# Chapter 4 : Synchronous generator

$$n_m = \frac{120 f_e}{P} = n_{sync}$$

$$E_A = \sqrt{2}\,\pi\, N_c\, \Phi\, f = K \Phi \omega$$

↳ induced voltage

## General equation

$$E_A = V_\phi + I_A (R_A + X_s j)$$

## Power calculations

$$P_{in} = \tau_{app}\, \omega_m$$

$$P_{conv} = \tau_{ind}\, \omega_m$$

$$P_{out} = \sqrt{3}\, V_L I_L \cos\theta$$

$$P_{copper\ losses} = 3 R_A (I_A)^2$$

δ : The angle between $E_A$ and $V_\phi$

## Voltage Regulation

$$V_R = \frac{V_{nl} - V_{fl}}{V_{fl}}$$

# Chapter 5 : Synchronous Motors

At coupling $n_m = \frac{120 f_e}{P}$

## General equation

$$V_\phi = E_A + I_A (R_A + X_s j)$$

$$P = \frac{3 E_A V_\phi \sin \delta}{X_s}$$ Assuming $R_A = 0$

$$\tau_{pull\ out} = 3 \tau_{rated\ (full\ load)}$$

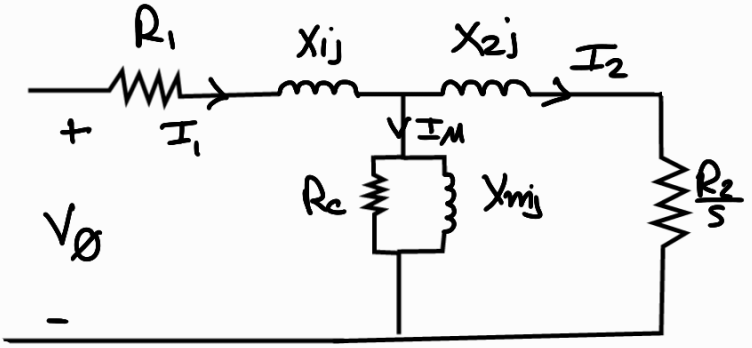
# Chapter 6 : Induction Motors

$n_{slip} = n_{sync} - n_m$ $\quad n_m$ = at full load

$n_{sync} = \frac{120 f_e}{P}$

$n_m = (1-S)\, n_{sync}$

$f_r = S f_e = \frac{P}{120} (n_{sync} - n_m)$




$Z_{eq} = R_1 + X_{1j} + \left( X_{2j} + \frac{R_2}{S} \,//\, X_{mj} \right)$

$I_2 = a_{eff} I_1$

## Power calculations

$P_{in} = \sqrt{3}\, V_L I_L \, PF$

$P_{scL} = 3 \underbrace{I_1^2 R_1}_{\text{Stator side}}$

$P_{RCL} = 3 I_2^2 R_2 = S P_{AG}$

$P_{AG} = P_{in} - P_{scL} - P_{core} = 3 I_2^2 \frac{R_2}{S}$

$P_{conv} = (1-S) P_{AG}$

$$\tau_{ind} = \frac{P_{AG}}{\omega_{sync}}$$

$$\tau_{load} = \frac{P_{out}}{\omega_m}$$

$$P_{out} = P_{conv} - P_{mech} - P_{core} - P_{misc}$$

## Rotor power factor

$$G_R = \tan^{-1}\left(\frac{X_2}{R_2/s}\right)$$ :-

$$3I_A^2 R_I = 3I_2^2 \frac{R_2}{S}$$

↳ parallel of $R_2 + X_{2j}$ and $X_{mj}$

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# General

$$PF = \tan^{-1}\left(\frac{Q}{P}\right)$$

$$S_{3\phi} = \sqrt{3}\, V_L\, I_L \qquad P_{in} = \sqrt{3}\, V_L\, I_L\, PF$$

$$P_{out} = PF \times S_{given}$$


$$Z_{Base} = \frac{V_{2\,to\,L}}{S_{3\phi}\,(given)}$$