

Problem 8-8

3-phase inverter, PWM,  $m_f = 39$ ,  $m_a = 0.8$ ,  $V_{LL1} = 200V$ , 52 Hz,  $L = 100$  mH,

From Eq. 8-57,

$$V_d = \frac{V_{LL1}}{0.612 m_a} \approx \frac{200}{0.612 \cdot 0.8} = 408V$$

Find peak ripple current.

As shown in Fig. 8-26b, the peak ripple current occurs near the zero-crossing points of  $v_{An1}$ . Since  $m_f$  is large,  $v_{control,A}$ ,  $v_{control,B}$  and  $v_{control,C}$  can be assumed to be constant during one switching frequency time period. At the zero-crossing of  $v_{control,A}$  therefore,

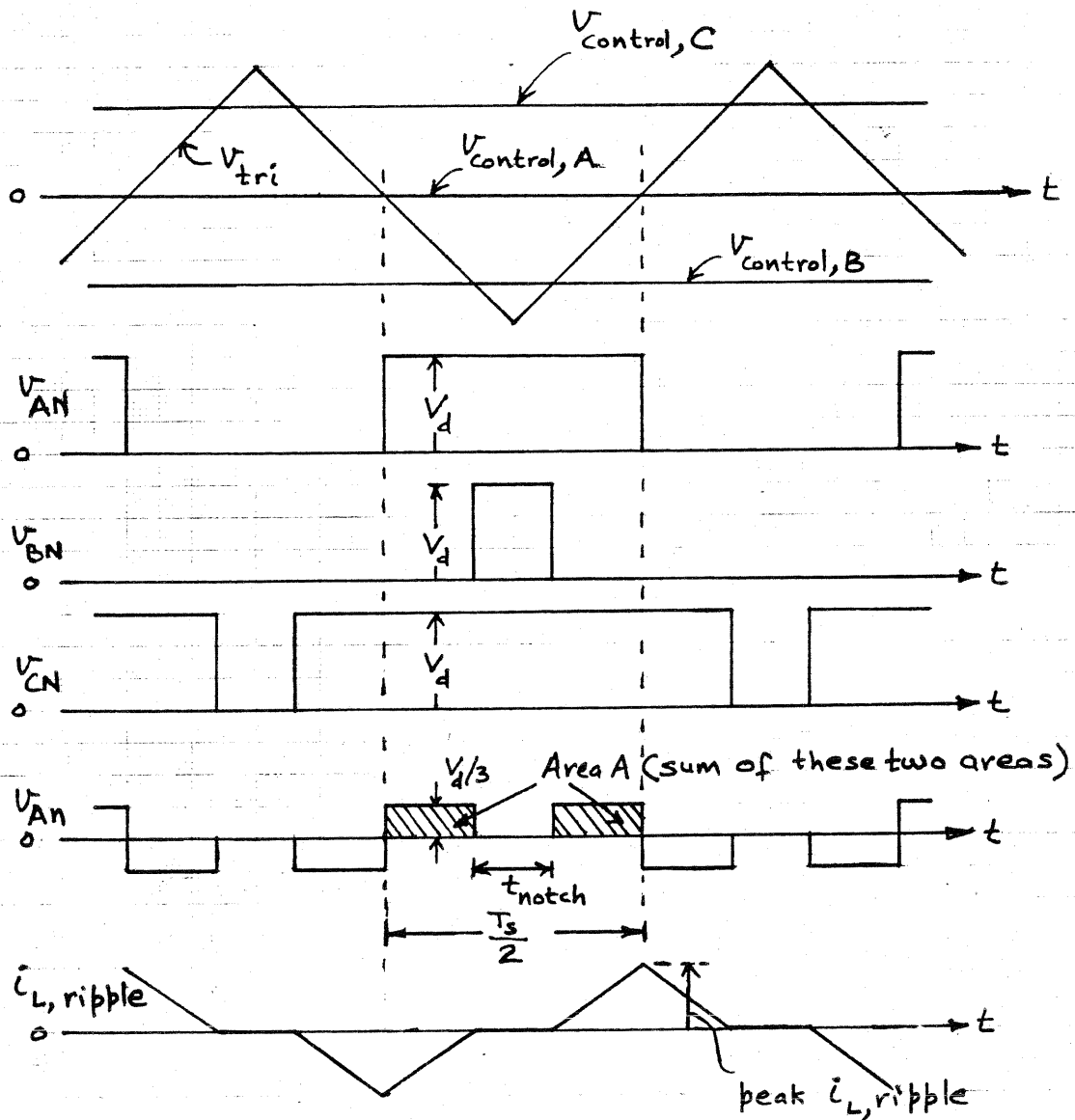
$$v_{\text{control},A} = 0$$

$$v_{\text{control},B} = 0.8 \hat{V}_{\text{tri}} \sin(0-120^\circ) = -0.693 \hat{V}_{\text{tri}}$$

and,  $v_{\text{control},C} = 0.8 \hat{V}_{\text{tri}} \sin(0-240^\circ) = 0.693 \hat{V}_{\text{tri}}$

The voltage waveforms for these control voltages are shown in the figure below.  $v_{An}$  is obtained from Eq. 8-71

$$v_{An} = \frac{2}{3} v_{AN} - \frac{1}{3} (v_{BN} + v_{CN})$$



During one switching-frequency time period near the zero-crossing of  $v_{\text{control},A}$ , the fundamental frequency component  $v_{An1}$  and the back-emf  $e_A$  of the load in Fig. 8-25a can be assumed to be zero. Therefore,  $v_{An}$  appears as the ripple voltage across  $L$  during this interval.

Using the concept given by Eq. 8-42,

$$\text{peak-to-peak } i_{L,\text{ripple}} = \frac{1}{L} \int_0^{T_s/2} v_{an} \cdot dt = \frac{\text{Area } A}{L}$$

In the  $v_{An}$  waveform shown above,

$$t_{\text{notch}} = \frac{T_s}{2} \left( 1 - \frac{|v_{\text{control},B}|}{\hat{V}_{\text{tri}}} \right) = \frac{T_s}{2} (1 - 0.693) = \frac{T_s}{2} \cdot 0.307$$

$$\therefore \text{Area } A = \frac{V_d}{3} \frac{T_s}{2} (1 - 0.307) = \frac{V_d}{6f_s} \cdot 0.693$$

$$\begin{aligned} \therefore \text{peak-to-peak } i_{L,\text{ripple}} &= \frac{\text{Area } A}{L} = 0.693 \frac{V_d}{6Lf_s} = \frac{0.693 \cdot 408}{6 \cdot 0.1 \cdot 39 \cdot 52} \\ &= 0.232 \text{ A} \end{aligned}$$

$$\therefore \text{peak } i_{L,\text{ripple}} = \frac{0.232}{2} = 0.116 \text{ A}$$