EECE 370 Formula Sheet:

Chapter 1:

$H = \frac{N \cdot i}{lc}$ [A/m] $\mu o = 4\pi \cdot 10^{-7}$ $\lambda = N * \phi$ [Wb·t]

Power factor correction:

$mmf = N \cdot i = \phi \cdot R_t$ $\phi = B \cdot A$ [Wb] $L = \frac{\lambda}{i}$ [Wb·t/A] P=VIcos(θ) [W]

$B = \mu \cdot H$ [T] $\mu = \mu o \cdot \mu r$ $w = \frac{1}{2} L i^2$ Q=VIsin(θ) [VAR]

$R = \frac{l_c}{\mu * A}$ F = i· (B x l) = i·l·B E = (VxB) ·l = B· $l \cdot v$ S=VI [VA]

Laws:

Ampere's : N·i = $\sum H \cdot l$ Faraday's : $e = N \cdot \frac{d\phi}{dt}$ Lenz's : $e = -N \cdot \frac{d\phi}{dt}$

3-Phase Circuits:

Parameter\Connection	Y-Connected	Δ –Connected
Current	$I_l = I_\phi$	$I_l = \sqrt{3} I_\phi$
Voltage	$V_l = \sqrt{3} V_\phi$	$V_l = V_\phi$
Real Power	$3V_\phi I_\phi \cos(\theta)$ *or* $\sqrt{3} V_l I_l \cos(\theta)$	$3V_\phi I_\phi \cos(\theta)$ *or* $\sqrt{3} V_l I_l \cos(\theta)$
Reactive Power	$3V_\phi I_\phi \sin(\theta)$ *or* $\sqrt{3} V_l I_l \sin(\theta)$	$3V_\phi I_\phi \sin(\theta)$ *or* $\sqrt{3} V_l I_l \sin(\theta)$
Apparent Power	$s = \sqrt{p^2 + q^2}$	$s = \sqrt{p^2 + q^2}$

Chapter 2: Transformers:

$E_{max} = \omega \cdot N \cdot \phi_{max}$ $E_{rms} = 4.44 \cdot f \cdot N \cdot \phi_{max}$ $\phi_{max} = \sqrt{2} \phi_{rms}$

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Ideal Transformers:

$\frac{V_p}{V_s} = \frac{N_p}{N_s} = \alpha$ $\frac{I_p}{I_s} = \frac{N_s}{N_p} = \frac{1}{\alpha}$ $\frac{Z_p}{Z_s} = (\frac{N_p}{N_s})^2 = \alpha^2$

Real Transformers: (same equations as above)

$E_p = V_p - I_p(R_p + jX_p)$ $E_s = V_s + (R_s + jX_s)$ $I_p = I_\phi + I_s'$

Quality Parameters:

$efficiency: \eta = \frac{P_{out}}{P_{in}} * 100 = \frac{P_{out}}{P_{out} + P_{loss}} * 100 = 1 - \frac{P_{loss}}{P_{in}} * 100$ [%]

$P_{loss} = {I_p}^2 R_p + {I_s}^2 R_s + {I_c}^2 R_c$ Copper loss: $= {I_s'}^2 * R_{eq}$ Core Loss $= \frac{{V_p}^2}{R_c}$

Voltage Regulation: $\frac{V_{snl} - V_{sfl}}{V_{sfl}} * 100$

Transformer testing:

OC-Test: $S_{oc} = V_{oc} * I_{oc}$ $R_c = \frac{{V_{oc}}^2}{P_{oc}}$ $Q_{oc} = \sqrt{{S_{oc}}^2 - {P_{oc}}^2}$ $X_m = \frac{{V_{oc}}^2}{Q_{oc}}$

SC-Test: $R_{eq} = \frac{P_{sc}}{{I_{sc}}^2}$ $Z_{eq} = \frac{V_{sc}}{I_{sc}}$ $X_{eq} = \sqrt{{Z_{eq}}^2 - {R_{eq}}^2}$ $R_p = R_s' = 0.5 R_{eq}$ $X_{lp} = X_{ls}' = 0.5 * X_{eq}$

Autotransformers:

$\frac{V_l}{V_h} = \frac{N_c}{N_c + N_{se}}$ $\frac{I_l}{I_h} = \frac{N_{se} + N_c}{N_c}$ $S_{in} = V_l * I_l$ $S_{out} = V_h * I_h$ $\frac{S_{IO}}{S_w} = 1 + \frac{N_c}{N_{se}}$

Phase Transformers:

Y-Δ: $\frac{V_{lp}}{V_{ls}} = \sqrt{3}\alpha$ $\Delta - Y$: $\frac{V_{lp}}{V_{ls}} = \frac{\alpha}{\sqrt{3}}$ $\Delta - \Delta$: $\frac{V_{lp}}{V_{ls}} = \alpha$

AC Machinery Fundamentals

$e = 2BlV\sin(\theta)$ $\theta = \omega t$ $v = r\omega$ $A = 2rl$ $e_{rms} = 4.44 f N_c \phi_{max}$ $SR = \frac{S_{nl} - S_{fl}}{S_{fl}}$

$mmf_p = 1.5 * mmf_m \cos(\theta - \omega t)$ $\theta_{el} = \frac{p}{2}\theta_{mech}$ $n = \frac{120f}{p}$ $\omega = \frac{2\pi n}{60}$ $\tau = 2rilB\sin(\omega t)$

$e(t) = \sqrt{2} E_{rms} \sin(\omega t)$ $E_a = \frac{N_c}{\sqrt{2}} \phi \omega$ $P_{out} = 3V_\phi \frac{E_a \sin(\delta)}{X_s} = T_{ind} \omega_n$

Testing:

DC: $R_a = \frac{V_{dc}}{2I_{dc}}$ $Z_s = \frac{V_{oc}}{I_f}$ $X_s = \sqrt{{Z_s}^2 - {R_a}^2}$

Induction motors:

Slip: S=$\frac{n_s - n_m}{n_s} * 100$[%] $n_m = 120\frac{f}{p}(1 - s)$

$P_{scl} = 3{I_1}^2 R_1$ $P_{rcl} = 3{I_2}^2 R_2$ $P_g = 3{I_2}^2 \left(\frac{R_2}{s}\right)$ $P_{conv} = P_g(1 - s)$ $T_{ind} = \frac{P_g}{\omega_s}$ $T_l = \frac{P_{out}}{\omega_m}$