Department of Mechanical, Materials and Manufacturing Engineering

Electromechanical Devices MMME2051EMD

DC Permanent Magnet Motor

Torque, $T = K I_a$

Back-EMF, $E_b = K \omega$

Supply voltage, $V = E_b + I_a R_a$

Induction Motors

Slip, $s = \frac{n_s - n}{n_s}$ where $n_s = \frac{60 f}{p}$

where f = frequency in Hz, p = no. of pole pairs, n is running speed in rev min^{-1} and n_s is synchronous speed in rev min^{-1}

Torque $T = \frac{3p}{2\pi f} \cdot \frac{V^2 as}{X_R (a^2 + s^2)}$ Newton metres, where $a = \frac{R_R}{X_R}$, p = no. of pairs of poles

Mechanical output power, $P_m = T\left(\frac{2\pi f}{p}\right)(1-s)$ Watts

Transformers

Ideal transformer formulae (assuming zero resistance and zero core reluctance)

$$\frac{N_1}{N_2} = \frac{V_1}{V_2} = \frac{I_2}{I_1}$$

$Z_{eq} = \left(\frac{N_1}{N_2}\right)^2 Z_2$ Ohms

AC Circuits

Resistance and inductance in series: Complex Impedance

In Cartesian form:

$Z = (R + j\omega L)$ Ohms

in polar form:

$Z = \sqrt{R^2 + \omega^2 L^2} \angle (+\phi_L)$ Ohms where $\phi_L = tan^{-1}\left(\frac{\omega L}{R}\right)$

Modulus:

$|Z| = \sqrt{R^2 + \omega^2 L^2}$ Ohms

Resistance and capacitance in series: Complex Impedance

In Cartesian form:

$Z = R - j\left(\frac{1}{\omega C}\right)$ Ohms

in polar form:

$Z = \sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2} \angle(-\phi_c)$ Ohms where $\phi_c = tan^{-1}\left[\frac{1}{\omega CR}\right]$

Modulus:

$|Z| = \sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}$ Ohms

Power dissipation

Average power, $P = |V||I|\cos\phi$ Watts

Power dissipation in a resistor, $P = |I|^2 R$ Watts