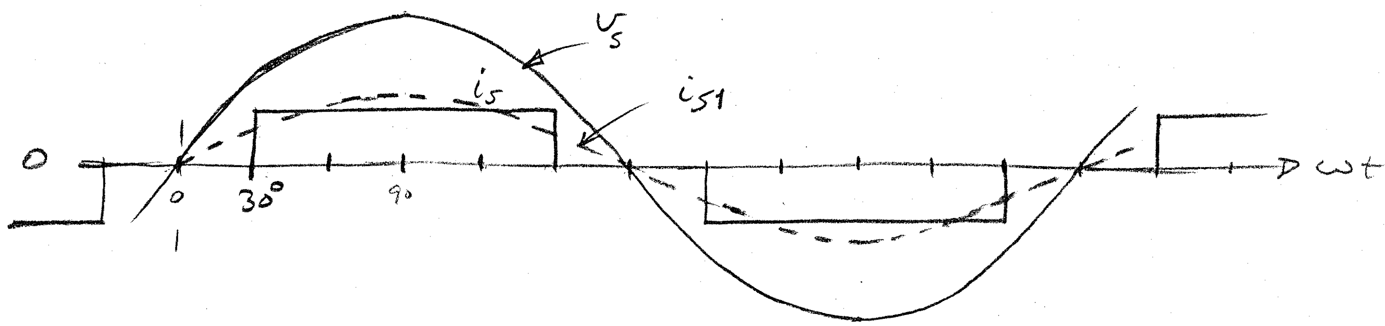
Problem 5-27



Using $\omega t = 0$ as shown above, i_s odd and quarter-wave symmetric. Therefore, from Table 3-1

$a_h = 0$ for all h, $b_h = 0$ for all even h and,

$$b_h = \frac{4}{\pi}\int_0^{90^\circ} i_s \cdot \sin h\omega t \cdot d(\omega t) \quad \text{for odd } h$$

for

$0 < \omega t < 30^\circ$, $i_s = 0$

$30^\circ < \omega t < 90^\circ$, $i_s = I_d$

$$\therefore \quad b_h = \frac{4 I_d}{\pi}\int_{30^\circ}^{90^\circ} \sin(h\omega t) \cdot d(\omega t) = \frac{4 I_d}{\pi h} \cos h\omega t \Big|_{90^\circ}^{30^\circ}$$

$$= 4\frac{I_d}{\pi h}\left[\cos(30h^\circ) - \cos(90h^\circ)\right] \qquad h = \text{odd}$$

Quantity within the bracket:

$$\left[\cos(30h^\circ) - \cos(90h^\circ)\right] = \frac{\sqrt{3}}{2} \quad \text{for } h = 1, 5, 7, 11, 13, \ldots$$

$$= 0 \quad \text{for all other odd } h$$

$$\therefore \quad b_h = \frac{4}{\pi}\frac{\sqrt{3}}{2}\frac{I_d}{h} = \frac{2\sqrt{3}}{\pi h} I_d \quad \text{for } h = 1 \text{ and } 6n \pm 1 \text{ where } n = 1, 2, 3, \ldots$$

From Eq. 3-21

$$i_s(t) = \frac{2\sqrt{3}}{\pi} I_d \left[\sum \frac{1}{h}\sin(h\omega t)\right]$$

$$\therefore \quad i_{s1}(t) = \frac{2\sqrt{3}}{\pi} I_d \sin\omega t \qquad \text{for } h = 1$$

$\therefore \quad \phi_1 = 0 \quad$ and $\quad DPF = 1.0 \qquad$ Eq 5-72

$$I_{s1} = \frac{1}{\sqrt{2}}\left(\frac{2\sqrt{3}}{\pi} I_d\right) = \frac{\sqrt{6}}{\pi} I_d \qquad \text{Eq 5-70}$$

$$\frac{I_{sh}}{I_{s1}} = \frac{1}{h} \qquad \text{Eq. 5-71}$$

$$I_s = \sqrt{I_{s1}^2 + \sum I_{sh}^2}$$

$$= \sqrt{\left(\frac{\sqrt{6}}{\pi} I_d\right)^2 \left[1 + \sum_{h=5} \left(\frac{1}{h}\right)^2\right]}$$

$$= \frac{\sqrt{6}}{\pi} I_d \sqrt{1 + \sum_{h=5} \frac{1}{h^2}} = 0.816\, I_d \qquad \text{Eq 5-69}$$

$$PF = DPF \cdot \frac{I_{s1}}{I_s} = 0.955 \qquad \text{Eq 5-73}$$