ECE330: Power Circuits & Electromechanics

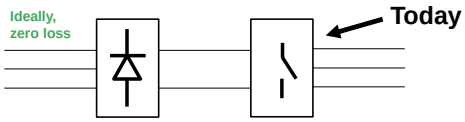
Lecture 25. Efficiently generating a sine wave.

Prof. Richard Y. Zhang
Univ. of Illinois at Urbana-Champaign
ryz@illinois.edu

1

1

Last time: Variable speed drive

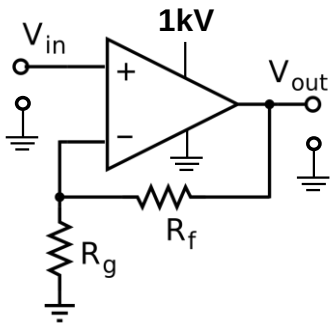





2

2

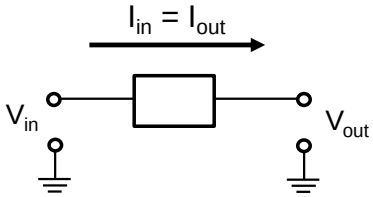
What's wrong with this?



3

3

Rules for high efficiency



100% Efficiency

Short circuit $V_{in} = V_{out}$

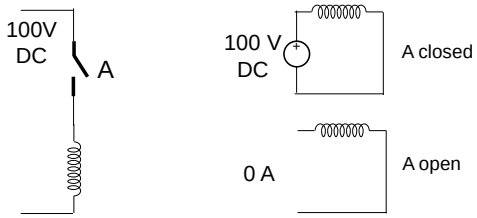
Open circuit $I_{in} = I_{out} = 0$

But Vin = 1kV DC and Vout = 500V AC ???

4

4

Hypothetical one-switch inverter

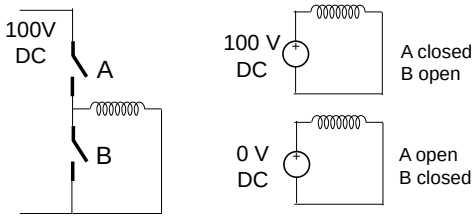


- Short-circuit with 100V vs open-circuit.
- Inductor doesn't like large di/dt.
- In practice will blow up the switch

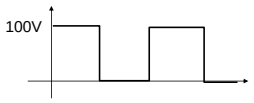
5

5

Basic two-switch inverter



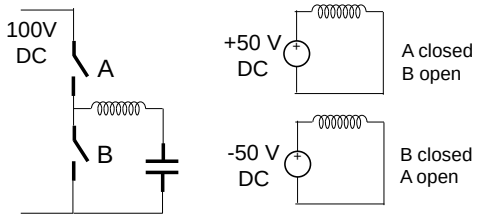
- Switching voltage source 100V / 0V.
- But nonzero average voltage!



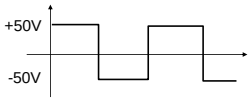
6

6

Half-bridge inverter



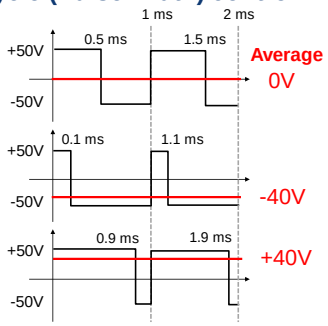
- Finally, an AC waveform! (sort of)
- No voltage control



7

7

Duty cycle (Pulse width) control

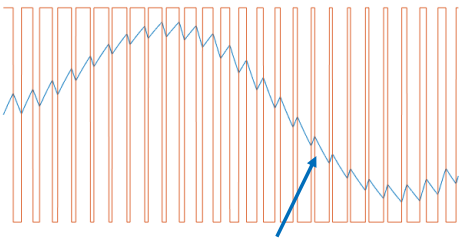


Slowly varying the average allows us to generate an arbitrary AC waveform

8

8

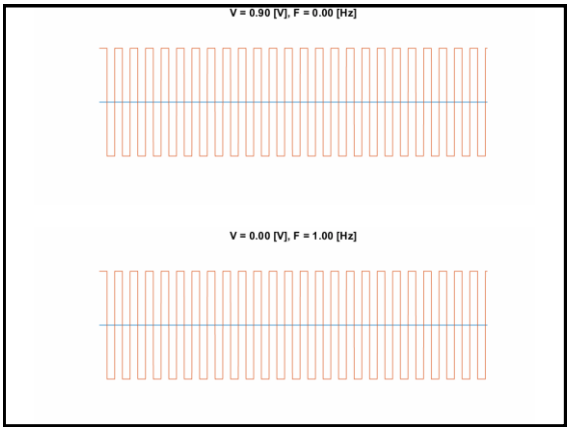
Applying a low-pass filter recovers the underlying sine wave



Harmonic distortion ("Ripple")

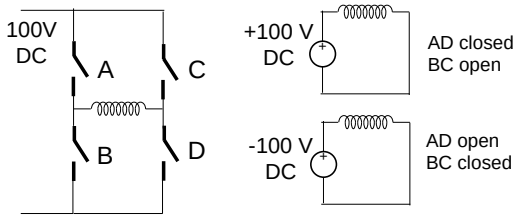
9

9



10

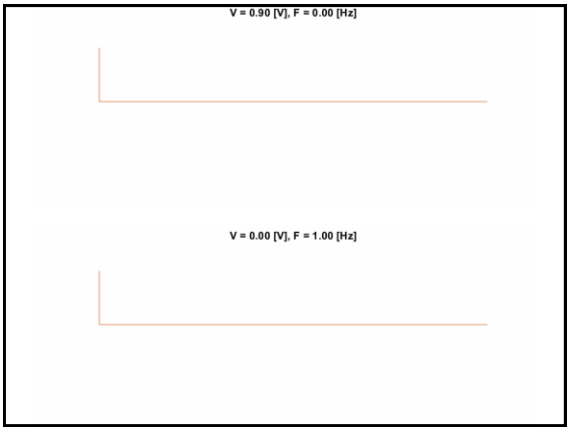
Full-bridge inverter



- Two levels of voltage supply
- But three levels of voltage output

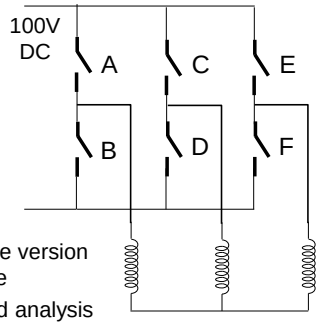
11

11



12

Six pulse inverter

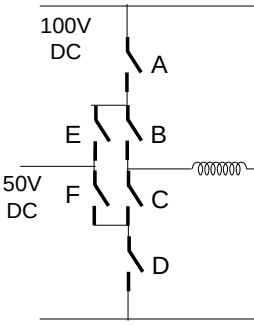


- Three-phase version of full-bridge
- Complicated analysis

13

13

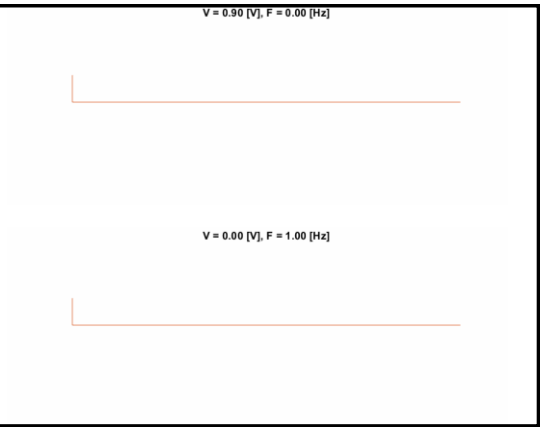
Three-level full-bridge (Neutral Point Clamp)



- Three levels of voltage supply
- But five levels of voltage output
- Explosion in the number of switches

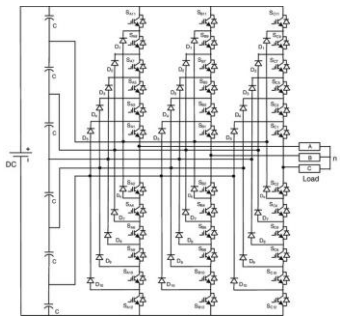
14

14



15

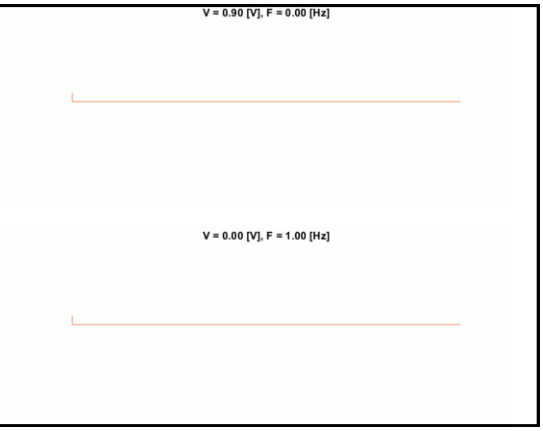
Seven-level full-bridge (Neutral Point Clamp)



- Seven levels of voltage supply
- But thirteen levels of voltage output
- Historically, almost never used. Complex and unreliable.
- Exciting new research (Stillwell research group)

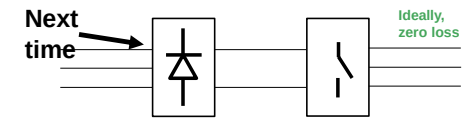
16

16



17

Today: Inverters



18

18