4 3

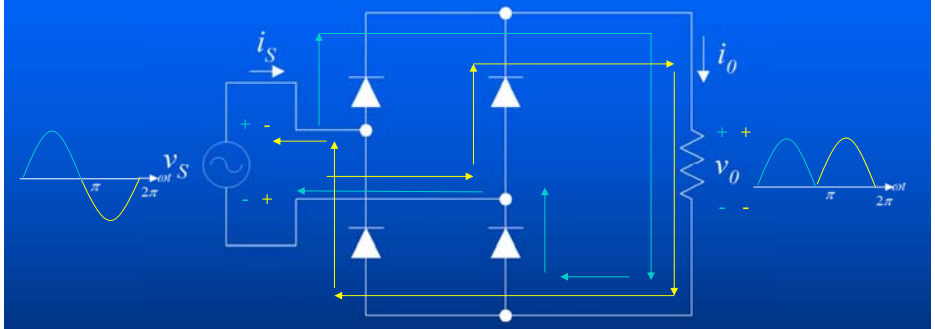
Full-wave Rectifier & 3-Phase Rectifier
AC → DC

4.1

- 0
- (Ripple)
-
- (Bridge Rectifier)
-

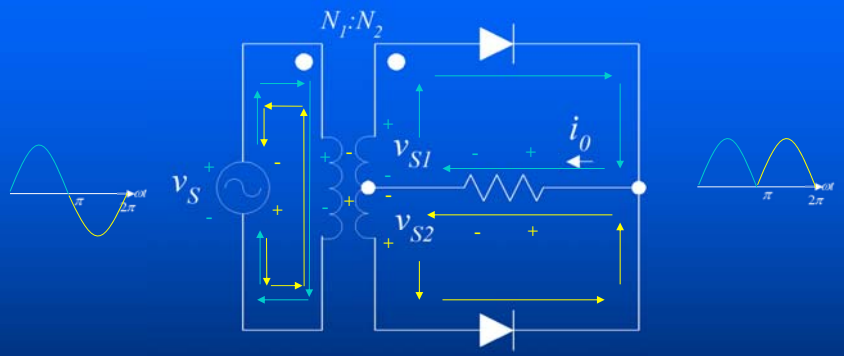
(Center-tapped transformer rectifier)

4.2 :



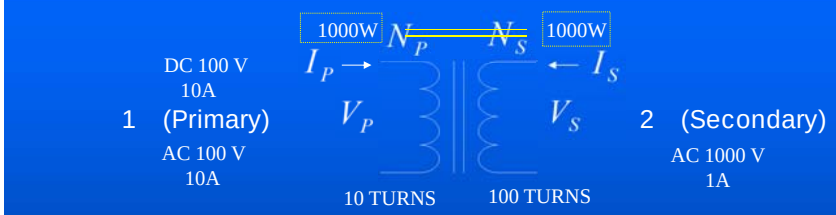
-

4.2 :



- 양방향으로 전류가 흐름

: ,

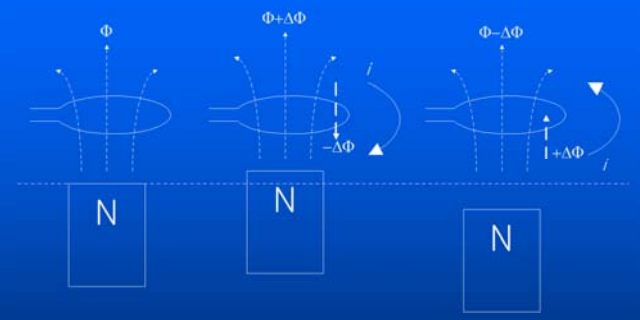


- ,

$$V_P = N_P \frac{d\phi}{dt},\ V_S = N_S \frac{d\phi}{dt},\ \therefore \frac{V_p}{V_S} = \frac{N_p \frac{d\phi}{dt}}{N_S \frac{d\phi}{dt}} = \frac{N_p}{N_S}$$

-

$$\frac{N_p}{N_s} = \frac{V_P}{V_S} = \frac{I_S}{I_P} = a \qquad \because V_P I_P = V_S I_S$$



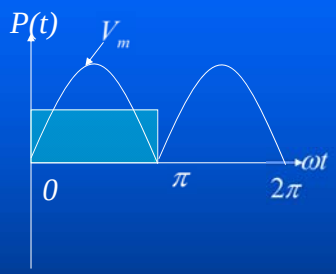
- Faraday's Law( )

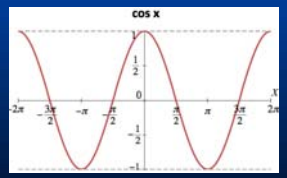
$$emf = -\frac{d\phi}{dt}$$

emf: electromotive force

Lentz's Law

4.2 : R





$$V_0 = \frac{1}{T}\int_{t0}^{t0+T} v(t)\,dt$$

$$V_0 = \frac{1}{\pi}\int_0^{\pi} V_m \sin\omega t\, d(\omega t)$$

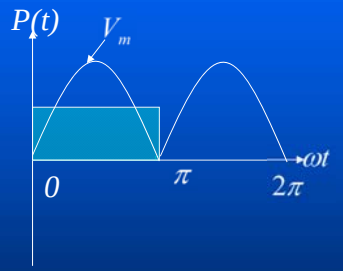
$$\int \sin dt = -\cos t$$

$$= \frac{V_m}{\pi}\left[-\cos\omega t\right]_0^{\pi}$$

$$= \frac{V_m}{\pi}\left(-\cos\pi + \cos 0\right)$$

$$= \frac{2V_m}{\pi}$$

4.2 : R



$$V_{rms} = \sqrt{\frac{1}{\pi}\int_0^{\pi} \left(V_m \sin\omega t\right)^2 d(\omega t)}$$

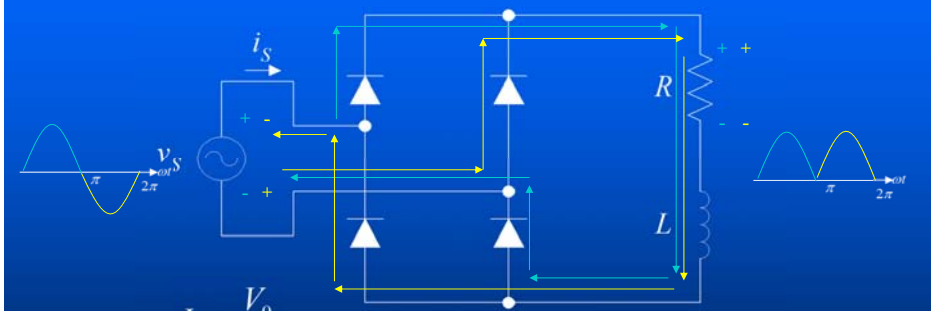
$$\left(\sin^2\omega t = \frac{1-\cos 2\omega t}{2}\right)$$

$$= \sqrt{\frac{V_m^{\,2}}{\pi}\left[\frac{\omega t}{2} - \frac{\sin 2\omega t}{4}\right]_0^{\pi}}$$

$$= \sqrt{\frac{V_m^{\,2}}{\pi}\left(\frac{\pi}{2} - \frac{\sin 2\pi}{4} - \frac{0}{2} + \frac{\sin 0}{4}\right)}$$

$$= \frac{V_m}{\sqrt{2}}$$

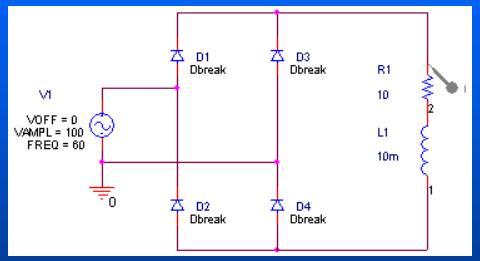
4.2 : R-L



$$I_0 = \frac{V_0}{R}$$

$$I_n = \frac{V_n}{Z_n} = \frac{V_n}{|R + jn\omega L|}$$

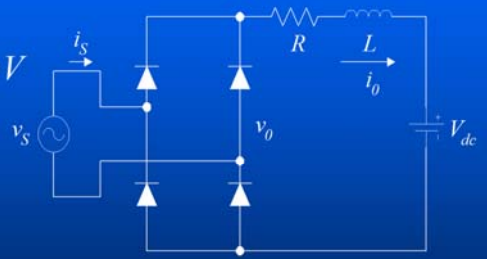
4-2 R-L



- *Parameter*
  - ✓ *R=10 Ω*
  - ✓ *L=10 mH*
  - ✓ *f=60 Hz*
  - ✓ *V_m=100 V*
  - ✓ *Transient Step =0 50 ms*
- *Find*
  - ✓ *I, I_{avg} ,I_{rms}*

4.2 :R-L

$V_m = 100\,V$



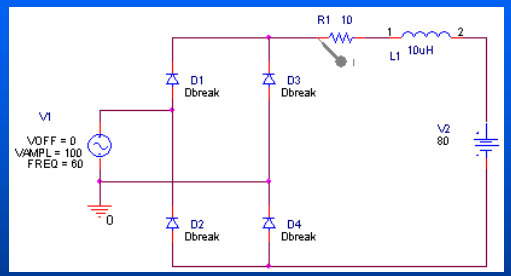
$$i = \frac{V_m - V_{dc}}{Z}$$

$$= \frac{100 - 0}{1} = 100\,A$$

$$i = \frac{100 - 50}{1} = 50\,A$$

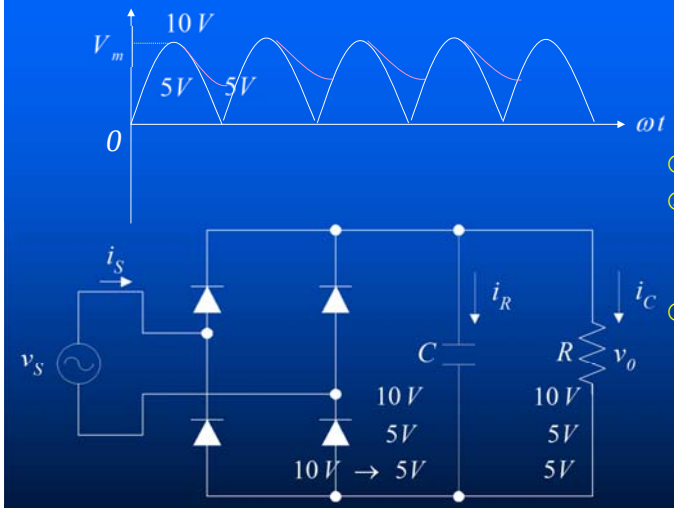
$$i = \frac{100 - 100}{1} = 0$$

4-3 R-L



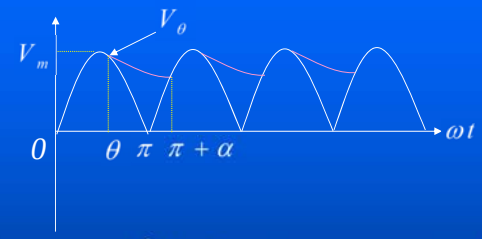
- *Parameter*
  - ✓ *R=2 Ω*
  - ✓ *L=10 mH*
  - ✓ *f=60 Hz*
  - ✓ *V_m=100 V*
  - ✓ *V_{dc}=80 V*
  - ✓ *Transient Step =0 50 ms*
- *Find*
  - ✓ *P, I_{avg} ,I_{rms}*

4.2 : R-C



① 병렬시 전압시 같음
② 10V 인가시 커패시터와 저항이 전압이 10V로 동일
③ 전압이 10V에서 5V로 될 때 커패시터의 전압이 10V에서 5V가 되어 방전된 전압이 출력을 직류에 가까도록함

4.2 : R-C



$$V_0(\omega t) = \begin{cases} V_m \sin \omega t & at\ diode\ on \\ (V_m \sin\theta) e^{-\frac{(\omega t-\theta)}{\omega RC}} & at\ diode\ off \end{cases}$$

* $V_\theta = V_m \sin\theta\ ,\quad \theta = \tan^{-1}(-R\cdot\omega C)$

4.2 : R-C

■ (Firing Angle)

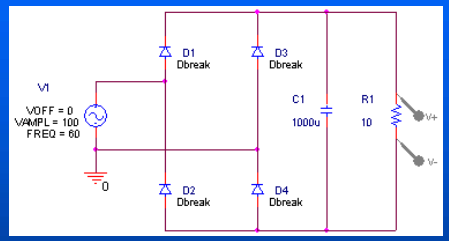
$for\ \ \omega t = \alpha$

$$V_m \sin(\pi+\alpha) = (V_m \sin\theta) e^{-\frac{(\pi+\alpha-\theta)}{\omega RC}}$$

■ α

- (Numerical Analysis)
-
- Pspice :

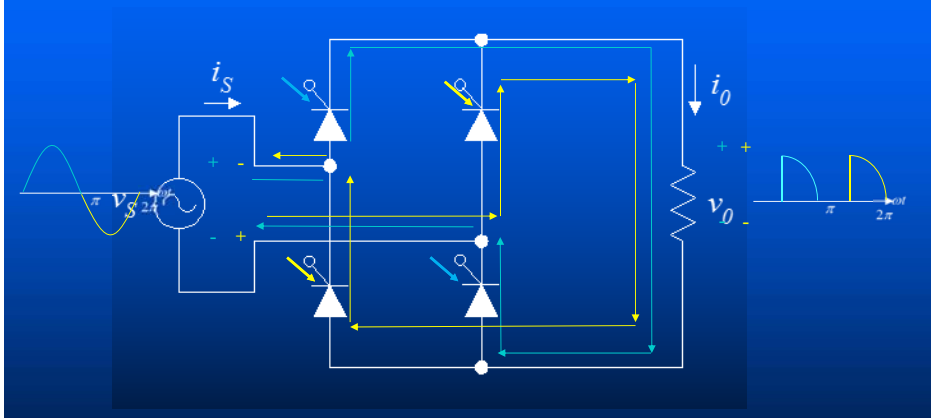
4-5 L-C



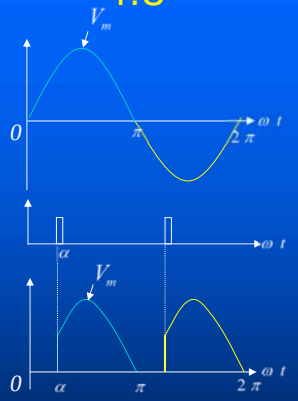
■ *Parameter*
- ✓ *R=10 Ω*
- ✓ *L=5 mH*
- ✓ *C=1000 μF*
- ✓ *f=60 Hz*
- ✓ *V_m=100 V*
- ✓ *Transient Step =0 50 ms*

■ *Find*
- ✓ *V*

4.3



4.3 :



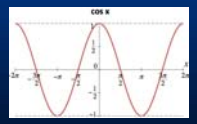
$$V_0 = \frac{1}{T}\int_{t0}^{t0+T} v(t)\,dt$$

$$V_0 = \frac{1}{\pi}\int_{\alpha}^{\pi} V_m \sin\omega t\, d(\omega t)$$

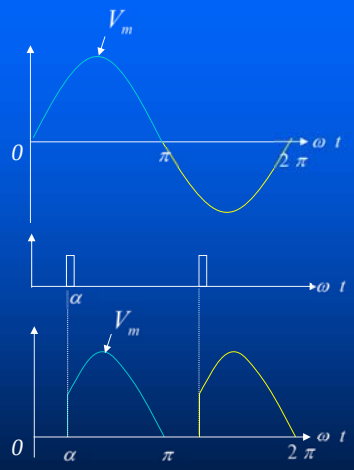
$$\int \sin dt = -\cos t$$

$$= \frac{V_m}{\pi}\left[-\cos\omega t\right]_{\alpha}^{\pi}$$

$$= \frac{V_m}{\pi}\left(1+\cos\alpha\right)$$



4.3 :



$$V_{rms} = \sqrt{\frac{1}{\pi}\int_{\alpha}^{\pi}\left(V_m \sin\omega t\right)^2 d(\omega t)}$$

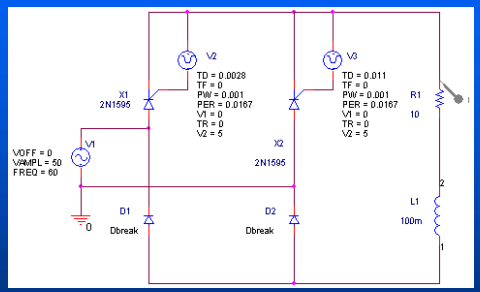
$$\left(\sin^2\omega t = \frac{1-\cos 2\omega t}{2}\right)$$

$$= \sqrt{\frac{V_m^2}{\pi}\left[\frac{\omega t}{2} - \frac{\sin 2\omega t}{4}\right]_{\alpha}^{\pi}}$$

$$= \sqrt{\frac{V_m^2}{\pi}\left(\frac{\pi}{2} - \frac{\sin 2\pi}{4} - \frac{\alpha}{2} + \frac{\sin 2\alpha}{4}\right)}$$

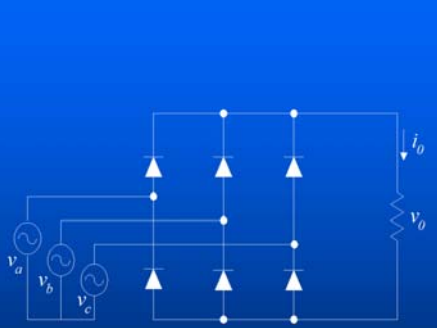
$$= V_m\sqrt{\left(\frac{1}{2} - \frac{\alpha}{2\pi} + \frac{\sin(2\alpha)}{4\pi}\right)}$$

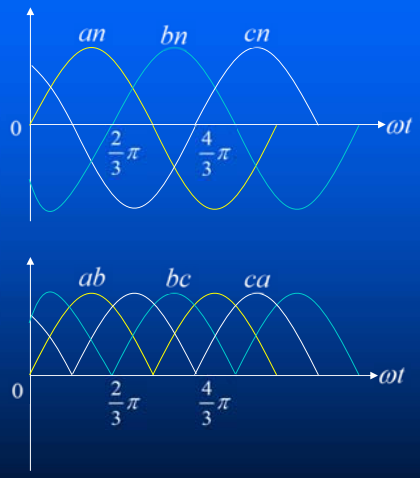
4 - 9



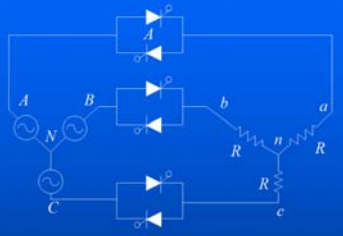
- *Parameter*
  - ✓ *R=10 Ω*
  - ✓ *L=100 mH*
  - ✓ *f=60 Hz*
  - ✓ *α=60*
    - *TD1:0.0028(1/360)*
    - *TD2:0.011(4/360)*
  - ✓ *V_m=169.7 V→50V*
  - ✓ *Transient Step =0 50 ms*
- *Find: i, i_{avg} , P*

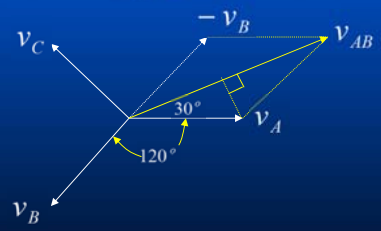
4.4 3





4.4 3 :





$$v_A = \sqrt{2}V \sin \omega t$$

$$v_B = \sqrt{2}V \sin\left(\omega t - \frac{2\pi}{3}\right)$$

$$v_C = \sqrt{2}V \sin\left(\omega t - \frac{4\pi}{3}\right)$$

$$v_{AB} = 2v_A \cos(30^o)\angle 30^o$$

$$= 2v_A \frac{\sqrt{3}}{2}\angle 30^o$$

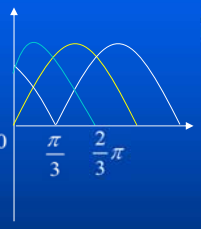
$$= \sqrt{3}v_A \angle 30^o$$

3

결선	선간전류	선전류	전력
Y	$\sqrt{3}$ × 상전압	상전류	$\sqrt{3}$ × 상전압 × 상전류
Δ	상전압	$\sqrt{3}$ × 상전류	$\sqrt{3}$ × 상전압 × 상전류

4.4 3 : Fourier

$$V_0(t) = V_0 + \sum_{n=6,12,18}^{\infty} V_n \cos(n\omega_0 t + \pi)$$



$$V_0 = \frac{1}{\pi/3}\int_{\frac{\pi}{3}}^{\frac{2\pi}{3}} V_{m,L-L}\sin\omega t d(\omega t) = \frac{V_{m,L-L}}{\pi/3}\left[-\cos\omega t\right]_{\frac{\pi}{3}}^{\frac{2\pi}{3}}$$

$$= \frac{V_{m,L-L}}{\pi/3}\left\{-\cos\frac{2\pi}{3} + \cos\frac{\pi}{3}\right\} = \frac{V_{m,L-L}}{\pi/3}\left\{-\left(-\frac{1}{2}\right) + \frac{1}{2}\right\}$$

$$= \frac{3V_{m,L-L}}{\pi} = 0.95V_{m,L-L}$$

$$V_n = \frac{V_l}{\pi(n^2-1)}, \quad n = 6,12,18$$

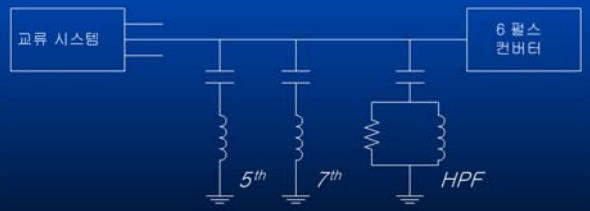
4.4 3 :

-

$$i_a(t) = \frac{2\sqrt{3}}{\pi} I_0 \left(\cos \omega_0 t - \frac{1}{5}\cos 5\omega_0 t + \frac{1}{7}\cos 7\omega_0 t - ....\right)$$

-

- Filter



4-12 3 (1)

(a)

$$V_0 = \frac{3V_{m,L-L}}{\pi} = \frac{3\sqrt{2}(480)}{\pi} = 648V$$

(b)

$$I_0 = \frac{V_0}{R} = \frac{648}{25} = 25.9\,A$$

(c)

$$I_{D,avg} = \frac{I_0}{3} = \frac{25.9}{3} = 8.63\,A$$

$$I_{D,rms} = \frac{I_{0,rms}}{\sqrt{3}} \approx \frac{25.9}{\sqrt{3}} = 15.0\,A$$

4-12 3 (2)

(d)

$$I_{s,avg} = \sqrt{\frac{2}{3}} I_{0,rms}$$

$$\approx \sqrt{\frac{2}{3}}(25.9) = 21.2\,A$$

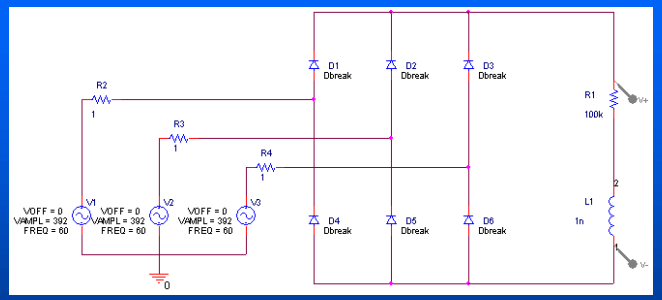
(e)

$$S = \sqrt{3} V_{L-L,rms} I_{0,rms}$$

$$= \sqrt{3}(480)(21.2)$$

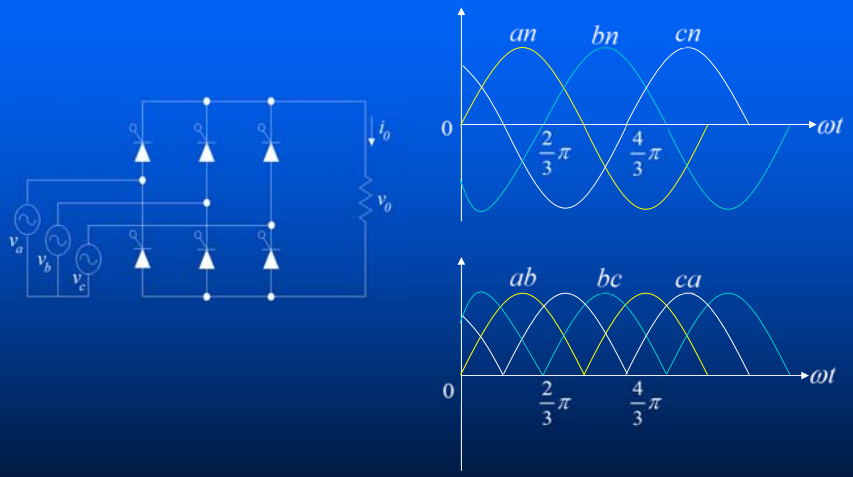
$$= 17.6\,KVA$$

4-12 3 : Pspice Simulation



- *Parameter*
  - ✓ *R=100 kΩ L=50 mH f=60 Hz*
  - ✓ $V_m = \frac{\sqrt{2}(480)}{\sqrt{3}} = 392$ *Step=0:0.1 ms:50 ms*
- *Find : V_0, I_{avg}, I_{rms}*

4.5 3



4.5.2 3 :

$$V_0 = \frac{1}{\pi/3}\int_{\frac{\pi}{3}+\alpha}^{\frac{2\pi}{3}+\alpha} V_{m,L-L}\sin\omega t\, d(\omega t)$$

$$= \frac{V_{m,L-L}}{\pi/3}\left[-\cos\omega t\right]_{\frac{\pi}{3}+\alpha}^{\frac{2\pi}{3}+\alpha}$$

$$= \frac{V_{m,L-L}}{\pi/3}\left\{-\cos\left(\frac{2\pi}{3}+\alpha\right)+\cos\left(\frac{\pi}{3}+\alpha\right)\right\} \qquad \cos\frac{2\pi}{3} = -\cos\frac{\pi}{3}$$

$$= \frac{V_{m,L-L}}{\pi/3}\left\{\cos\left(\frac{\pi}{3}-\alpha\right)+\cos\left(\frac{\pi}{3}+\alpha\right)\right\} \qquad \begin{aligned}\cos(x+y) &= \cos x\cos y - \sin x\sin y\\ \cos(x-y) &= \cos x\cos y + \sin x\sin y\end{aligned}$$

$$= \frac{V_{m,L-L}}{\pi/3}\left\{\cos\frac{\pi}{3}\cos\alpha+\sin\frac{\pi}{3}\sin\alpha+\cos\frac{\pi}{3}\cos\alpha-\sin\frac{\pi}{3}\sin\alpha\right\}$$

$$= \frac{3V_{m,L-L}}{\pi}2\cos\frac{\pi}{3}\cos\alpha = \frac{3V_{m,L-L}}{\pi}\cos\alpha$$

4.5.2 3 (2)

-

$$V_0 = \frac{1}{\pi/3}\int_{\frac{\pi}{3}+\alpha}^{\frac{2\pi}{3}+\alpha} V_l\sin\omega t\, d(\omega t) = \frac{3V_l}{\pi}\cos\alpha$$

- 12 Pulse

$$V_0 = V_{0Y} + V_{0\Delta} = \frac{6V_l}{\pi}\cos\alpha$$

- 12 Pulse

$$i_{ac}(t) = i_Y(t) + i_\Delta(t) = \frac{4\sqrt{3}}{\pi}\left(\cos\omega_0 t - \frac{1}{11}\cos 11\omega_0 t + \ldots.\right)$$

4.6