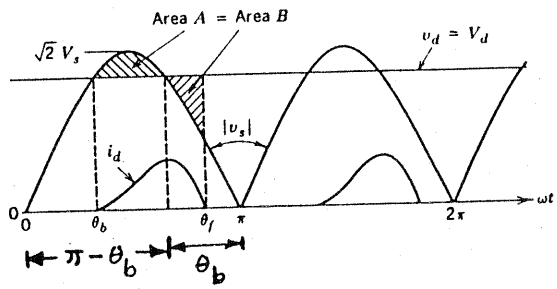
Problem 5-11



Calculate θ_b

$$\sqrt{2}\ V_s \sin\theta_b = V_d$$

$$\therefore\ \theta_b = \sin^{-1}\left(\frac{150V}{\sqrt{2}\ 120V}\right) = 1.084 \text{ rad.}$$

Derive $i_d(\theta)$

$$i_d(\theta) = \frac{1}{\omega L_s}\int_{\theta_b}^{\theta} v_L\, d\theta$$

$$= \frac{1}{\omega L_s}\int_{\theta_b}^{\theta} (\sqrt{2}\ V_s \sin\theta - V_d)\, d\theta$$

$$i_d(\theta) = \frac{1}{\omega L_s}\left[\sqrt{2}\ V_s(-\cos\theta + \cos\theta_b) - V_d(\theta - \theta_b)\right]$$

$$\therefore\ i_d(\theta) = -450.1\cos\theta - 397.9\theta + 641.8$$

Calculate θ_f

$$i_d(\theta_f) = 0 = -450.1\cos\theta_f - 397.9\,\theta_f + 641.8$$

$$\cos\theta_f + 0.884\cdot\theta_f = 1.426$$

$$\therefore\ \theta_f = 2.56 \text{ rad}$$

Calculate $I_{d,peak}$:

The peak current occurs at $(\pi-\theta_b)$ since v_L is positive between θ_b and $\pi-\theta_b$.

$$I_{d,peak} = i_d(\pi-\theta_b)\ ;\ \pi - \theta_b = 2.058 \text{ rad}$$

$$\therefore\ I_{d,peak} = -450.1\cos(2.058) - (397.9)(2.058) + 641.8 = 33.6\text{A}$$