

Problem 6-12

$$V_{LL} = 460\text{V}, f = 60\text{ Hz}, \omega = 377 \frac{\text{rad}}{\text{s}}, L_s = 25\text{ }\mu\text{H}, V_d = 525\text{ V}, \text{ and } P_d = 500\text{ kW}.$$

$$I_d = \frac{P_d}{V_d} = \frac{500 \times 1000}{525} = 952.4\text{ A}$$

$$V_d = 1.35 V_{LL} \cos\alpha - \frac{3\omega L_s}{\pi} I_d$$

$$\therefore \cos\alpha = \frac{525 + \left(\frac{3 \times 377}{\pi} \times 25 \times 10^{-6} \times 952.4\right)}{1.35 \times 460}$$

$$\therefore \alpha = 30.77^\circ$$

$$\cos(\alpha+u) = \cos\alpha - \frac{2\omega L_s}{\sqrt{2} V_{LL}} I_d$$

$$= 0.859 - \frac{2 \times 377 \times 25 \times 10^{-6}}{\sqrt{2} \times 460} \times 952.4$$

$$= 0.831$$

$$\text{or } (\alpha+u) = 33.76^\circ$$

Therefore, the commutation angle u is

$$u = 33.76^\circ - 30.77^\circ \simeq 3^\circ$$