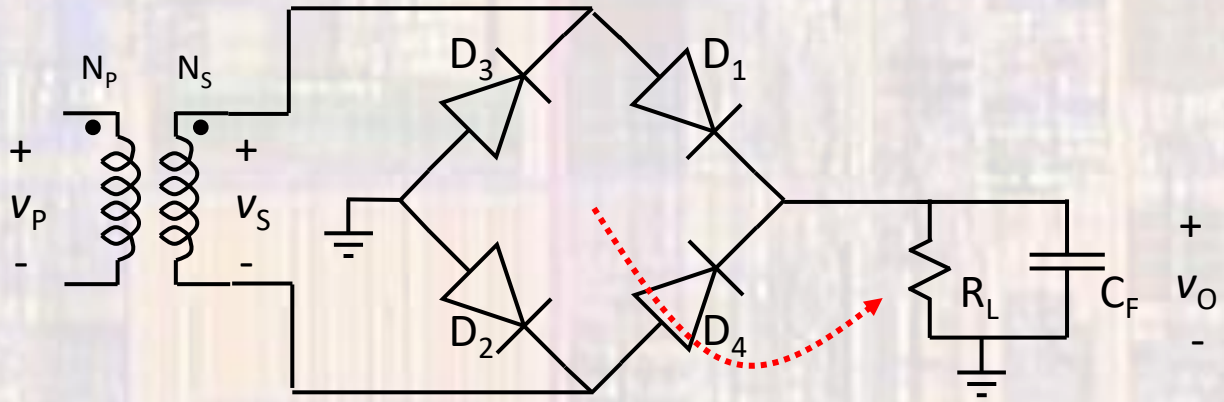
DC Voltage Generation

Last updated 12/14/21

DC Voltage Generation

- Add a simple Low Pass Filter to our rectifier



Filter time constant: $\tau = R_L C_F$

Filter Decay Equation: $v_O = v_{initial} e^{-t/\tau}$

DC Voltage Generation

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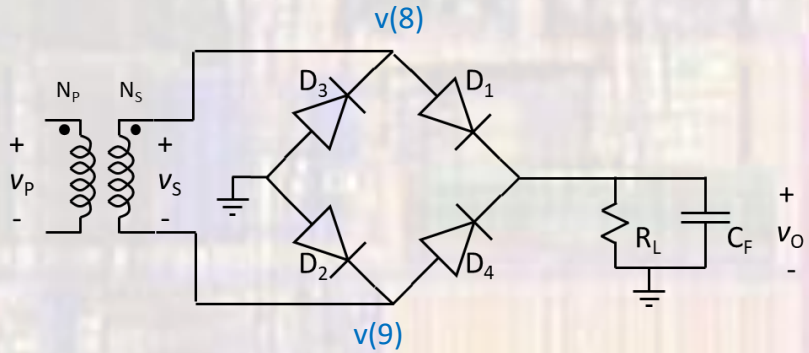

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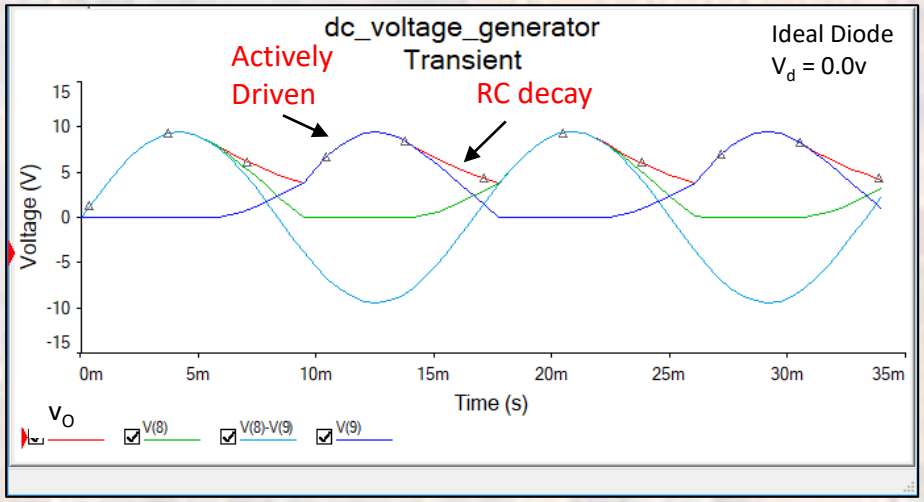
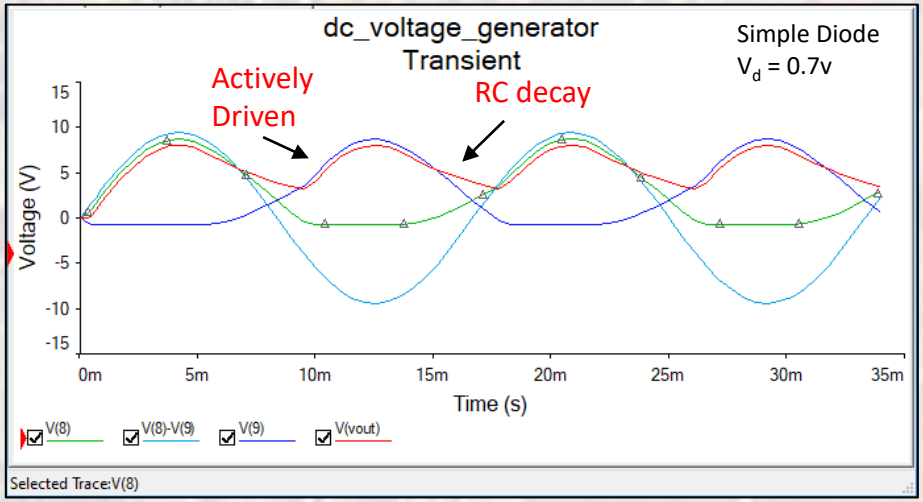
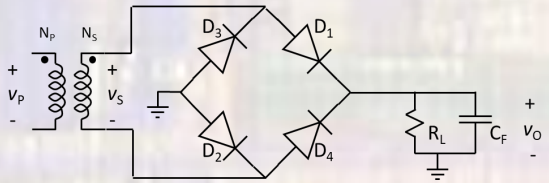




DC Voltage Generation

- Add a simple Low Pass Filter to our rectifier
  - Resulting output is a pseudo-DC signal



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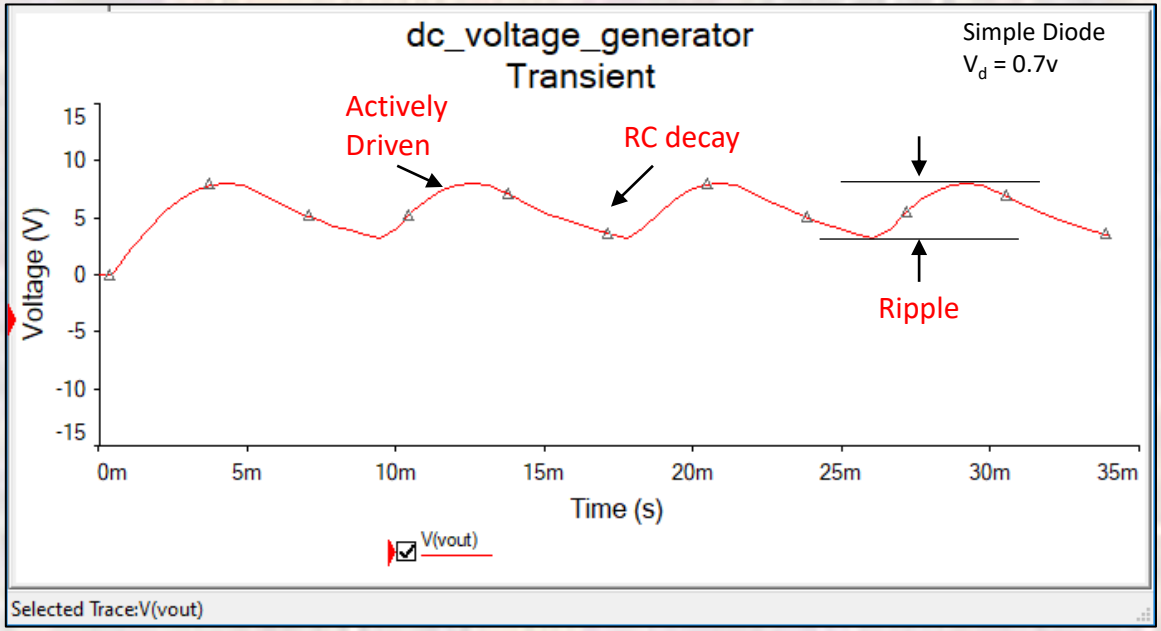
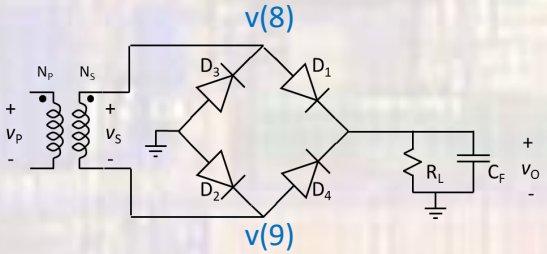


DC Voltage Generation

- Signal Analysis



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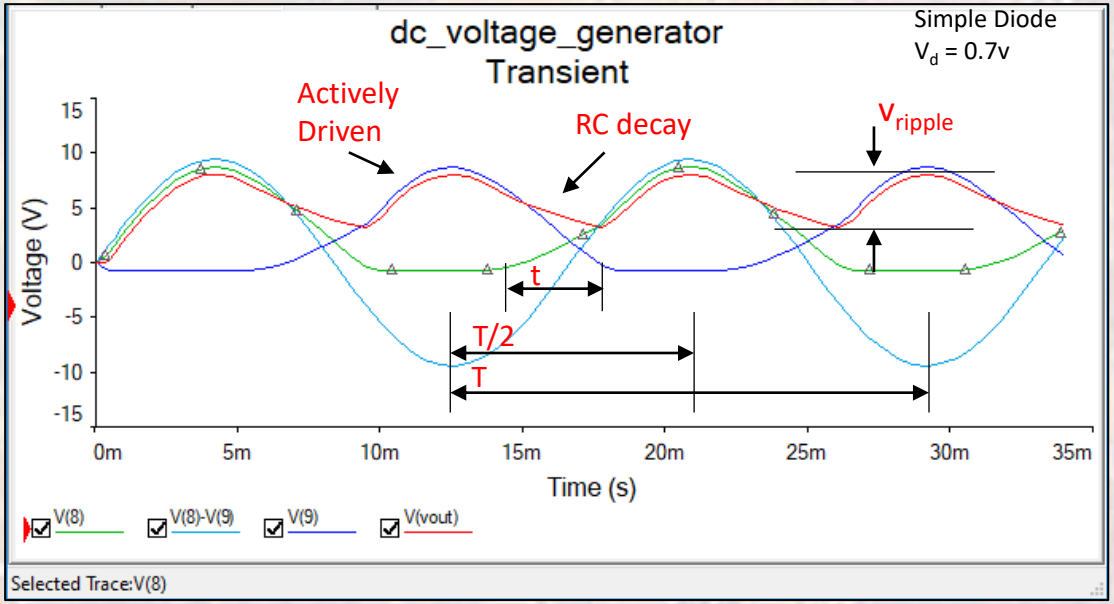


$v_{pk} = v_{Srms} * 1.414$

$v_{initial} \approx v_{pk} - 2v_D$

$t \leq T/2$

$e^{-t/\tau} \geq e^{-T/2\tau} = e^{-T/2RC}$

$v_O = v_{initial} e^{-T/2RC}$

$v_{ripple} = v_{initial} - v_{initial} e^{-T/2RC}$

$v_{ripple} = v_{initial}(1 - e^{-T/2RC})$

DC Voltage Generation

- Design Example 1
  - Design a bridge rectifier circuit to provide a peak output voltage of 15v and 250mv of ripple.
  - Assume nominal line voltage, simple diodes, R_L = 1KΩ

Transformer Design

15v peak out w/ 2 v_D → 16.4v peak v_S
16.4v peak v_S → 11.6v rms for v_S
11.6v rms with 120v rms input → N = 10.35

Filter Design

T = 1/60Hz = 16.666ms, R_L = 1KΩ

$$v_{ripple} = v_{initial}(1 - e^{-T/2RC})$$

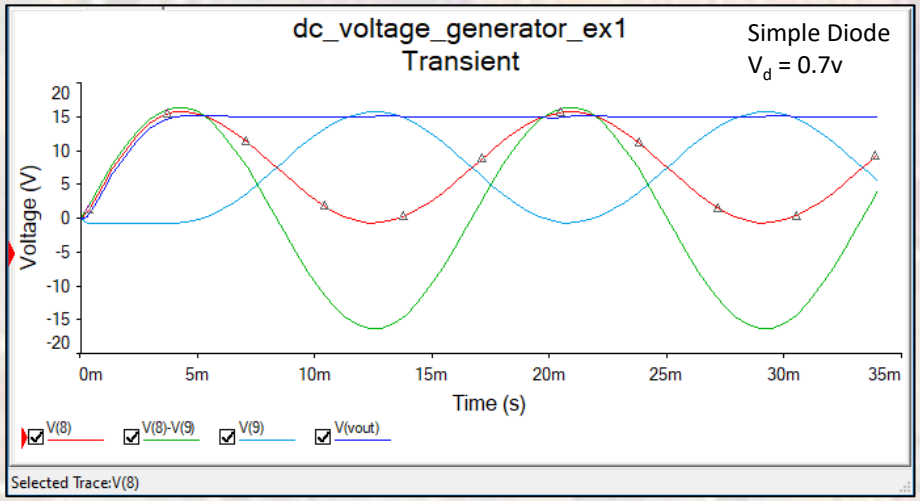
$$250mv = 15v(1 - e^{-16.666ms/2*1K\Omega*C})$$

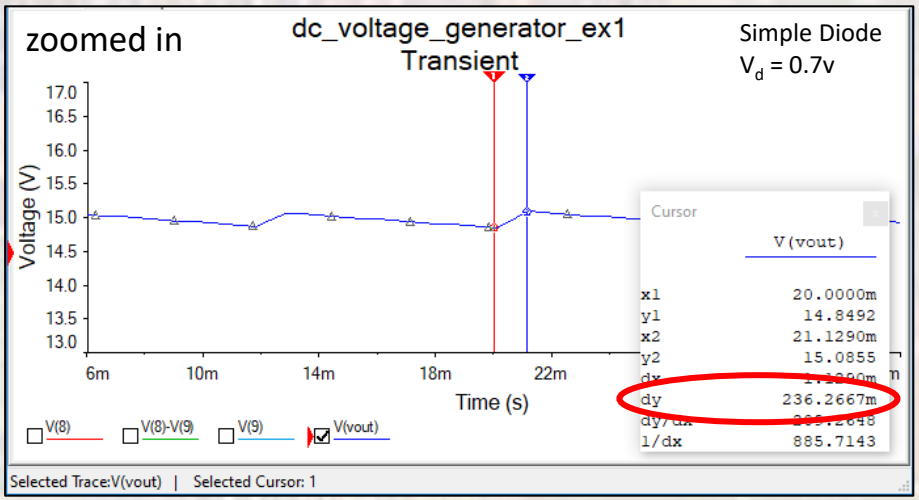
C_F = 496uF

DC Voltage Generation

- Design Example 1
  - Design a bridge rectifier circuit to provide a peak output voltage of 15v and 250mv of ripple.
  - Assume nominal line voltage, simple diodes, R_L = 1KΩ

v_{ripple} = 236mv





DC Voltage Generation

- Design Example 2
  - Design a bridge rectifier circuit to provide a minimum output voltage of 12.5v and < 500mv of ripple.
  - Assume nominal line voltage, simple diodes, R_L = 1KΩ

Transformer Design

13v peak out w/ 2 v_D → 14.4v peak v_S
14.4v peak v_S → 10.1v rms for v_S
Closest common transformer size would be 12v rms
12v rms → 15.57v peak v_S → 14.17v peak out

Filter Design

T = 1/60Hz = 16.666ms, R_L = 1KΩ

$$v_{ripple} = v_{initial}(1 - e^{-T/2RC})$$

$$500mv = 14.17v(1 - e^{-16.666ms/2*1K\Omega*C})$$

C_F = 231uF
Closest common (larger) capacitor size is 330uF
v_{ripple} = 353mv

Final Design

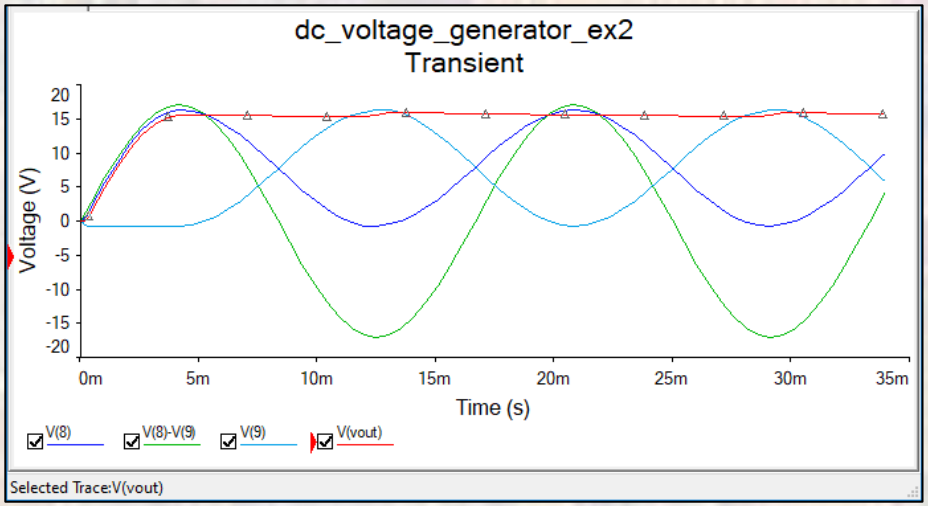
12v rms transformer
Simple bridge rectifier
330uF filter capacitor

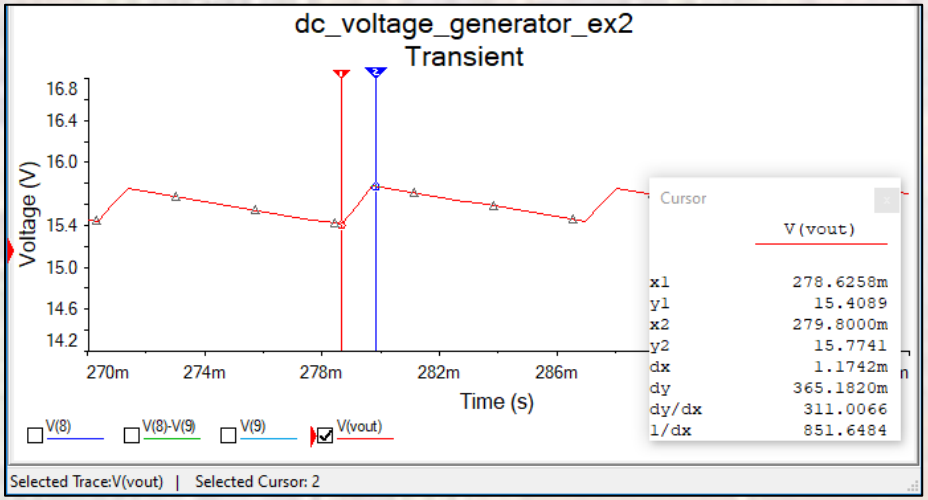
v_O = 13.83v to 14.17v (353mv ripple)

DC Voltage Generation

- Design Example 2
  - Design a bridge rectifier circuit to provide a minimum output voltage of 12.5v and < 500mv of ripple.
  - Assume nominal line voltage, simple diodes, R_L = 1KΩ

v_{Omin} = 15.4v
v_{ripple} = 365mv





Why different from the predicted results?