ENGG 225
Formula Sheet

1 Introduction

$$i(t) = \frac{d\,q(t)}{dt}$$

$$V(t) = \frac{d\,W(t)}{d\,q(t)}$$

$$V = i\,R$$

$$P = i\,V$$

$$P = i^2 R$$

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

$$W = \int_{t_1}^{t_2} P(t)\,dt$$

$$\sum i_n = 0$$

$$\sum V_n = 0$$

2 Resistive Circuits

$$\sum_{k=1}^{n} R_k = R_{eq}$$

$$\frac{1}{R_{eq}} = \sum_{k=1}^{n} \frac{1}{R_k}$$

$$V_k = \frac{R_k}{\sum R} V$$

$$i_1 = \frac{R_2}{R_1 + R_2} i$$

3 Operational Amplifiers

$$V_1 = V_2$$

$$i_n = i_p = 0$$

4 Inductors and Capacitors

$$i(t) = C\frac{d\,V(t)}{dt}$$

$$V(t) = \frac{1}{C}\int_{t_0}^{t} i(\tau)\,d\tau + v(t_0)$$

$$\begin{aligned} P(t) &= V(t)i(t) \\ &= C\,v(t)\frac{d\,V(t)}{dt} \\ &= i(t)\left(\frac{1}{C}\int_{t_0}^{t} i(\tau)\,d\tau + v(t_0)\right) \end{aligned}$$

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

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

$$V(t) = L\frac{d\,i(t)}{dt}$$

$$i(t) = \frac{1}{L}\int_{t_0}^{t} V(\tau)\,d\tau + i(t_0)$$

$$P(t) = L\,i(t)\frac{d\,i(t)}{dt}$$

$$E = \frac{1}{2}L\,i(t)^2$$

$$L_{eq} = \sum L$$

$$\frac{1}{L_{eq}} = \sum \frac{1}{L}$$

5 Alternating Current

$$f = \frac{1}{f}$$

$$\omega = 2\pi f$$

$$\sin(\omega t) = \cos\left(\omega t - \frac{\pi}{2}\right)$$

$$P_{avg} = \frac{\left(\sqrt{\frac{1}{T}\int_0^T V^2(t)\,dt}\right)^2}{R} = \frac{V_{RMS}^2}{R}$$

$$V_{RMS} = \sqrt{\frac{1}{T}\int_0^T V^2(t)\,dt}$$

$$V_{RMS} = \frac{V_m}{\sqrt{2}}$$

$$I_{RMS} = \frac{I_m}{\sqrt{2}}$$

$$\bar{V_a} = V_a\angle\theta_a$$

$$z_L = j\omega L$$

$$z_C = \frac{-j}{\omega C}$$

$$z_R = R$$

$$\bar{V} = z\,\bar{I}$$

$$P(t) = V_{RMS}I_{RMS}\cos(\theta_V - \theta_I)\big[1 + 2\cos(2\omega t + 2\theta_V)\big] + V_{RMS}I_{RMS}\sin(\theta_V - \theta_I)\sin(2\omega t + 2\theta_V)$$

$$P_{avg} = P_{Real} = V_{RMS}I_{RMS}\cos(\theta_V - \theta_I)$$

$$\theta_P = \theta_V - \theta_I$$

$$PF = \cos\theta_P$$

$$Q = V_{RMS}I_{RMS}\sin(\theta_V - \theta_I)$$

$$S = V_{RMS}I_{RMS}$$

$$\bar{S} = \frac{1}{2}\bar{V}\bar{I}^*$$

$$\bar{S} = P + Qj$$

$$\text{given } z = R + jx$$

$$P = I_{RMS}^2 R$$

$$Q = I_{RMS}^2 x$$

6 DC Machines

$$\eta = \frac{P_{out}}{P_{in}} \times 100\%$$

$$P_{in} = V\,i$$

$$P_{out} = T_{out}\omega_m$$

$$SR = \frac{n_{\text{no load}} - n_{\text{full load}}}{n_{\text{full load}}} \times 100\%$$

$$\boxed{E_A = K\phi\omega_m}$$

$$\boxed{T_{dev} = K\phi i_A}$$

$$\boxed{P = T\omega}$$