EET360 Equation Sheet

Electromagnetics

$MMF = NI$ in A-t $\qquad H = \dfrac{MMF}{l}$ in A-t/m

$B = \dfrac{\Phi}{A}$ in Wb/m^2 $\qquad \mu = \dfrac{B}{H}$ in Wb/A-t-m

AC Equations

P=real power (Watts)

S=apparent power (VA)

Q=reactive power (VARs)

Single Phase

$$S = VI = \sqrt{P^2 + Q^2}$$

$$Q = VI\sin\theta = S\sin\theta$$

$$P = VI\cos\theta = S\cos\theta$$

$$\text{power factor} = \cos\theta = \frac{P}{S}$$

Three Phase Equations

$V_{line} = \sqrt{3}\ V_{phase}$ for Y

$I_{line} = \sqrt{3}\ I_{phase}$ for Δ

$$S = \sqrt{3}\ V_{line}I_{line}$$

$$Q = \sqrt{3}\ V_{line}I_{line}\sin\theta$$

$$P = \sqrt{3}\ V_{line}I_{line}\cos\theta$$

$$S = 3\ V_{phase}I_{phase}$$

$$Q = 3\ V_{phase}I_{phase}\ \sin\theta$$

$$P = 3\ V_{phase}I_{phase}\ \cos\theta$$

Transformers

$$\text{Turns ratio} = a = \frac{N_{HS}}{N_{LS}} = \frac{V_{HS}}{V_{LS}} = \frac{I_{LS}}{I_{HS}}$$

$E_P = 4.44\,N_P f\Phi_{max}$ $\qquad E_S = 4.44\,N_S f\Phi_{max}$

For ideal transformers $S_{in} = S_{out}$

Motor Equations

s=slip, n=slip speed, n_r=rotor speed

n_s=synchronous speed, P= # of poles

f_s=line frequency

$$s = \frac{n_s - n_r}{n_s} \qquad n = n_s - n_r \qquad n_s = \frac{120 f_s}{P}$$

P=power, T=torque, n_r=rotor speed

η=efficiency

$$P = \frac{T n_r}{7.04} \text{ Watts} \qquad P = \frac{T n_r}{5252} \text{ hp}$$

1 hp=746 Watts

$$\eta = \frac{P_{out}}{P_{in}} = \frac{P_{in} - P_{losses}}{P_{in}} = \frac{P_{out}}{P_{out} + P_{losses}}$$

$$P_{out} = P_{in} - P_{losses}$$

DC Machine Equations

$E_a = n\Phi_p k_G \qquad I_f = \dfrac{E_{bat}}{R_f + R_{rheo}} \qquad T_D = B_p I_a k_M$

$$VR = \frac{V_{nl} - V_{rated}}{V_{rated}} \qquad SR = \frac{n_{nl} - n_{rated}}{n_{rated}}$$

$$n = \left.\frac{V_T - I_a R_{acir}}{\Phi_p k_G}\right|_{\Phi_p = 0} \qquad T_D = \frac{7.04 E_a I_a}{n} \text{ ft-lb}$$

$$P_{mech} = E_a I_a = \frac{T_D n}{7.04} \text{ watts}$$