EE-464 STATIC POWER CONVERSION-II

Review of the Previous Semester

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What we did last semester?

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- Line Commutated Rectifiers

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  - Diode Rectifiers

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Fundamental Definitions

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- THD (Total Harmonic Distortion)

Line Frequency Diode Rectifiers

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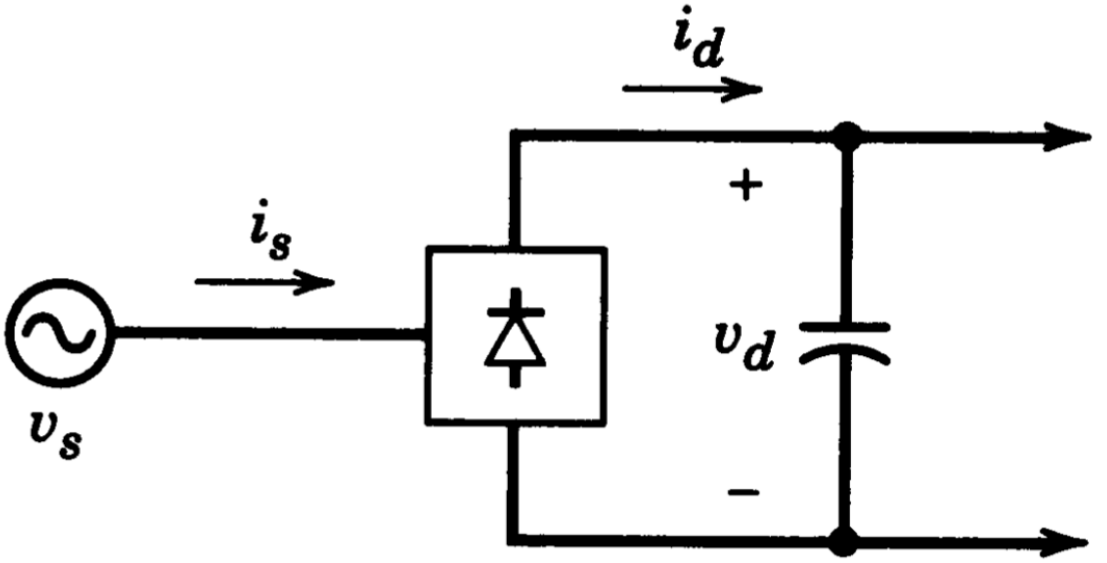
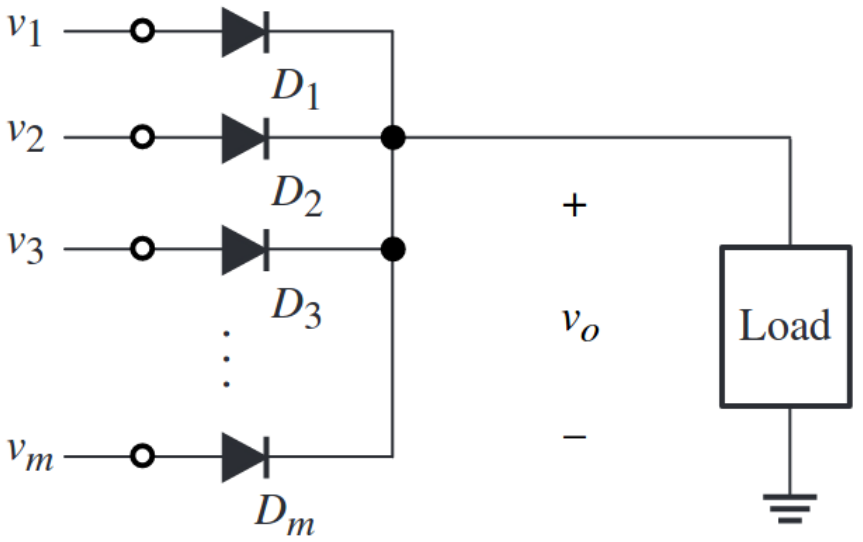


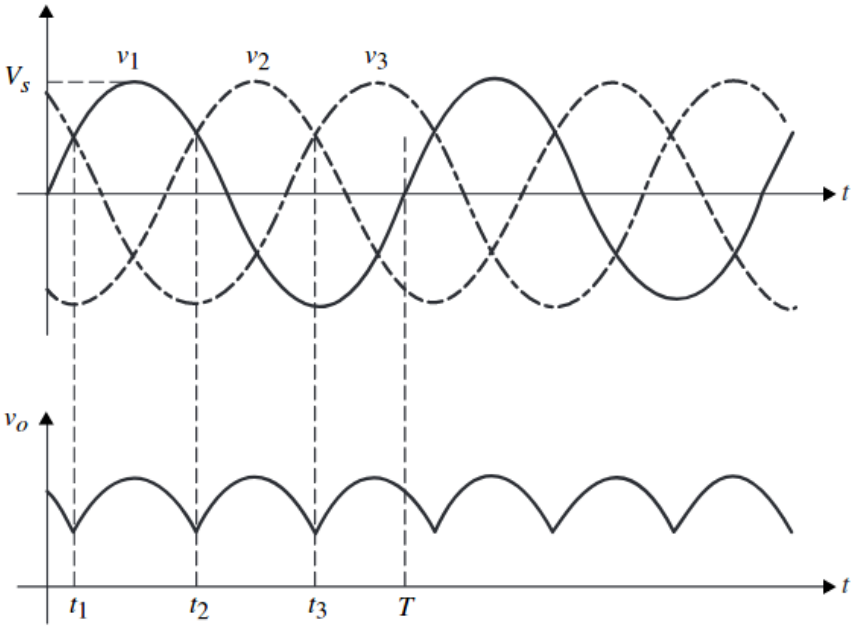
3-Phase Half Wave Rectifier

N-Phase Generalized Form



3-Phase Half Wave Rectifier

Voltage Waveforms



3-Phase Half Wave Rectifier

Average Voltage?

3-Phase Half Wave Rectifier

Average Voltage?

$$V_{dc} = \frac{3\sqrt{6}}{2\pi} V_{rms}$$

3-Phase Full Wave (Bridge) Rectifier

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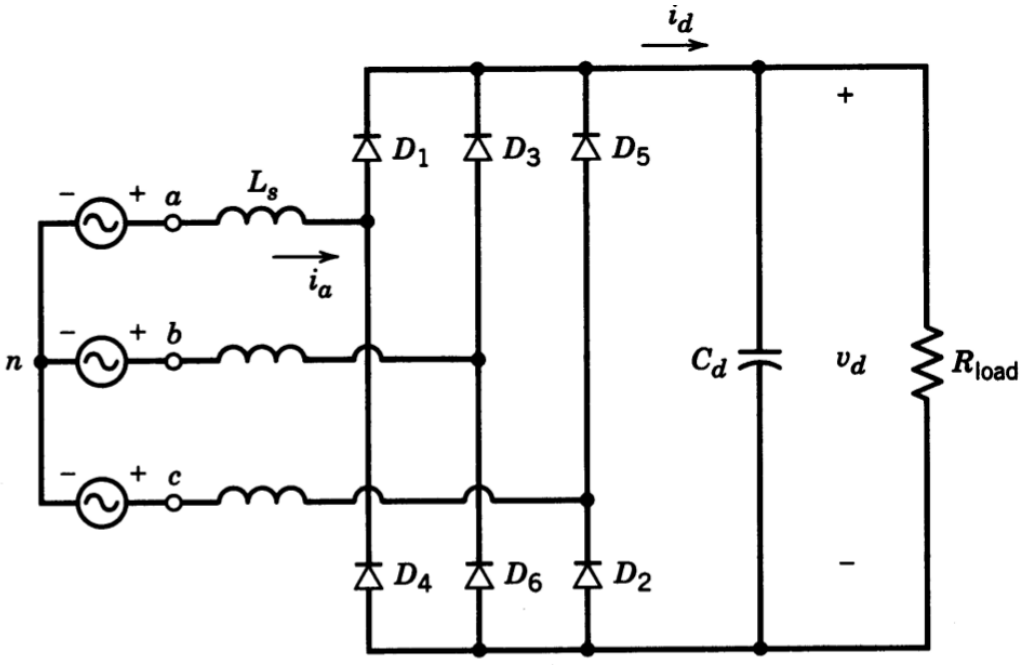

3-Phase Full Wave (Bridge) Rectifier

Can you draw the voltage and current waveforms?

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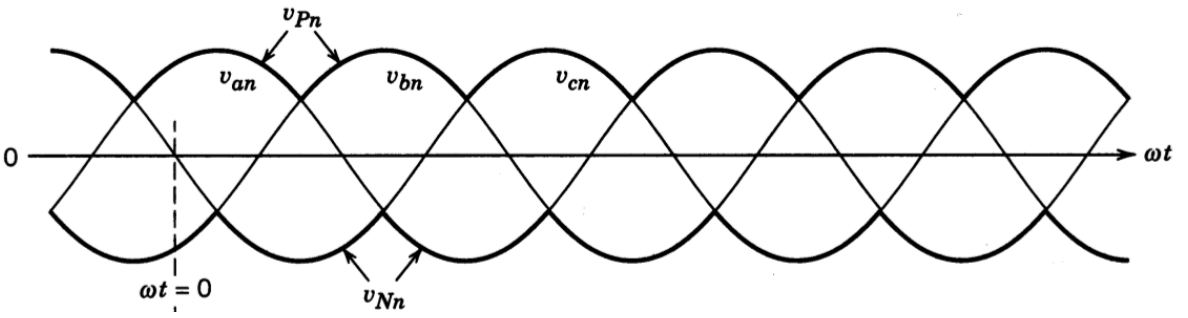

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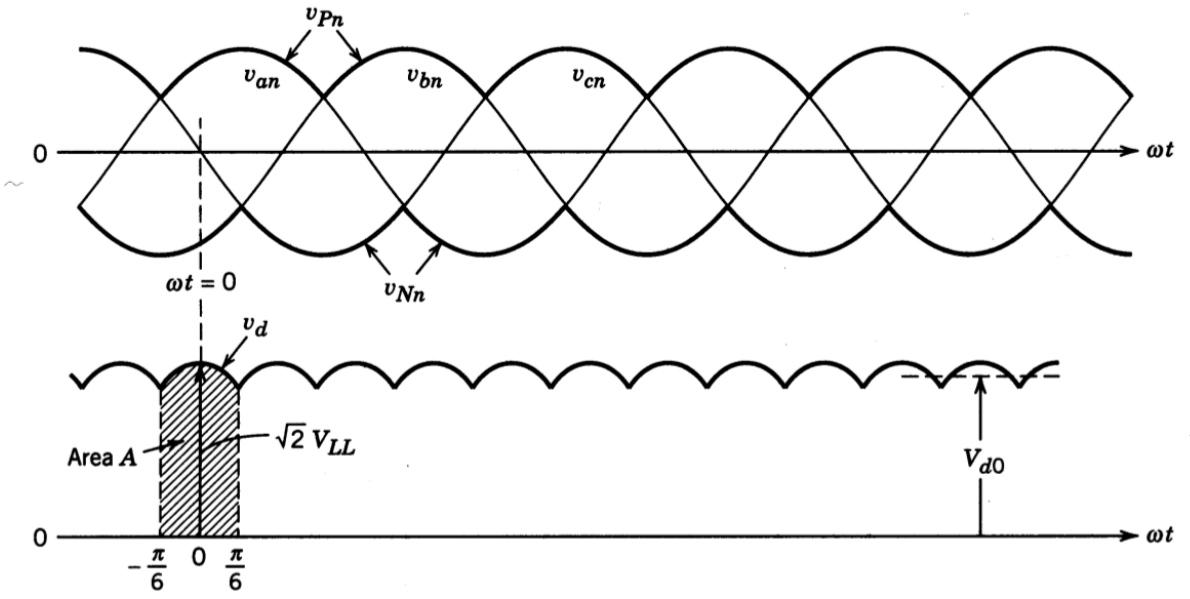


3-Phase Full Wave (Bridge) Rectifier

Average voltage?

3-Phase Full Wave (Bridge) Rectifier

Average voltage?

$$V_{dc} = \frac{3\sqrt{6}}{\pi} V_{ph}$$

or

3-Phase Full Wave (Bridge) Rectifier

Average voltage?

$$V_{dc} = \frac{3\sqrt{6}}{\pi} V_{ph}$$

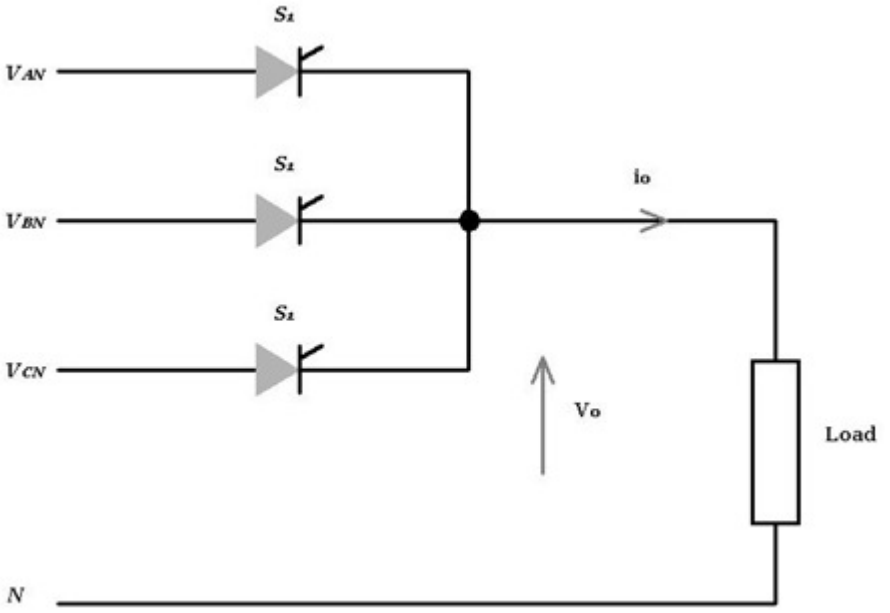
or

$$V_{dc} = \frac{3\sqrt{2}}{\pi} V_{l-l} = 1.35 V_{l-l}$$

=540 Vdc for a 400 V grid

Half-bridge Tyristor Rectifier

Half-bridge Tyristor Rectifier



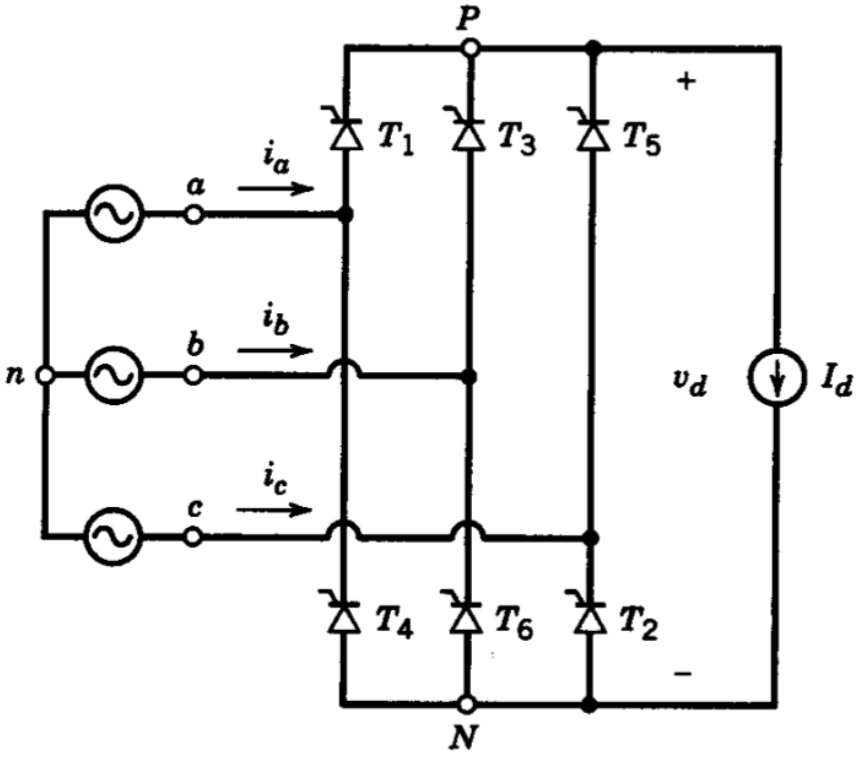
Half-bridge Tyristor Rectifier

Average Voltage?

$$V_{dc(\alpha)} = \frac{3\sqrt{6}}{2\pi} V_{ph,rms} cos(\alpha)$$

Full-bridge Tyristor Rectifier

Full-bridge Tyristor Rectifier



Output Voltage vs. Firing Angle

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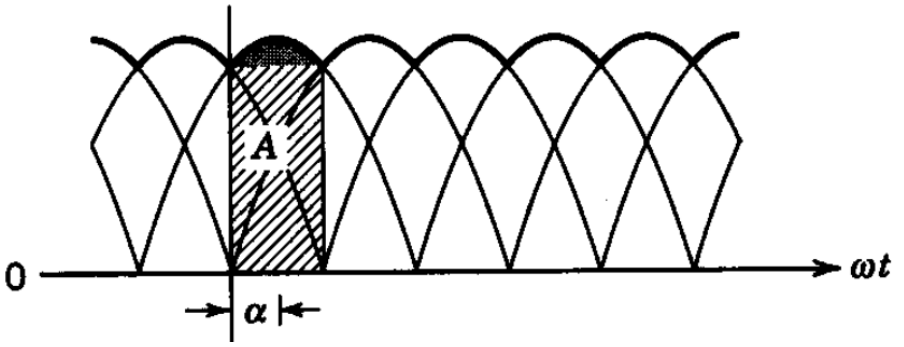
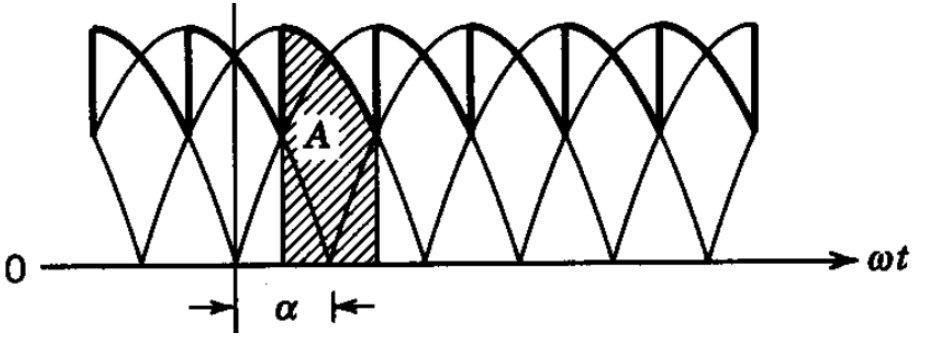


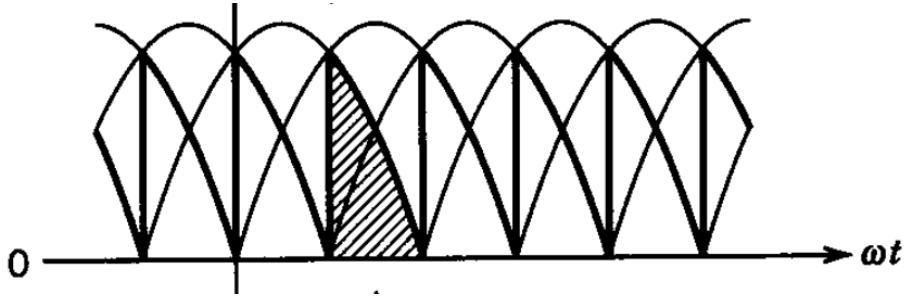
(a) $\alpha = 0$

Output Voltage vs. Firing Angle



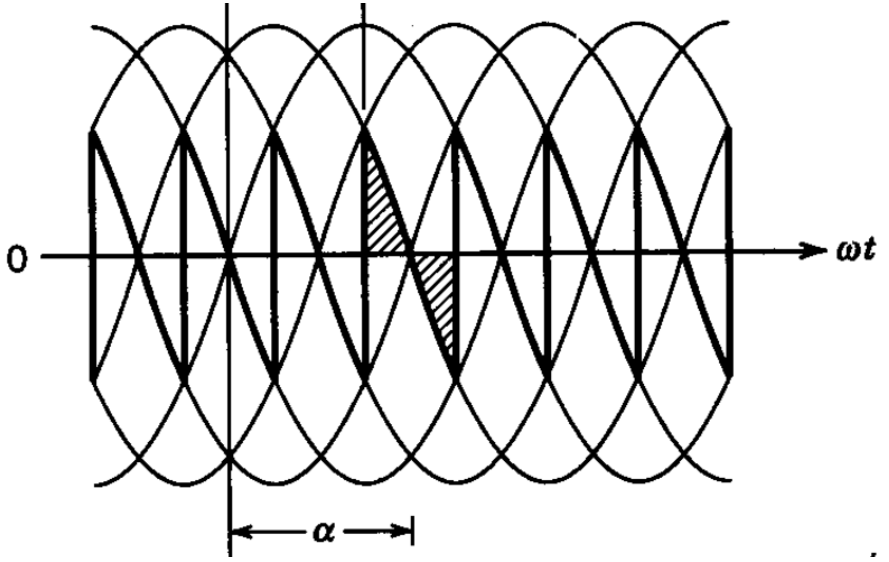
(b) $\alpha = 30°$

Output Voltage vs. Firing Angle



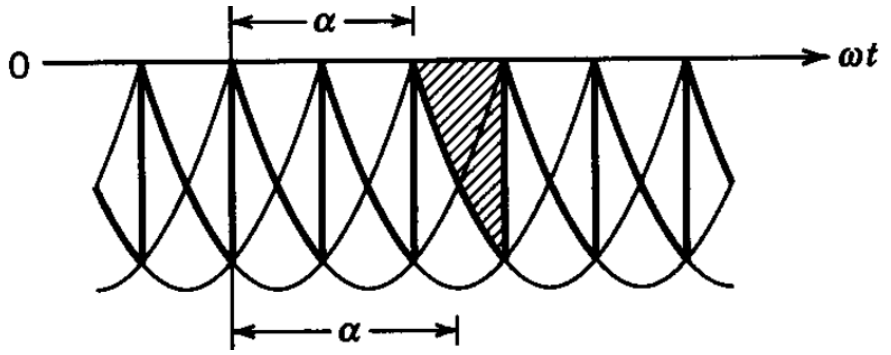
(c) $\alpha = 60°$

Output Voltage vs. Firing Angle



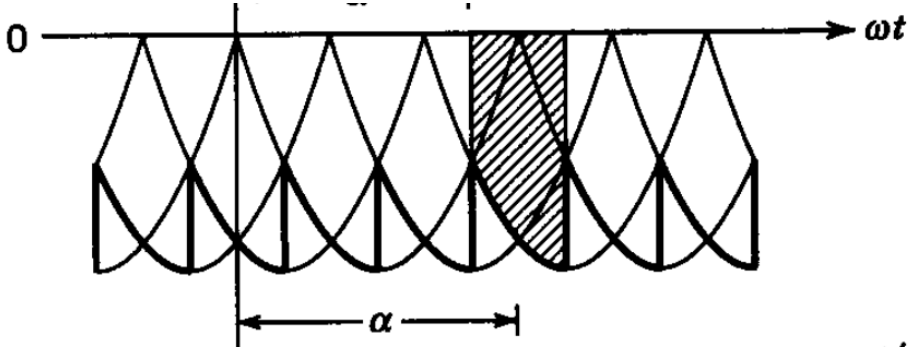
(d) $\alpha = 90°$

Output Voltage vs. Firing Angle



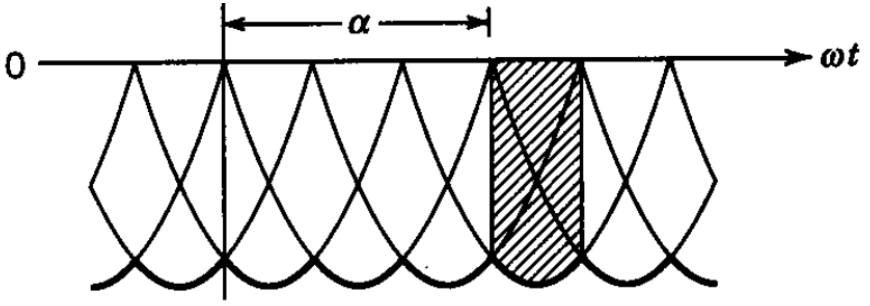
(e) $\alpha = 120°$

Output Voltage vs. Firing Angle



(f) $\alpha = 150°$

Output Voltage vs. Firing Angle



(g) $\alpha = 180°$

s

DC/DC Converters

- Buck Converter
- Boost Converter
- Buck-Boost Converter

Step-Down (Buck) Converter:

Can you plot the schematic?

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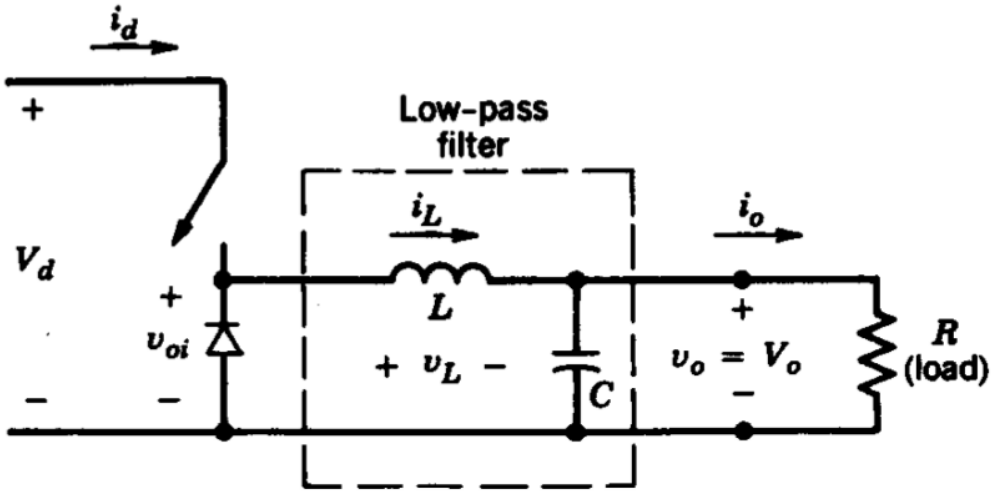
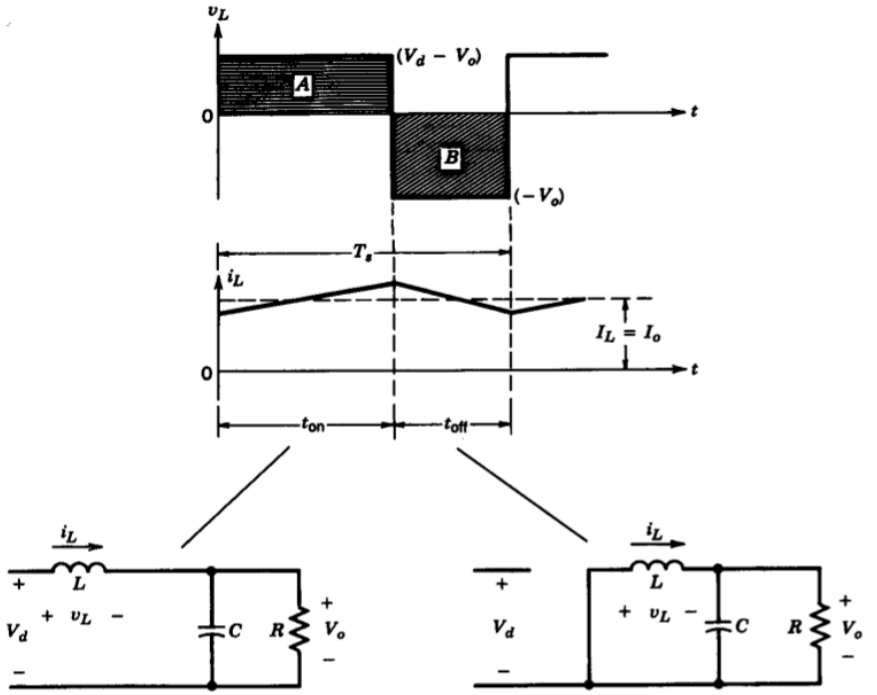


[Buck Converter Simulation]

Step-Down (Buck) Converter:

Operating Modes (CCM)



Step-Down (Buck) Converter:

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$$V_o = DV_d$$

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$$V_o = DV_d$$

Neglecting losses

$$I_o = I_d/D$$

Voltage Ripple

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$$\frac{\Delta V_o}{V_0} = \frac{(1-D)T_s^2}{8LC}$$

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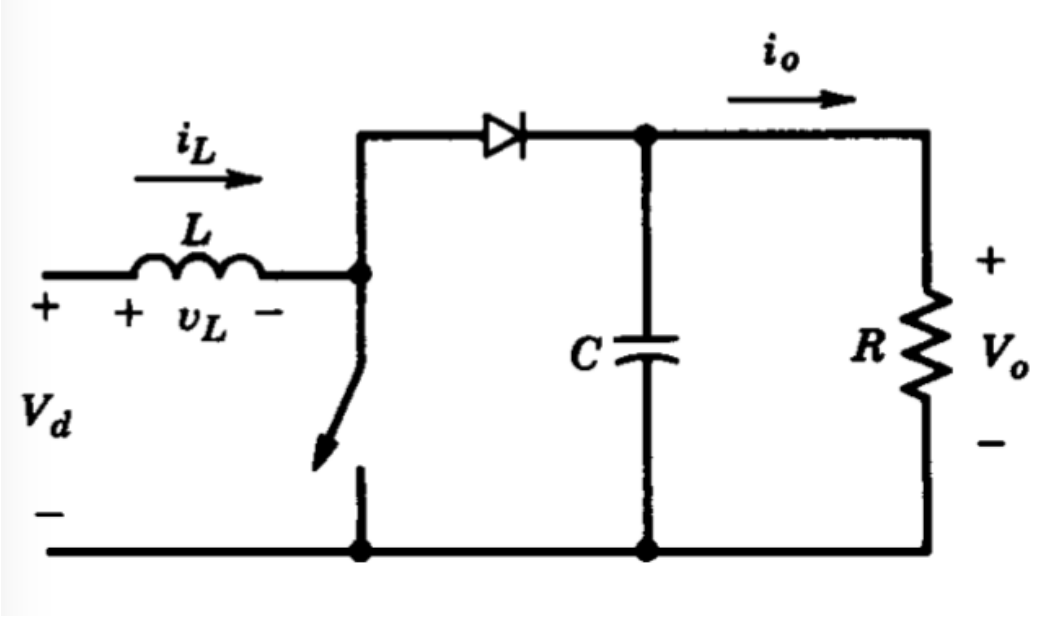
$$\frac{\Delta V_o}{V_0} = \frac{\pi^2(1-D)}{2}\left(\frac{f_c}{f_s}\right)^2$$

Step-Up (Boost) Converter

Step-Up (Boost) Converter



Step-Up (Boost) Converter

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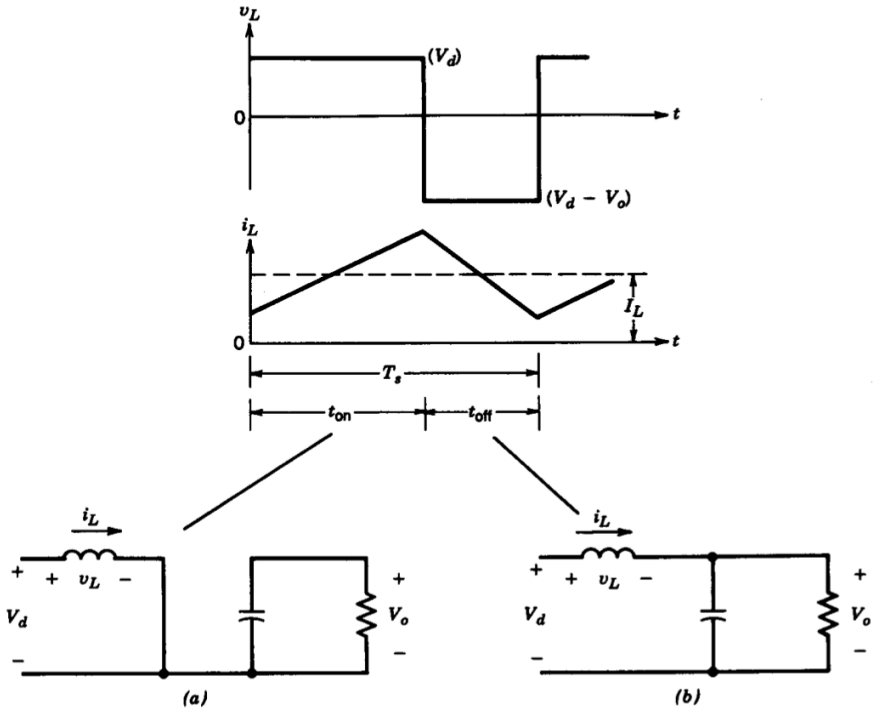

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$$V_d t_{on} + (V_d - V_o) t_{off} = 0$$

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$$\frac{I_o}{I_d} = (1 - D)$$

Buck-Boost Converter

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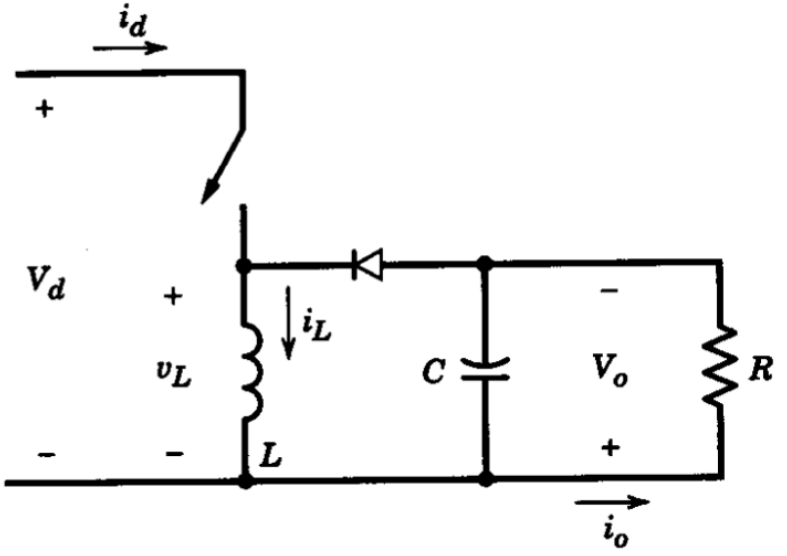


[Plexim Simulation]

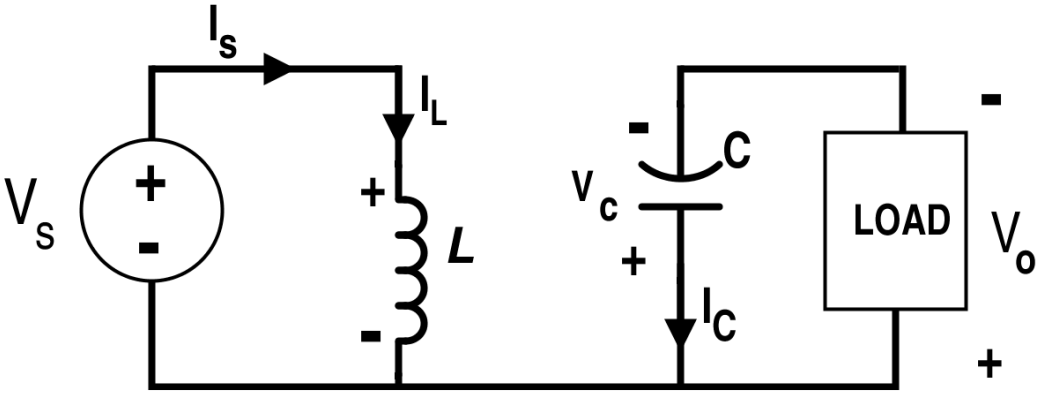
Buck-Boost Converter

Operating Modes

Buck-Boost Converter

Operating Modes

Switch is ON (Inductor Charges)



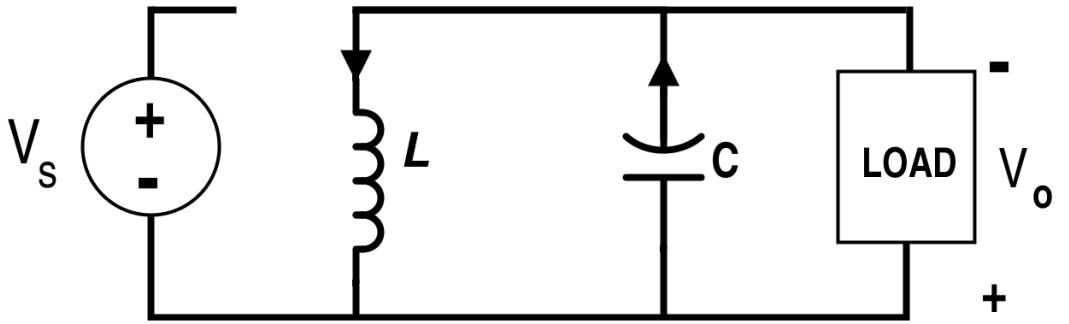
Buck-Boost Converter

Operating Modes

Buck-Boost Converter

Operating Modes

Switch is OFF (Inductor Discharges)



Buck-Boost Converter

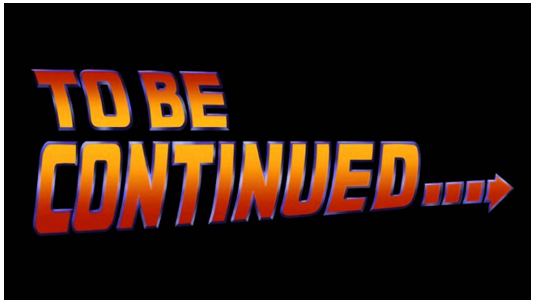
Output Voltage

Buck-Boost Converter

Output Voltage

$$V_o = \frac{D}{(1-D)} V_d$$

Notice the reverse polarity of Vo in the circuit



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- Ćuk Converter
- SEPIC Converter
- Flyback Converter
- Resonant Converters

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