Demonstration 8

Equations used from previous lectures

Fourier analysis

$$g(\theta) = f(t),\ \theta = \omega t$$

$$g(\theta) = \frac{a_0}{2} + \sum_{n=1}^{\infty}\left[a_n \cos(n\theta) + b_n \sin(n\theta)\right]$$

$$a_n = \frac{1}{\pi}\int_{\theta_0}^{\theta_0+2\pi} g(\theta)\cos(n\theta)d\theta \quad n = 0,1,2,3,...$$

$$b_n = \frac{1}{\pi}\int_{\theta_0}^{\theta_0+2\pi} g(\theta)\sin(n\theta)d\theta \quad n = 1,2,3,...$$

Table 3-1 Use of Symmetry in Fourier Analysis

Symmetry	*Condition Required*	a_h and b_h
Even	$f(-t) = f(t)$	$b_h = 0 \quad a_h = \frac{2}{\pi}\int_0^{\pi} f(t)\cos(h\omega t)\, d(\omega t)$
Odd	$f(-t) = -f(t)$	$a_h = 0 \quad b_h = \frac{2}{\pi}\int_0^{\pi} f(t)\sin(h\omega t)\, d(\omega t)$
Half-wave	$f(t) = -f(t + \frac{1}{2}T)$	$a_h = b_h = 0$ for even h $a_h = \frac{2}{\pi}\int_0^{\pi} f(t)\cos(h\omega t)\, d(\omega t)$ for odd h $b_h = \frac{2}{\pi}\int_0^{\pi} f(t)\sin(h\omega t)\, d(\omega t)$ for odd h
Even quarter-wave	Even and half-wave	$b_h = 0$ for all h $a_h = \begin{cases} \frac{4}{\pi}\int_0^{\pi/2} f(t)\cos(h\omega t)\, d(\omega t) & \text{for odd } h \\ 0 & \text{for even } h \end{cases}$
Odd quarter-wave	Odd and half-wave	$a_h = 0$ for all h $b_h = \begin{cases} \frac{4}{\pi}\int_0^{\pi/2} f(t)\sin(h\omega t)\, d(\omega t) & \text{for odd } h \\ 0 & \text{for even } h \end{cases}$

Current ripple in a three-phase inverter when the load is a three-phase ac motor and the back-emf has the same amplitude and phase as the output fundamental voltage.

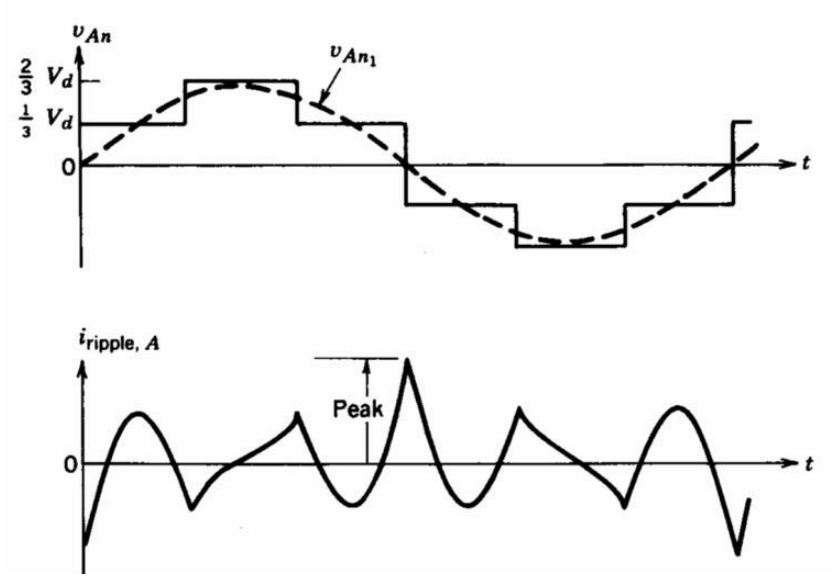


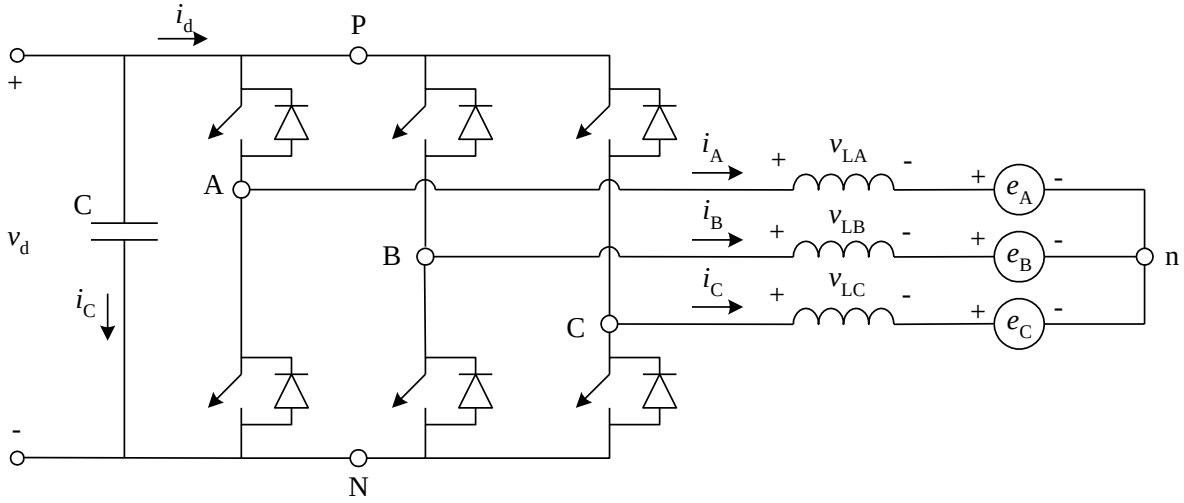
Fig.8.26a in Undeland book

Literature: Undeland book Chapter 8

Tutorial exercises

Problem 1 (P8-7 in Undeland book)

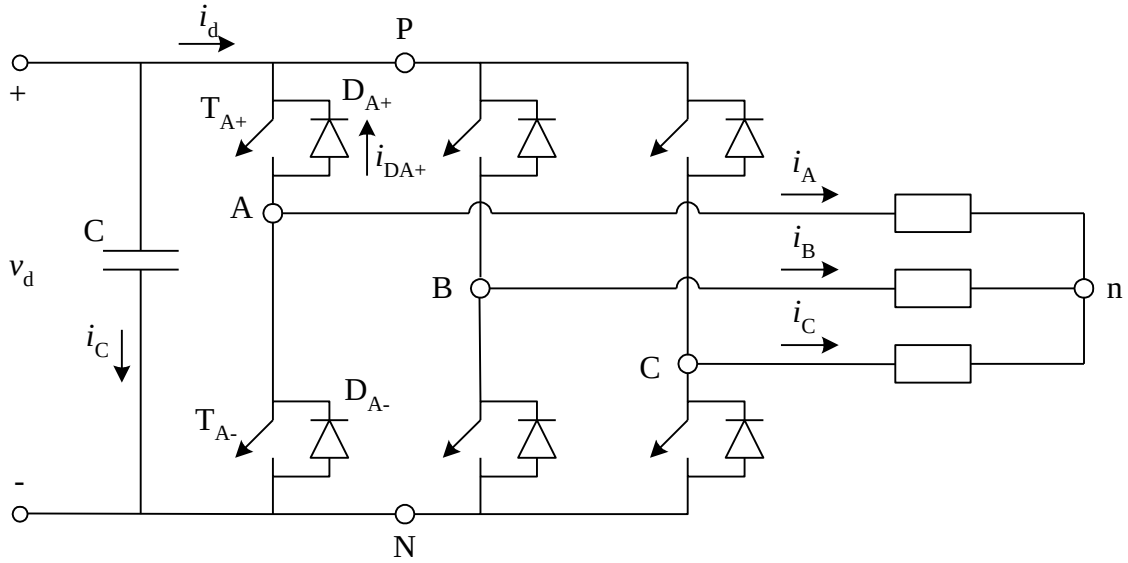
Consider the problem of ripple in the output current of a three-phase square-wave inverter. $V_{LL(1)} = 200V$ at a frequency of 52Hz and the load is a three-phase ac motor with $L = 100mH$. Assume the back-emf has the same amplitude and phase as the output fundamental voltage.



Calculate the peak ripple current.

Problem 2 (P8-10 in Undeland book)

In the three-phase, square-wave inverter (see Fig 8-24a in Undeland), consider the load to be balanced and purely resistive with a load-neutral point *n*.



Draw the steady state waveforms for v_{An}, i_A, i_{DA+} and i_d, where i_{DA+} is the current through diode D_{A+}.

Self-study exercises

From Undeland book:
P8-8, P8-11