Representation of Induced Stator Voltage due to Rotor Field

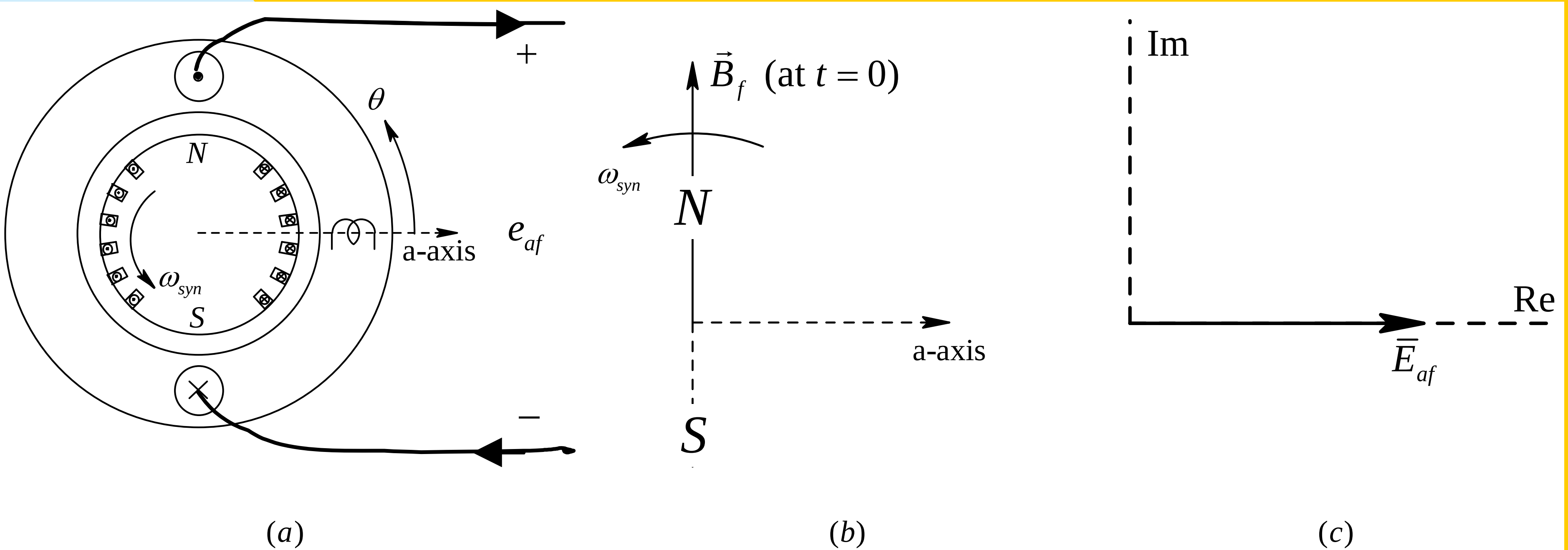

Fig. 9-8 Induced emf e_{af} due to rotating rotor field with the rotor.

$\vec{B}_f$: Space Vector

$$\bar{E}_{af} = (-j)k_f \omega \vec{B}_f(0)$$

$$\omega_{syn} = 2\pi f$$

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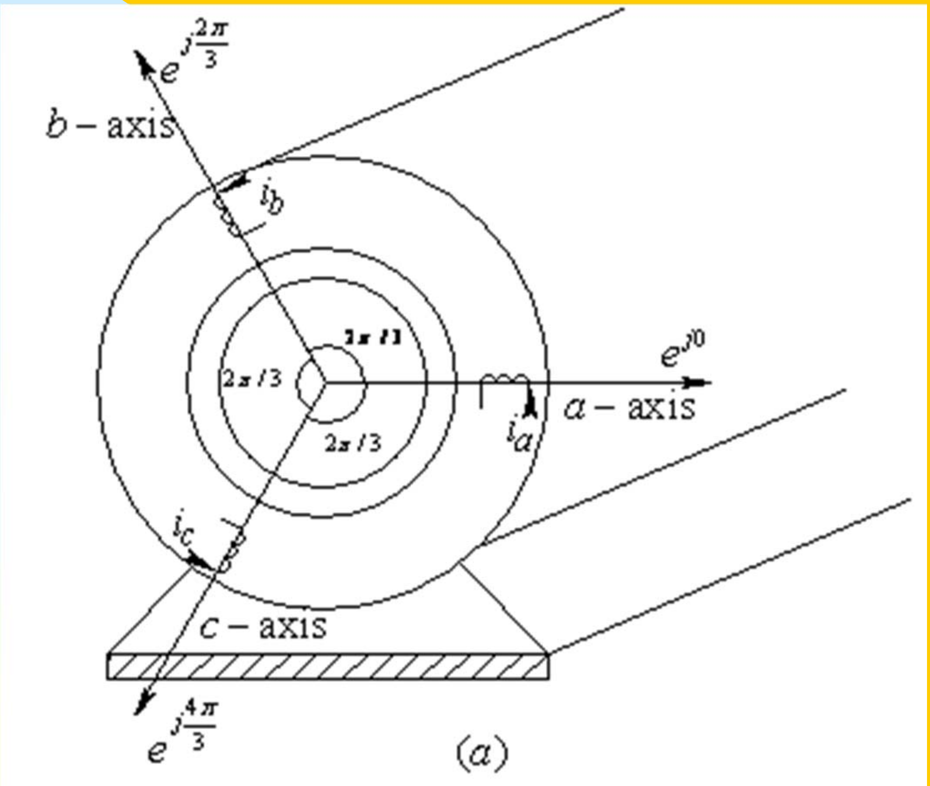
Armature Reaction Due to Three Stator Currents



$$\vec{B}_{i_a} = (k_1 i_a) e^{j0} \qquad \vec{B}_{i_b} = (k_1 i_b) e^{j2\pi/3} \qquad \vec{B}_{i_c} = (k_1 i_c) e^{j4\pi/3}$$

$$\vec{B}_{AR} = k_1 \left(i_a e^{j0} + i_b e^{j2\pi/3} + i_c e^{j4\pi/3} \right)$$

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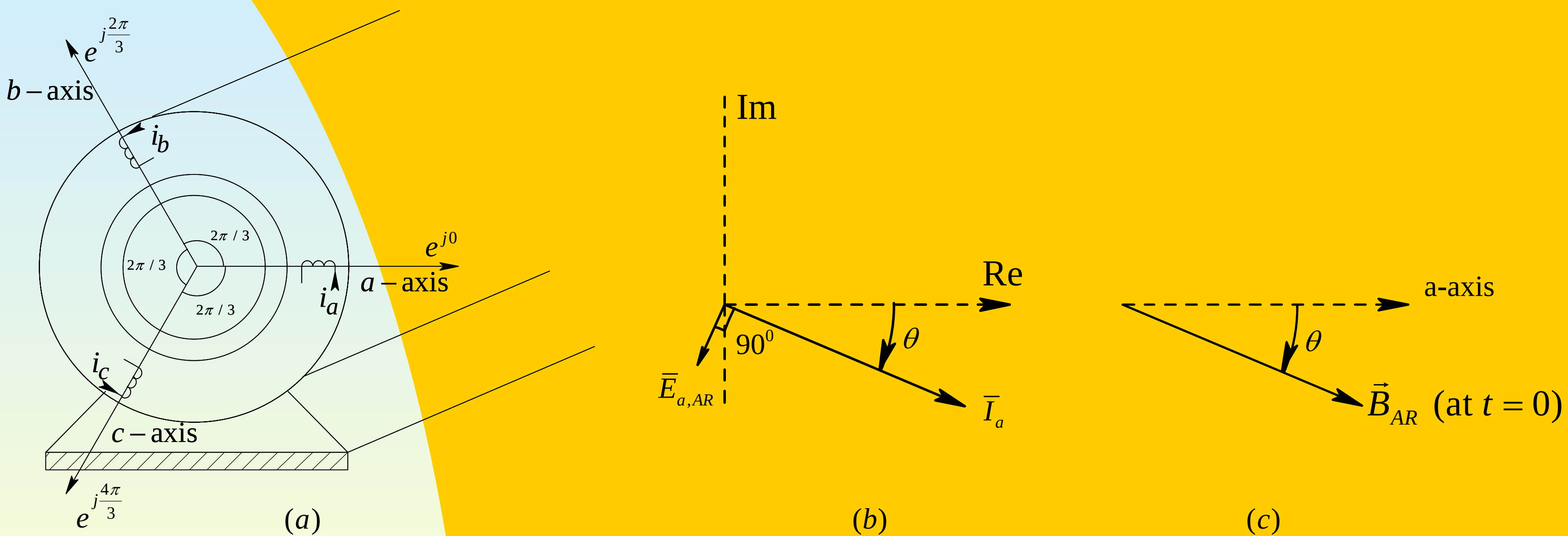
Armature Reaction Due to Three Stator Currents

$i_a = I_a \cos(\omega t - \theta)$ $\quad i_b = I_a \cos(\omega t - \theta - 2\pi/3)$ $\quad i_c = I_a \cos(\omega t - \theta - 4\pi/3)$



$$\vec{B}_{AR} = k_1\left(i_a e^{j0} + i_b e^{j2\pi/3} + i_c e^{j4\pi/3}\right) = \left(\frac{3}{\sqrt{2}} k_1 I_a\right) e^{j(\omega t - \theta)}$$

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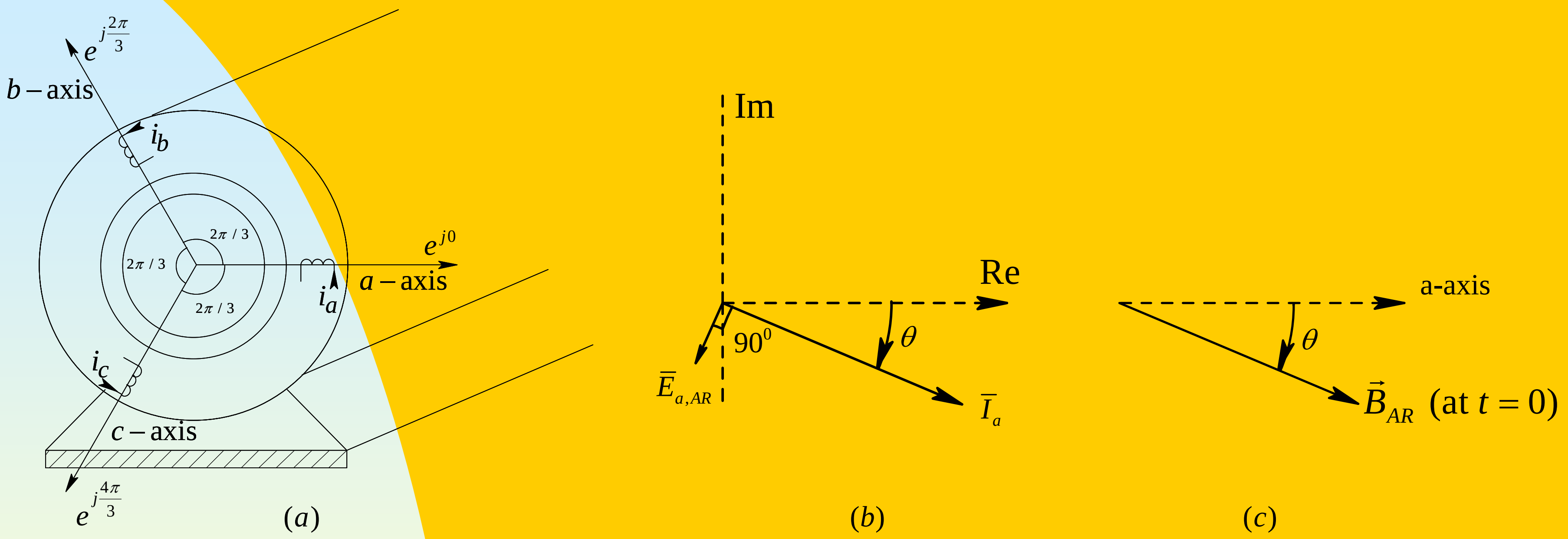
Induced Voltage due to Armature Reaction



$$\vec{B}_{AR} = \left(\frac{3}{\sqrt{2}} k_1 I_a\right) e^{j(\omega t - \theta)}$$

$$\bar{E}_{a,AR} = -jk_{AR}\omega\bar{I}_a$$

$$\bar{E}_{a,AR} = (-j) k_2 \omega \vec{B}_{AR} \,(\text{at}\, t = 0)$$

$$\bar{E}_{a,AR} = -jX_m \bar{I}_a$$

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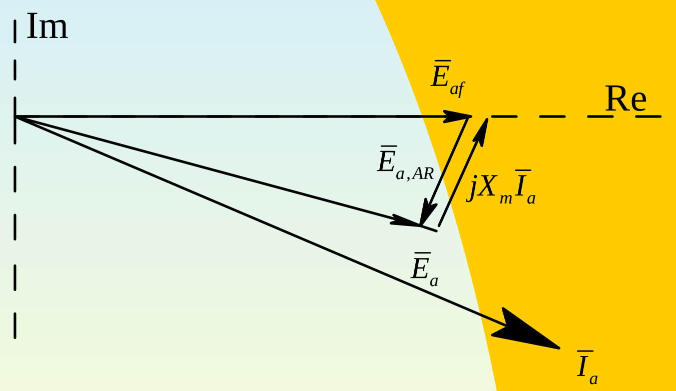
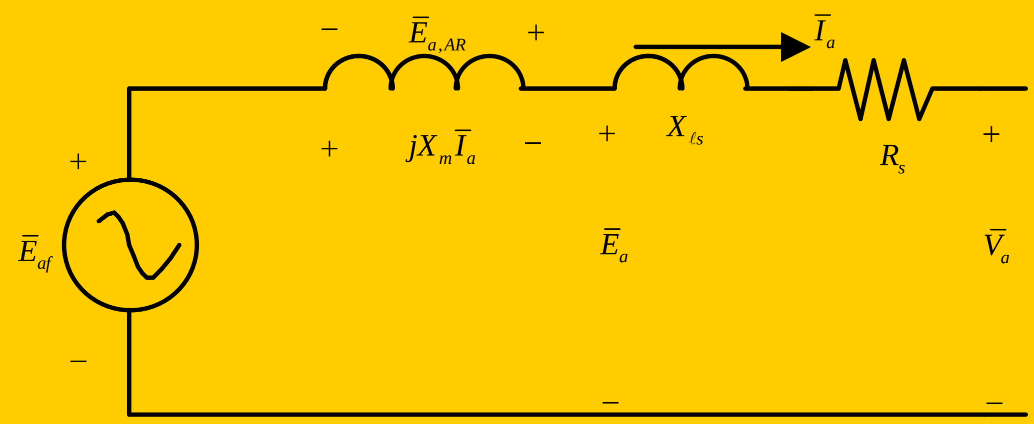
Superposition of the two Induced Voltages and Per-Phase Representation

$$\bar{E}_a = \bar{E}_{af} + \bar{E}_{a,AR} = \bar{E}_{af} - jX_m \bar{I}_a$$



(*a*)



(*b*)

$$\bar{V}_a = \bar{E}_{af} - jX_s \bar{I}_a - R_s \bar{I}_a$$

$$X_s \left(= X_{\ell s} + X_m\right)$$

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Power Out as a function of rotor Angle

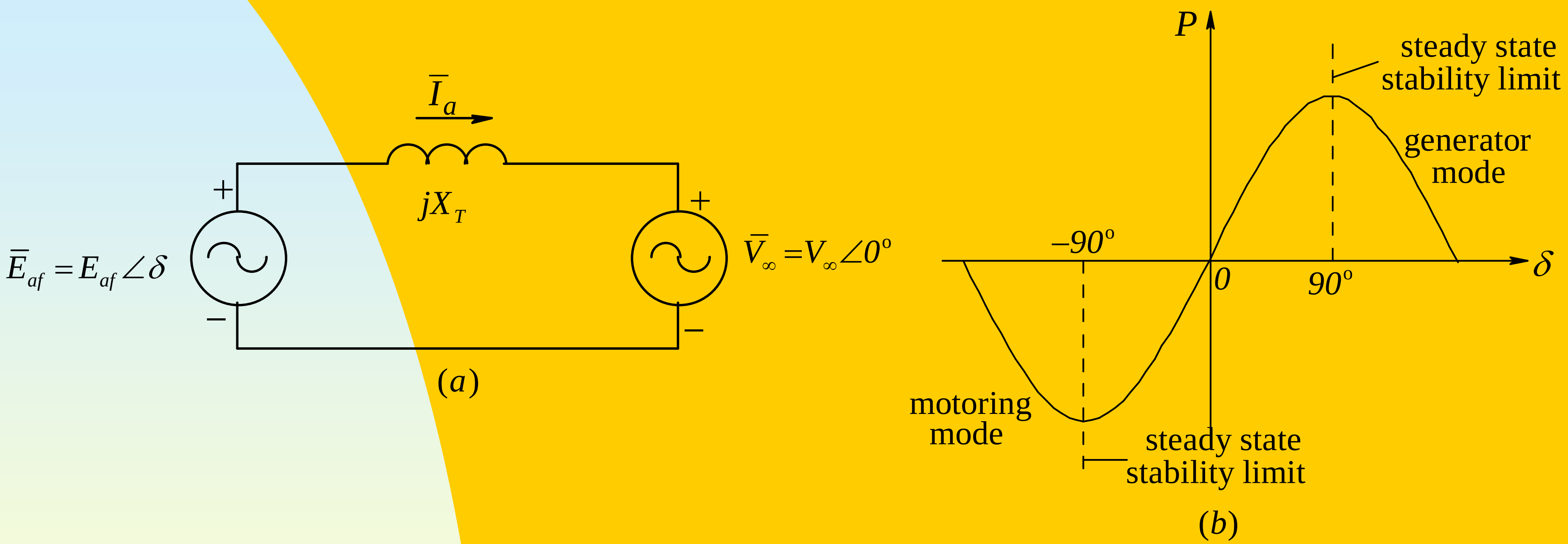

Fig. 9-11 Power output and synchronism.

$$P = 3\frac{E_{af}V_\infty}{X_T}\sin\delta$$

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Steady State Stability Limit

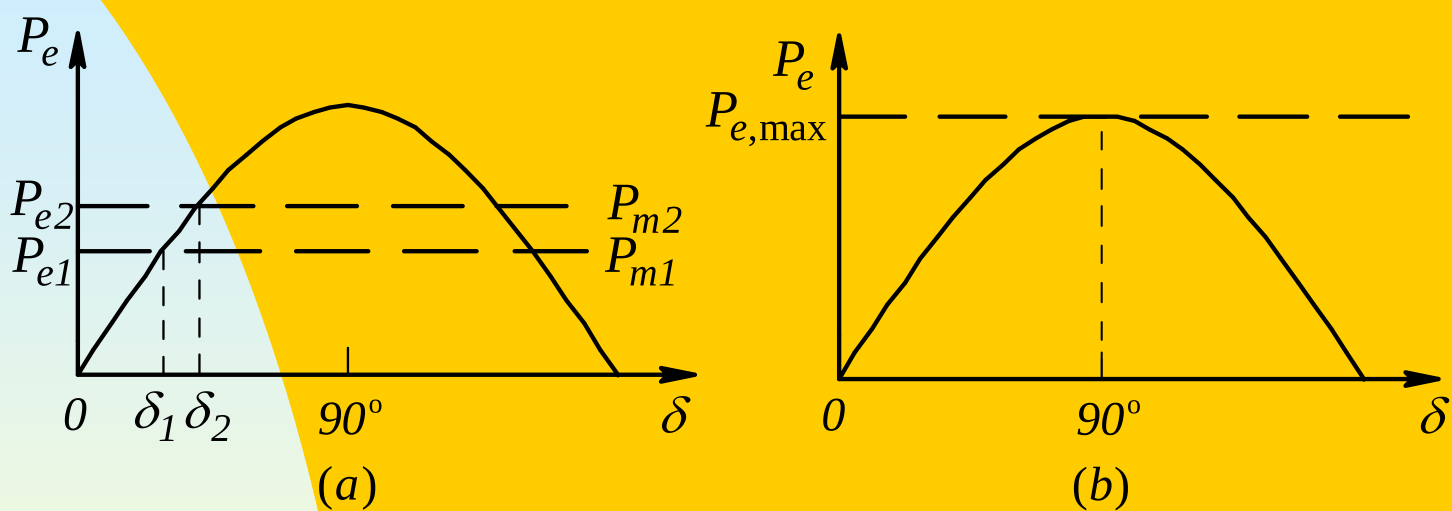

Fig. 9-12 Steady state stability limit.

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