm{V_n} = 0$$

$$\text{charge}: \mathrm{q(t)} = \mathrm{C}\varepsilon\left(1 - \mathrm{e}^{-t/RC}\right)$$

$$\text{discharge}: \mathrm{q(t)} = \mathrm{C}\varepsilon \mathrm{e}^{-t/RC}$$