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Tutorial 8: DC-AC Converters

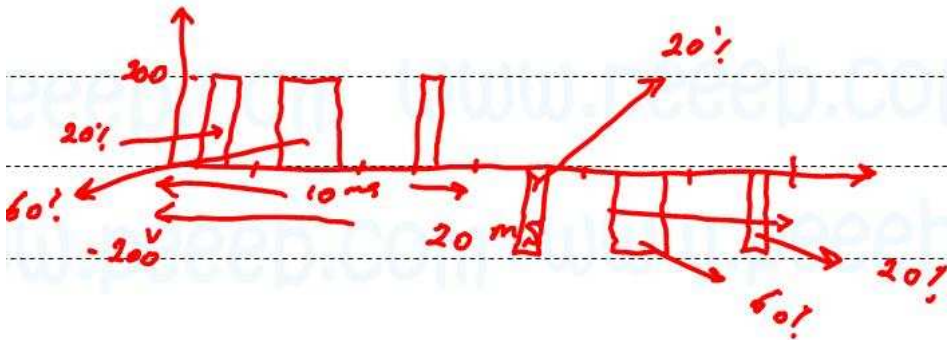
Presenter: Dr. Firuz Zare

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Q1: In a single phase inverter with unipolar modulation, a switching frequency, f_{sw} is 300 Hz and $V_{ac}=200$ V, $f=50$ Hz. Duty cycles for first half cycle are (0.2, 0.6 and 0.2).

- Sketch the output voltage?
- What is the rms output voltage?
- Assuming $R=0$ and $L=1$ mH, sketch the current waveform for the first cycle. (load current $i_{out}(0) = -1$)

$$n_{sw} = \frac{f_{sw}}{f} = \frac{300}{50} = 6$$

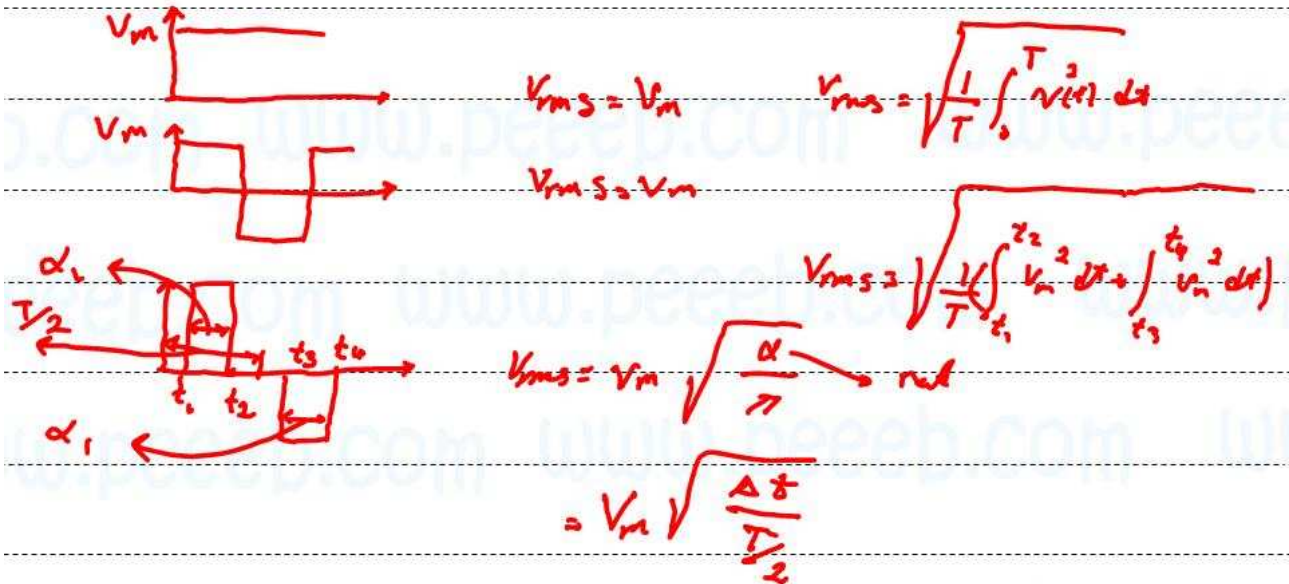


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$$T = 20 \text{ ms} \rightarrow f = 50 \text{ Hz}$$

$$V_{\text{rms}} = V_m \sqrt{\frac{\Delta t_1 + \Delta t_2 + \Delta t_3}{T/2}}$$

$$= 200 \sqrt{\frac{0.66 + 1.98 + 0.66}{10}} = 200 \times 0.57 \approx 115 \text{ V}$$

$$f_{\text{sw}} = 300 \text{ Hz} \cdot T_{\text{sw}} = \frac{1}{300 \text{ Hz}} \Rightarrow T_{\text{sw}} = 3.33 \text{ ms}$$

$$\Delta t_1 = 0.2 \times 3.33 = 0.666 \text{ ms} = \Delta t_3$$

$$\Delta t_2 = 0.6 \times 3.33 \approx 1.98 \text{ ms}$$

$$\Delta i = \frac{0.66 \times 10^{-3} \times 200}{1 \times 10^{-3}} = 132 \text{ A}$$

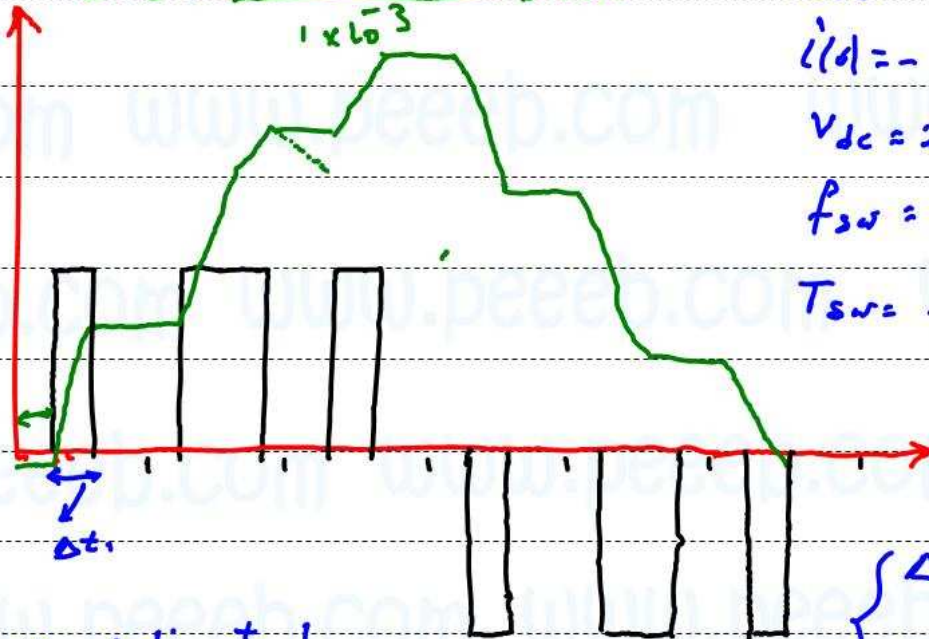
$$L = 1 \text{ mH}$$

$$i(d) = -1 \text{ A}$$

$$V_{dc} = 200 \text{ V}$$

$$f_{sw} = 300 \text{ Hz}$$

$$T_{sw} = \frac{1}{f_{sw}} = \frac{1}{300} = 3.3 \text{ } \mu\text{s}$$



$$V_L = L \frac{di}{dt}$$

$$\frac{di}{dt} = \frac{V_{out}}{L} \Rightarrow \frac{\Delta i}{\Delta t} = \frac{V_{out}}{L} \Rightarrow \Delta i = \frac{\Delta t}{L} V_{out}$$

$$\Delta t_1 = 0.2 \times 3.3 = 0.66 \text{ } \mu\text{s}$$

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Q2: In a three-phase system, with 120 degree modulation (each switch conducts for one third of cycle):

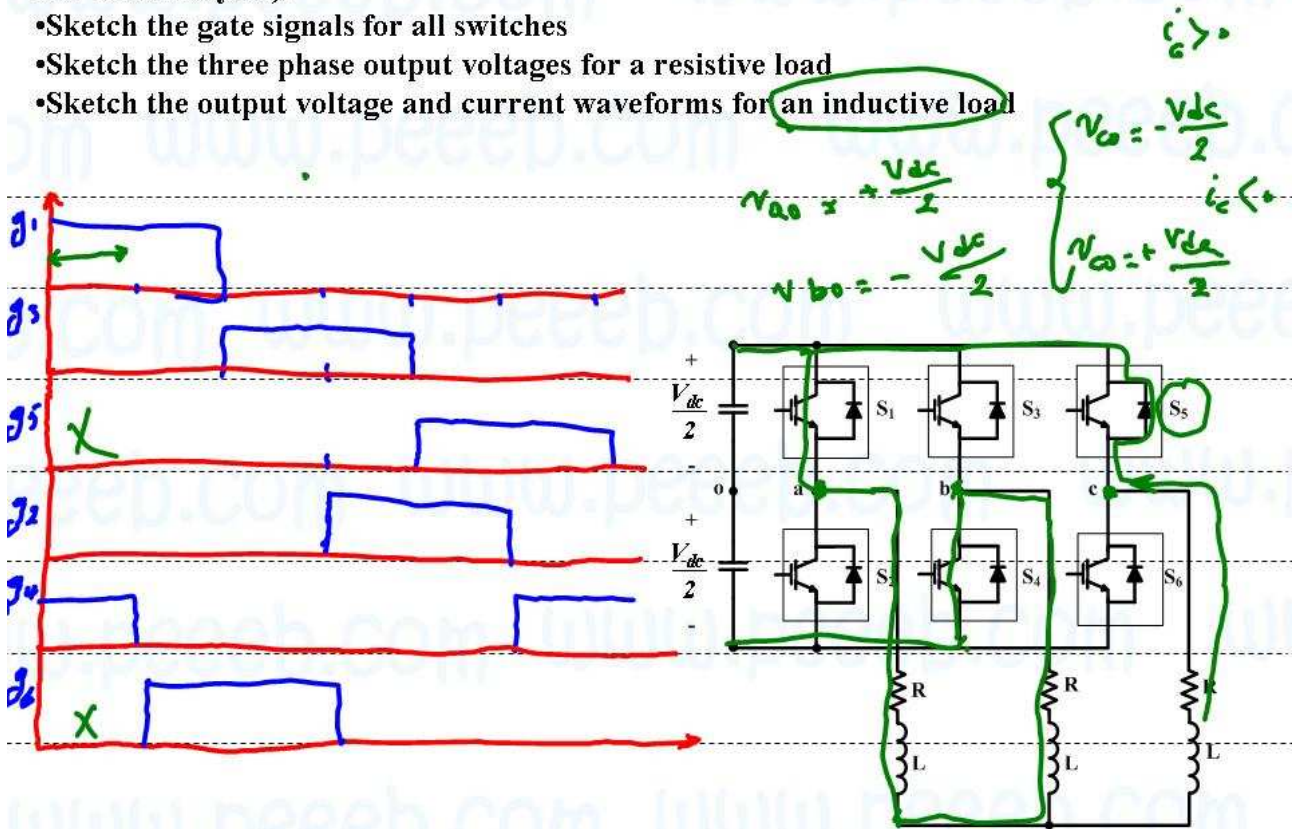
- Sketch the gate signals for all switches
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- Sketch the output voltage and current waveforms for an inductive load

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