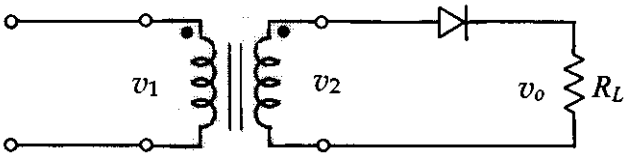
Half-Wave &Full Wave Rectifiers, Filtering, Regulated Power Supply

Half-Wave Rectifier Equivalent DC Output Voltage



Example

Given:

$v_{in(RMS)}$ = 110 V (60 HZ)

Turns Ratio 10:1

Find: $v_{out(DC\ Effective)}$

$v_{in(Peak)} = 1.414\ v_{in(RMS)} = 1.414 \times 110 = 155.5$ V

$v_{out(Peak)} = 1/10\ v_{in(Peak)} = 1/10 \times 155.5 = 15.6$ V

$v_{Diode} = 15.6 - 0.7 = 14.9$ V

$V_{out(DC\ Effective)} = 0.318\ v_{Diode} = 0.318 \times 14.9 \approx 4.7$ VDC

Exercise #1

Given: $v_{in(RMS)}$ = 110 V (60 HZ) Turns Ratio 5:1

Find: $V_{out(DC\ Effective)}$

Answer: 9.7 VDC

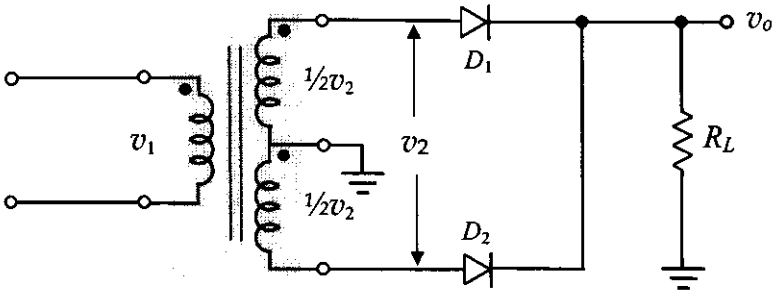
Exercise #2

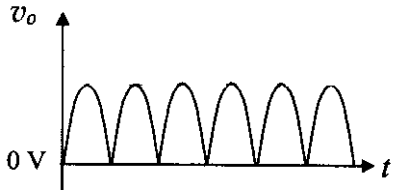
Given: $v_{in(RMS)}$ = 120 V (60 HZ) Turns Ratio 5:1

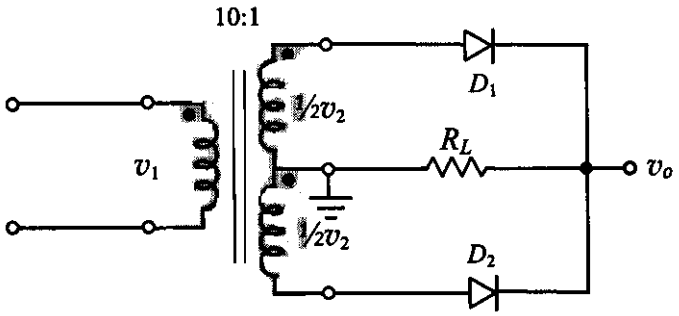
Find: $V_{out(DC\ Effective)}$

Answer: 10.6 VDC

Full-Wave Center-Tapped Rectifier Equivalent DC Output Voltage







Example

Given:
v_{in}(RMS) = 110 V (60 HZ)
Turns Ratio 10:1

Find: V_{out}(DC Effective)

v_{in}(Peak Center) = 1.414 v_{in}(RMS) = 1.414 x 110 = 155.5 V

v_{out}(Peak) = (1/2) (1/10) v_{in}(RMS) = 1/20 x 155.5 = 7.8 V

v_{Diode} = 7.8 - 0.7 = 7.1 V

V_{out}(DC Effective) = 0.636 v_{Diode} = 0.636 x 7.1 ≈ 4.5 VDC

Exercise #1

Given: v_{in}(RMS) = 110 V (60 HZ) Turns Ratio 5:1

Find: V_{out}(DC Effective)

Answer: 9.5 VDC

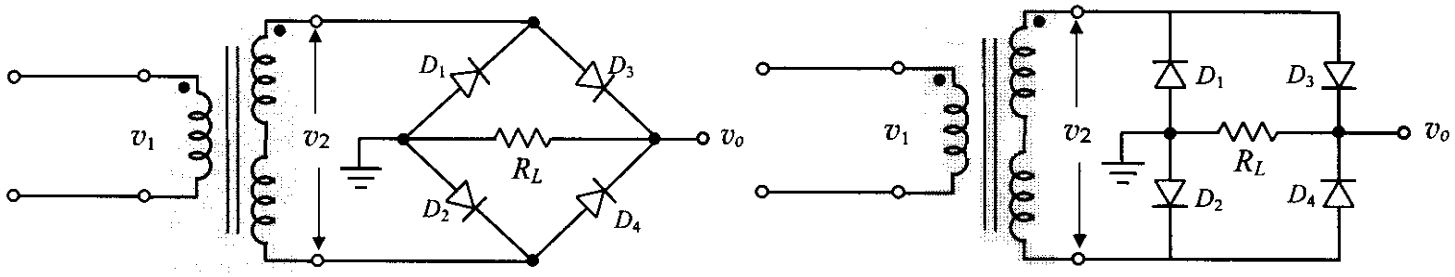
Exercise #2

Given: v_{in}(RMS) = 120 V (60 HZ) Turns Ratio 5:1

Find: V_{out}(DC Effective)

Answer: 10.4 VDC

Full-Wave Bridge Rectifier Equivalent DC Output Voltage



Example

Given:
v_{in}(RMS) = 110 V (60 HZ)
Turns Ratio 10:1

Find: V_{out}(DC Effective)

v_{in}(Peak) = 1.414 v_{in}(RMS) = 1.414 x 110 = 155.5 V

v_{out}(Peak) = 1/10 v_{in}(RMS) = 1/10 x 155.5 = 15.6 V

v_{Diode} = 15.6 - 2(0.7) = 14.2 V

v_{out}(DC Effective) = 0.636 v_{Diode} = 0.636 x 14.2 ≈ 9 VDC

Exercise #1

Given: v_{in}(RMS) = 110 V (60 HZ) Turns Ratio 5:1

Find: V_{out}(DC Effective)

Answer: 18.9 VDC

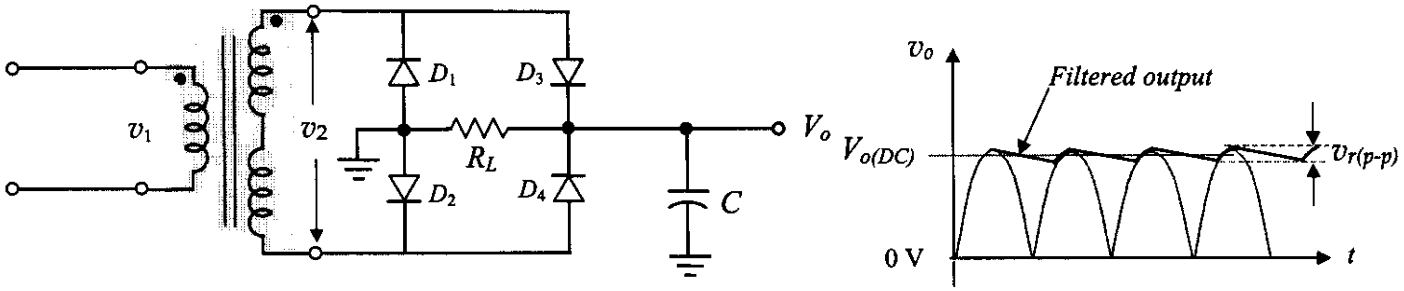
Exercise #2

Given: v_{in}(RMS) = 120 V (60 HZ) Turns Ratio 5:1

Find: V_{out}(DC Effective)

Answer: 20.7 VDC

Filtering



$v_{\text{ripple(peak- peak)}} = I_{\text{out(DC)}} / 2fC$

$I_{\text{out(DC)}} = V_{\text{out}}(\text{DC}) / \text{R}_{\text{Load}}$

Two Steps

1. Assume $V_{\text{out}}(\text{DC})$ (Without filtering, i.e., use peak of the rectified wave , **NOT** the DC average value.)
2. Solve for $I_{\text{out(DC)}}$ and $v_{\text{ripple(peak- peak)}}$
3. Recalculate $V_{\text{out}}(\text{DC})$ Load = $V_{\text{out}}(\text{DC})$ (without filtering) - $[v_{\text{ripple(peak- peak)}}] / 2$

Example

Given:
$v_{\text{in}}(\text{RMS})$ = 110 V (60 HZ)
Turns Ratio 10:1
R_{Load} = 100 Ω C = 1000 μF f = 60 Hz

Find: $V_{\text{out}}(\text{DC})$ Load

From Full-Wave Bridge Rectifier (from Example page 3, above) $V_{\text{out}}(\text{DC})$ (without filtering) = 14.2 VDC

$I_{\text{out(DC)}} = V_{\text{out}}(\text{DC}) / \text{R}_{\text{Load}} = 14.2/100 = 0.142\text{A} = 142\text{ mA}$

$v_{\text{ripple(peak- peak)}} = I_{\text{out(DC)}} / 2fC = 0.142 / (2 \times 60 \times 1000 \times 10^{-6}) = 1.18\text{ V}$

$V_{\text{out}}(\text{DC})$ Load = $V_{\text{out}}(\text{DC})$ (without filtering) - $[v_{\text{ripple(peak- peak)}}] / 2 = 14.2 - (1.18) / 2 = 13.6$ VDC

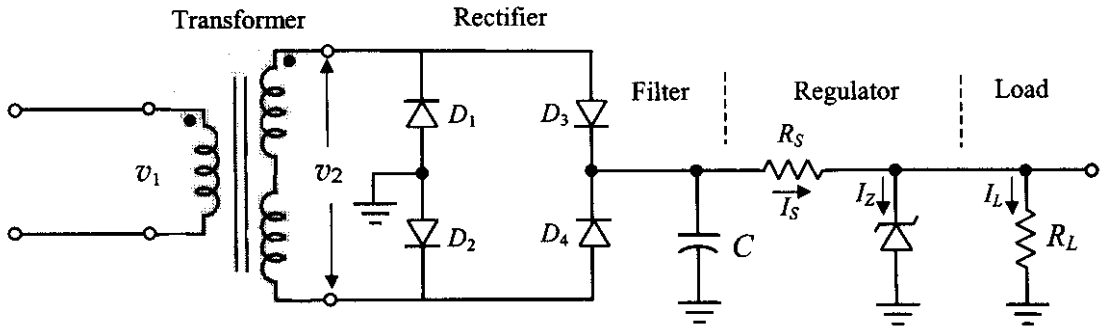
Exercise

Given:
$v_{\text{in}}(\text{RMS})$ = 120 V (60 HZ) Turns Ratio 5:1
R_{Load} = 240 Ω C = 470 μF f = 60 Hz
$V_{\text{out}}(\text{DC})$ (without filtering) = 32.5 VDC (from Problem, page 3, above. Note 32.5 not 32.5 x .636 = 20.7)

Find: $V_{\text{out}}(\text{DC})$ Load

Answer: $I_{\text{out(DC)}}$ = 136 mA $v_{\text{ripple(peak- peak)}}$ = 2.4 V $V_{\text{out}}(\text{DC})$ Load = 31.3 VDC

Regulated Power Supply



Scanned Images: Electronic Devices, Ali Aminian & Marian Kazimierczuk, Pearson-Prentice Hall, 2004