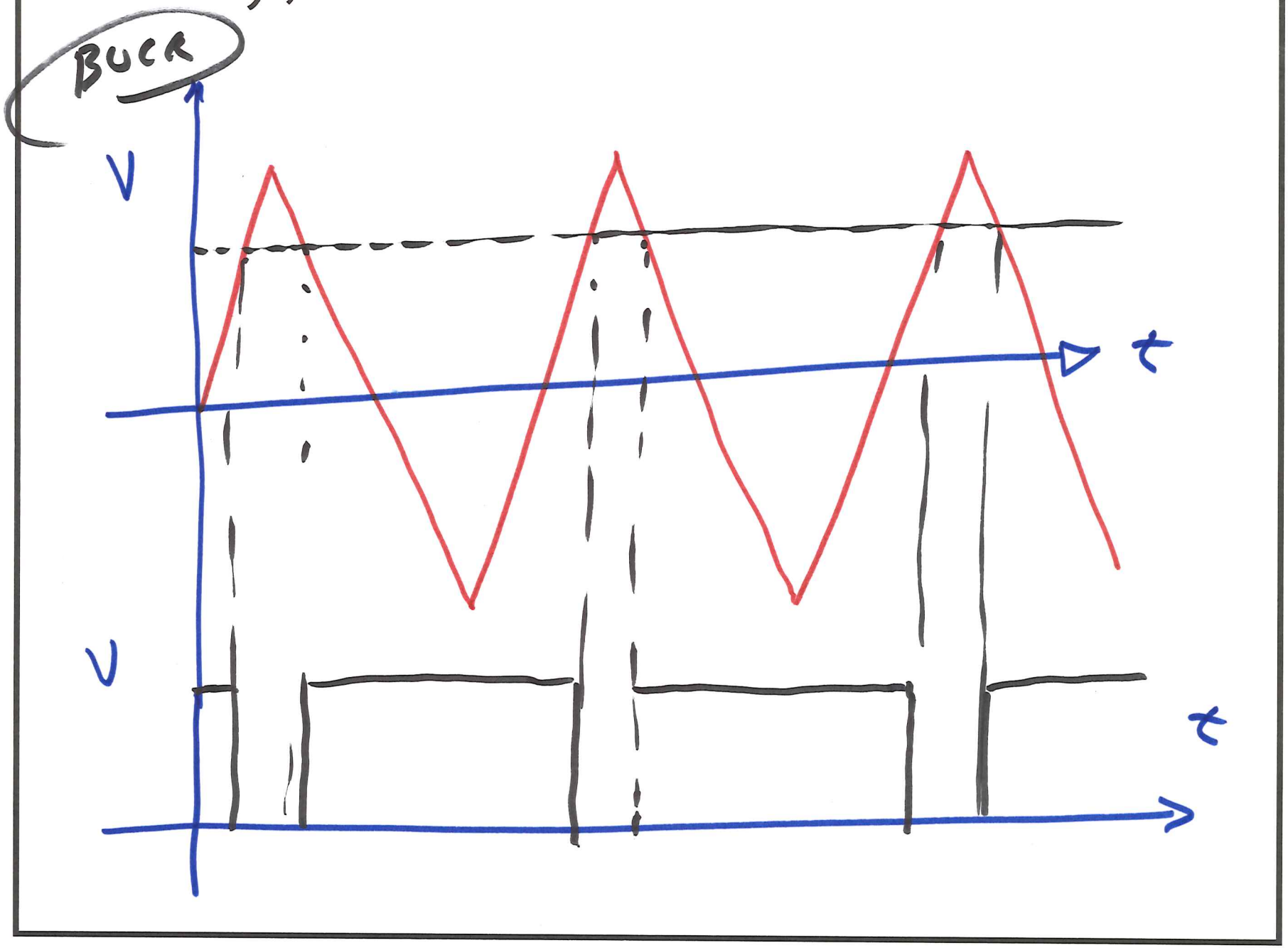
ECE 404-TD / 504-TD

ST: T&D APPLICATIONS OF VOLTAGE SOURCE CONVERTERS

SESSION no. 12


BUCK
V
t
V
t

EULER NOTATION

$$v_{an}(t) = 1.0 \cos(\omega t + 0^\circ)\ V$$

$$v_{an}(t) = \mathrm{Re}\left(1.0\, e^{j0^\circ} e^{j\omega t}\right) V$$

$$v_{bn}(t) = \ldots$$

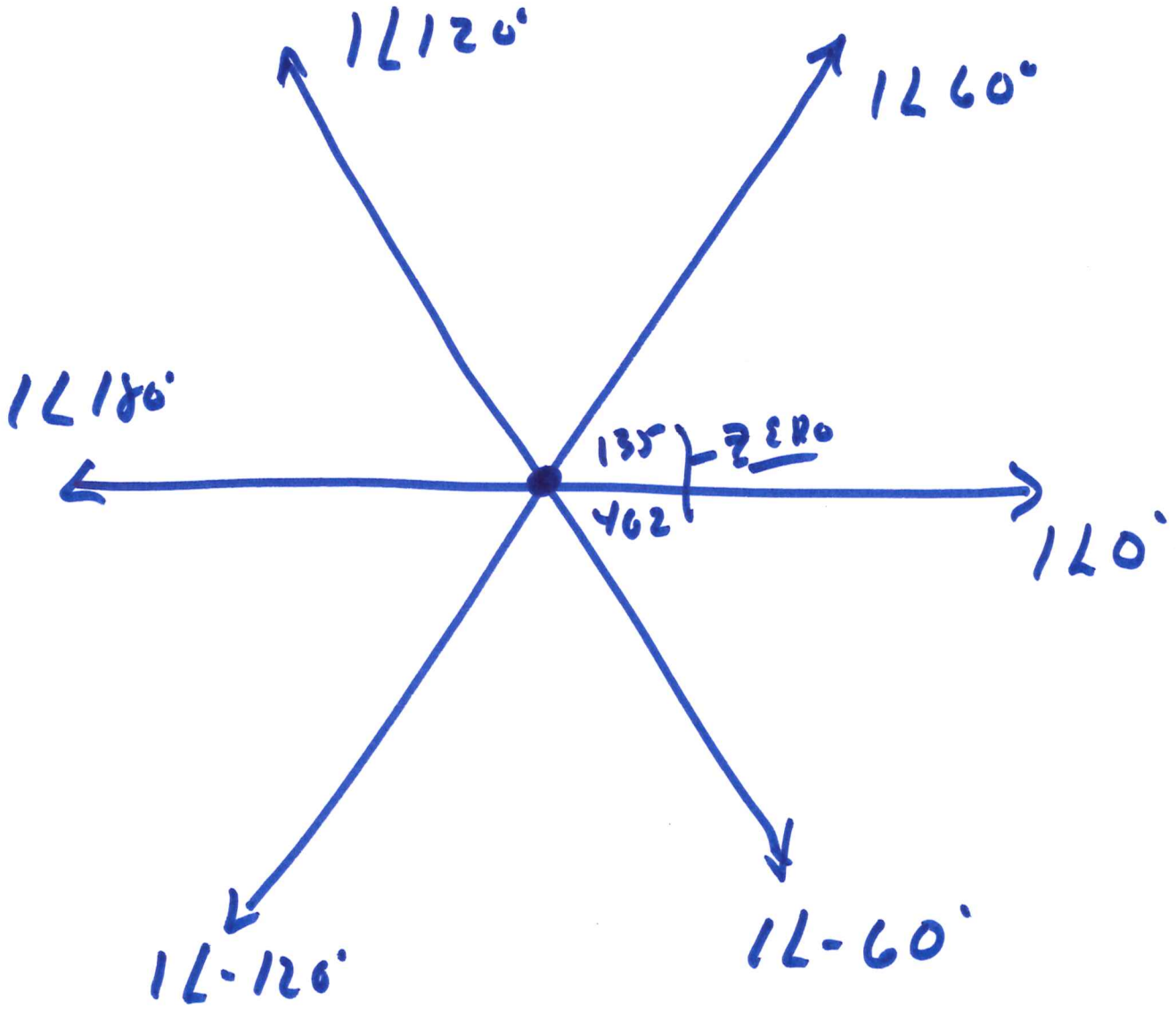
$$v_{cn}(t) = \ldots$$

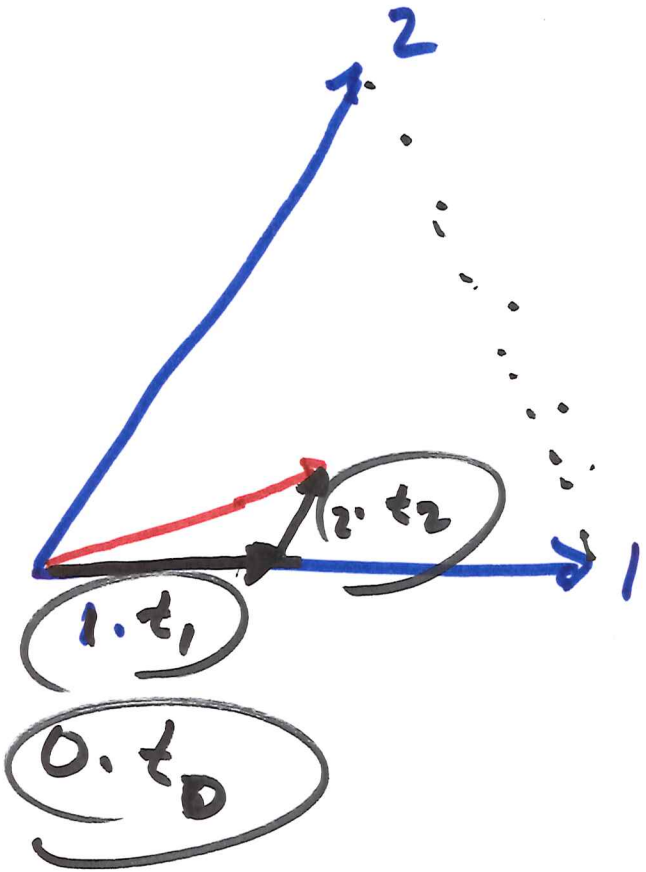
$$v_s(t) = \frac{2}{3}\left[v_a(t)\,e^{j0} + v_b(t)\,e^{-j\frac{2\pi}{3}} + v_c(t)\,e^{+j\frac{2\pi}{3}}\right] \quad (4)$$

SWITCHES ... GIVES US - 8 CASES

ON	A	B	C	v_s
612	1	$-\frac{1}{2}$	$-\frac{1}{2}$	$\frac{2}{3}$ $1.5\angle 0°$
123	$\frac{1}{2}$	$\frac{1}{2}$	-1	$\frac{2}{3}$ $1.5\angle 60°$
234	$-\frac{1}{2}$	1	$-\frac{1}{2}$	$\frac{2}{3}$ $1.5\angle 120°$
345	-1	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{2}{3}$ $1.5\angle 180°$
456	$-\frac{1}{2}$	$-\frac{1}{2}$	1	$\frac{2}{3}$ $1.5\angle -120°$
561	$\frac{1}{2}$	-1	$\frac{1}{2}$	$\frac{2}{3}$ $1.5\angle -60°$

UNITS ARE VOLTS


1∠120°
1∠60°
1∠180°
135
462
ZERO
1∠0°
1∠-120°
1∠-60°



$$T_s = t_1 + t_2 + t_0$$

ECE 404 / 504

T & D Applications of Voltage Sourced Converters

Lesson 12

Pulse Width Modulation

To get rid of some of the more troublesome harmonics—the lower order harmonics that tend to be large and to cause

undesirable harmonic torque in abundance.

We encrypt information about the waveform that we want. The information is in the pulse width. We are restricted to switches that are full ON or full OFF...hence, pulse width modulation is a practical way to do our switching.

Our textbook addresses two methods of pulse width modulation:

1. Sine triangle modulation
2. Space vector modulation

Sine-triangle is really not much different that our buck converter switching.

The advantage is even greater than we see in the FFT results. This is the voltage. The induction machine is a fifth order low filter from voltage to current.

☺ Faster switching frequency filters the current

☹ Faster switching frequency increases the losses.

440 Hz = A

256 Hz=Middle C

512 Hz=C one octave above Middle C

1KHz...~B two octaves above Middle C

Above 20 kHz, people cannot hear it. Sorry about that, mice, dogs, and roaches.

Space vector modulation

We gain the ability to calculate the voltage at each switching instant.

☹ Requires some capable calculation capacity.