3. *Calculations for RMS diode Current*

$$I_r := \left(\frac{2}{T} \cdot \int_{\frac{T}{6}}^{\frac{T}{3}} i_L(t)^2 \, dt \right)^{\frac{1}{2}} \qquad I_r = 30.11$$

4. *Calculations for RMS Output Current*

$$I_{rms} := \sqrt{3} \cdot I_r$$

$I_{rms} = 52.16$ *RMS Output Current*

Prob 3-15

$V_s := 120$ $f := 60$ $R := 140$ $\omega := 2 \cdot \pi \cdot f$ $\omega = 376.99$ $RF := \frac{5}{100}$

$V_m := \sqrt{2} \cdot V_s$ $V_m = 169.71$

(a) Using Eq. (3-67)

$$C_e := \frac{1}{4 \cdot f \cdot R} \cdot \left(1 + \frac{1}{\sqrt{2} \cdot RF} \right) \qquad C_e \cdot 10^6 = 450.66 \quad \mu F$$

(b) $$V_{dc} := V_m - \frac{V_m}{4 \cdot f \cdot R \cdot C_e} \qquad V_{dc} = 158.5$$

Prob 3-16

$V_s := 120$ $f := 60$ $R := 140$ $\omega := 2 \cdot \pi \cdot f$ $\omega = 376.99$

$V_m := \sqrt{2} \cdot V_s$ $V_m = 169.71$

(a) Using Eq. (3-67)

$$C_e := \frac{1}{2 \cdot f \cdot R} \cdot \left(1 + \frac{1}{\sqrt{2} \cdot RF} \right) \qquad C_e \cdot 10^6 = 901.32$$

Prob 3-19

(a)

$f := 60$ $Vdc := 48$ $Idc := 20$ $\omega := 2\cdot\pi\cdot f$ $\omega = 376.99$

$Vs := 120$ $Vm := \sqrt{2}\cdot Vs$

$x := \frac{Vdc}{Vm}$ $\alpha := \operatorname{asin}(x)$ $180\cdot\frac{\alpha}{\pi} = 16.43$

Using Eq. (3-74)

$k := \sqrt{1-(x)^2} + \left(\frac{2}{\pi} - \frac{\pi}{2}\right)x$ $100\cdot k = 69.49$

$Ipk := \frac{Idc}{k}$ $Ipk = 28.78$

Using Eq. (3-77)

$Lcr := \frac{Vm}{\omega\cdot Ipk}$ $1000\cdot Lcr = 15.64$ mH

Using Eq. (3-76)

$$k_r := \sqrt{\frac{1}{\pi}\left[\int_{\alpha}^{\alpha+\pi} \left[(\cos(\alpha) - \cos(\phi)) - \pi\cdot(\phi-\alpha)\right]^2 d\phi\right]}$$

$100\cdot k_r = 81.91$

$Irms := k_r\cdot Ipk$ $Irms = 23.57$

(b)

$I_{dc} := 15$ $Ipk := 69.25$

$k := \frac{100\cdot I_{dc}}{Ipk}$ $k = 21.66$

$x_n := 60$ $x_{n1} := 65$

$\alpha_n := 36.87$ $\alpha_{n1} := 40.54$

$k_n := 23.95$ $k_{n1} := 15.27$

$a_o/2 = I_a/2$

$$a_n = \frac{1}{\pi}\int_0^{\pi} I_a \cos(n\theta)\, d\theta = 0$$

$$b_n = \frac{1}{\pi}\int_0^{\pi} I_a \sin(n\theta)\, d\theta = \frac{I_a}{n\pi}(1-\cos n\theta)$$

$\varphi_n = \tan^{-1}(a_n/b_n) = 0$

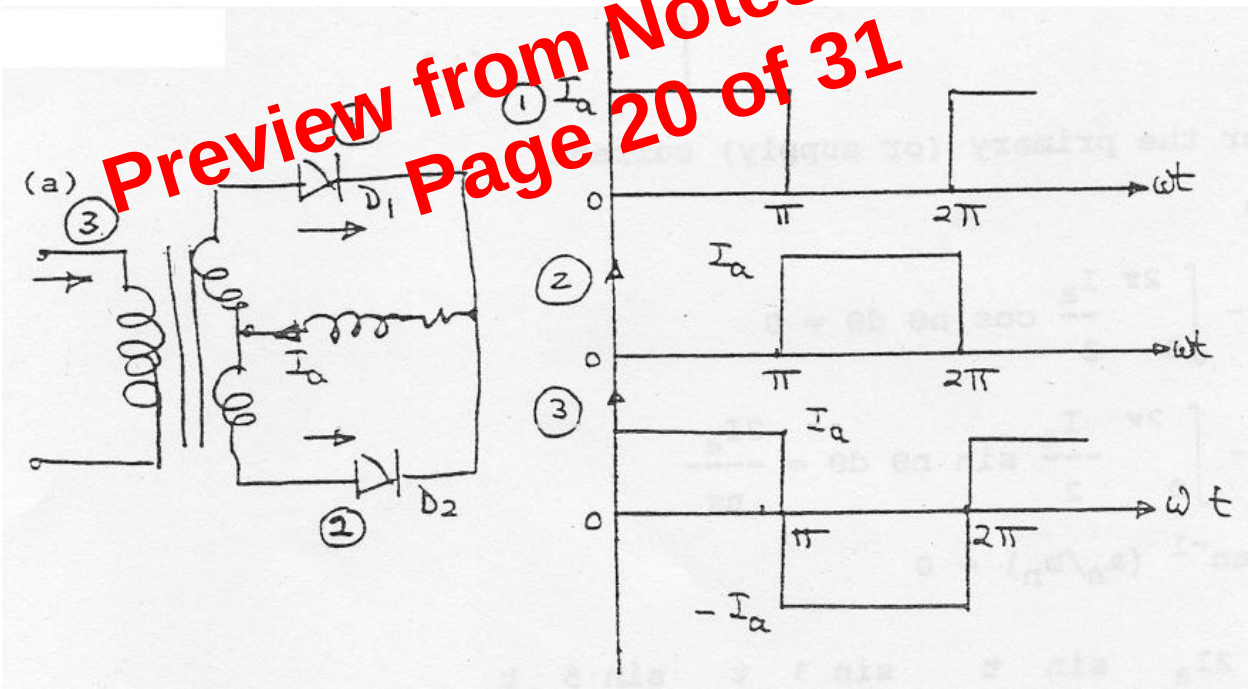
$C_n = \sqrt{(a_n^2 + b_n^2)}$ and $I_1 = C_1/\sqrt{2} = \sqrt{2}I_a/\pi$

and $I_s = I_a/\sqrt{2}$

PF = $I_1/I_s = 2/\pi = 0.6366$ and $HF = \sqrt{(I_s/I_1)^2 - 1} = 1.211$

Problem 3-24

(a)



(b) For the primary (or supply) current: From Eq. (3-23), the primary current is

$$b_n = \frac{2I_a}{\sqrt{3}\pi}\left[\int_{\pi/6}^{\pi/2}\sin(n\theta)\,d\theta + \int_{\pi/2}^{5\pi/6}2\sin(n\theta)\,d\theta + \int_{5\pi/6}^{7\pi/6}\sin(n\theta)\,d\theta\right]$$

$$= \frac{8I_a}{\sqrt{3}n\pi}\sin\frac{2n\pi}{3}\sin\frac{n\pi}{3}\cos\frac{n\pi}{6}$$

$$C_n = \frac{8I_a}{\sqrt{3}n\pi}\sin\frac{n\pi}{3}\cos\frac{n\pi}{6}$$

$\varphi_n = \tan^{-1}(a_n/b_n) = \tan^{-1}(\cot(2n\pi/3))$

$C_1 = 2\sqrt{3}I_a/\pi$ and $I_1 = C_1/\sqrt{2} = \sqrt{2}\,\sqrt{3}I_a/\pi$, $\varphi_1 = \tan^{-1}(-1/\sqrt{3}) = -\pi/6$

(c) For the primary (or secondary) phase current,

$a_o/2 = 0$

$$a_n = \frac{2I_a}{\pi}\int_{\pi/6}^{5\pi/6}\cos(n\theta)\,d\theta = \frac{4I_a}{n\pi}\sin\frac{n\pi}{3}\cos\frac{n\pi}{2}$$

$$b_n = \frac{2I_a}{\pi}\int_{\pi/6}^{5\pi/6}\sin(n\theta)\,d\theta = \frac{4I_a}{n\pi}\sin\frac{n\pi}{3}\sin\frac{n\pi}{2}$$

$C_n = \frac{4I_a}{n\pi}\sin\frac{n\pi}{3}$ and $\varphi_n = \tan^{-1}(a_n/b_n) = \tan^{-1}(\cot n\pi/2)$

$I_1 = C_1/\sqrt{2} = \sqrt{2}\,\sqrt{3}I_a/\pi$ and $I_s = I_a\sqrt{(2/3)}$

PF = $I_1/I_s = 3/\pi = 0.9549$ and $HF = \sqrt{(I_s/I_1)^2 - 1} = 0.3108$

Prob 3-31

$q := 12 \qquad V_{dc} := 240 \qquad I_T := 300 \qquad R := \frac{V_{dc}}{I_T} \qquad R = 0.8$

Using Eq. (3-25)

(a) $V_m := \frac{V_{dc}}{\frac{q}{\pi}\cdot\sin\left(\frac{\pi}{q}\right)} \qquad V_m = 242.764$

$V_{dc} := V_m\cdot\frac{q}{\pi}\cdot\sin\left(\frac{\pi}{q}\right) \qquad V_{dc} = 240$

$I_{dc} := \frac{V_{dc}}{R} \qquad I_{dc} = 300$

Using Eq. (3-26)

$V_{rms} := V_m\cdot\sqrt{\frac{q}{2\pi}\cdot\left(\frac{\pi}{q}+\frac{1}{2}\cdot\sin\left(\frac{2\cdot\pi}{q}\right)\right)} \qquad V_{rms} = 240.013$

$I_{rms} := \frac{V_{rms}}{R} \qquad I_{rms} = 300.016$

$P_{dc} := V_{dc}\cdot I_{dc} \qquad P_{ac} := V_{rms}\cdot I_{rms} \qquad P_{dc} = 7.2\times10^4 \qquad P_{ac} = 7.201\times10^4$

$\eta := \frac{P_{dc}}{P_{ac}}\cdot100 = 99.989$

(b) $FF := \frac{V_{rms}}{V_{dc}} \qquad FF\cdot100 = 100.005$

(c) $RF := \sqrt{FF^2 - 1} \qquad RF\cdot100 = 1.028$

(d) $V_s := \frac{V_m}{\sqrt{2}} \qquad V_s = 171.66$

Using Eq. (3-27)

$I_s := \frac{V_m}{R}\cdot\sqrt{\frac{1}{2\cdot\pi}\cdot\left(\frac{\pi}{q}+\frac{1}{2}\cdot\sin\left(\frac{2\cdot\pi}{q}\right)\right)} \qquad I_s = 86.607$

$VA := \frac{q}{2}V_s\cdot I_s \qquad VA = 8.92\times10^4$