PS 250 Exam 2 formulas

Daniel E. Janusch

March 13, 2025

$$C = \frac{Q}{V} \tag{1}$$

equivalences	Series	Parallel
Capacitor	$\left[\sum \frac{1}{C_i}\right]^{-1}$	$\sum C_i$
Resistor	$\sum R_i$	$\left[\sum \frac{1}{R_i}\right]^{-1}$

(2)

$$U = \frac{1}{2}\frac{Q^2}{C} = \frac{1}{2}CV^2 = \frac{1}{2}QV \tag{3}$$

$$u = \frac{\varepsilon_0}{2}\frac{V^2}{d^2} = \frac{\varepsilon_0}{2}E^2 \quad \text{(energy density inside a capacitor)} \tag{4}$$

$$\text{dielectric: } C = KC_0,\ K = \frac{C}{C_0} = \frac{\varepsilon}{\varepsilon_0} \tag{5}$$

$$I = \frac{\mathrm{d}Q}{\mathrm{d}t} = |q|nAv_d \ni n \sim 20^{28}\ \left[\mathrm{m}^{-3}\right] \tag{6}$$

$$J = \frac{I}{A} = \frac{E}{\rho} \quad \text{(current density)} \tag{7}$$

$$|\vec{v}_{\text{electron}}| \sim 10^6, \quad |\vec{v}_d| \sim 10^{-4} \tag{8}$$

$$R = \frac{V}{I} = \frac{\rho L}{A} \tag{9}$$

$$P = VI = \frac{V^2}{R} = I^2R \tag{10}$$

$$\text{parallel plate: } C = \frac{Q}{V} = \frac{\varepsilon A}{d}, E = \frac{V}{d} = \frac{Q}{Cd} = \frac{Q}{\varepsilon A}, d = \frac{\varepsilon A}{C} = \frac{\varepsilon AV}{Q} \tag{11}$$

$$\text{Junction/Current rule: } \sum I_{\text{in}} = \sum I_{\text{out}} \tag{12}$$

$$\text{Loop/Voltage rule: } \sum V = 0 \quad \text{(around a closed loop)} \tag{13}$$