UNIVERSITY OF MIAMI
Department of Electrical and Computer Engineering
EEN 311

Name: _____
Section: _____
Date: _____

EXPERIMENT 1

RECTIFIERS AND DC POWER SUPPLIES

PURPOSE: The purpose of this experiment is to demonstrate the characteristics of three different diode rectifier circuits and to gain insight into the design of dc power supplies. The half-wave rectifier, center tapped full-wave rectifier, and full-wave bridge rectifier will be studied.

Preliminary Work

1. Sketch the voltage output of the half-wave rectifier shown below (V_{out} vs ωt). Derive the expression for the dc voltage output $V_{out,dc} = V_m/\pi$. *Hint*: Find the average value of V_{out}.

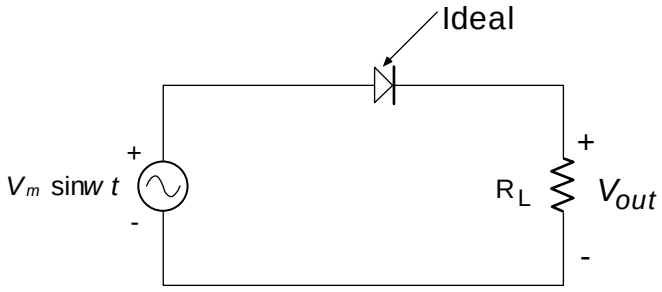


Figure 1.1 Half-wave Rectifier Circuit

2. Sketch the output voltage waveform of the full-wave rectifier shown below (V_{out} vs ωt). Derive the expression for the dc voltage output $V_{out,dc} = 2V_m/\pi$.

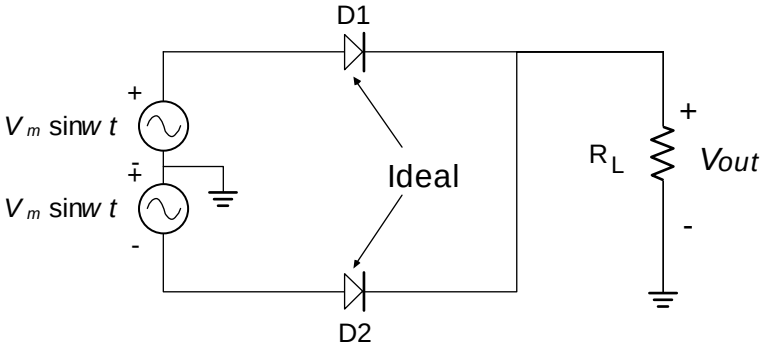


Figure 1.2 Full-wave Rectifier Circuit

3. The approximate form of the output of the full-wave rectifier with a capacitor filter shown in Fig. 1.7 is given below. Derive an expression for the dc (average) output voltage V_{DC} and the ripple voltage V_r. The equations should be in term of R_L, C, peak input amplitude V_m, and input frequency *f*.

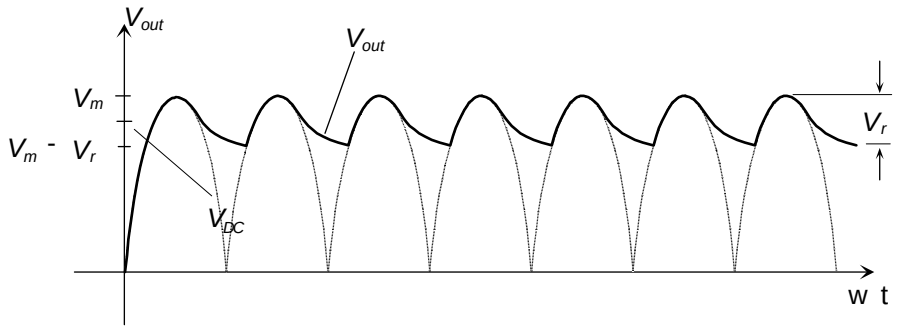


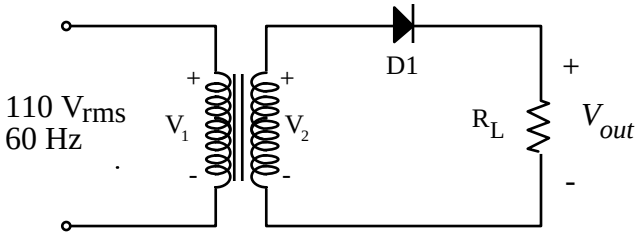
Figure 1.3 Full-wave Rectifier Output with Smoothing Capacitor

Experimental Procedure

I. Half-Wave Rectifier:

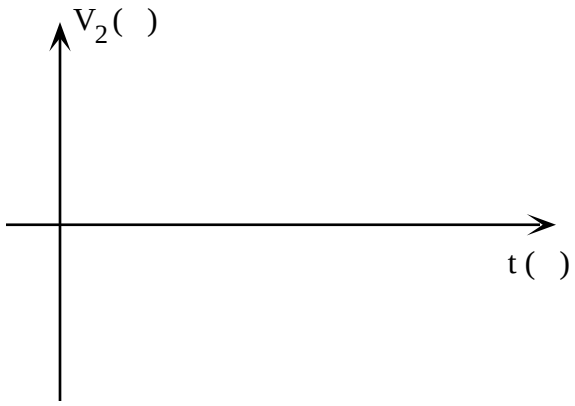
Set up the circuit shown in Fig. 1.4. Measure $V_{out,dc}$ using the digital voltmeter (DVM) and the oscilloscope. Note that the oscilloscope in AC mode does not display the DC levels of the input waveform.

a) Sketch the oscilloscope patterns of V_2 and V_{out}.



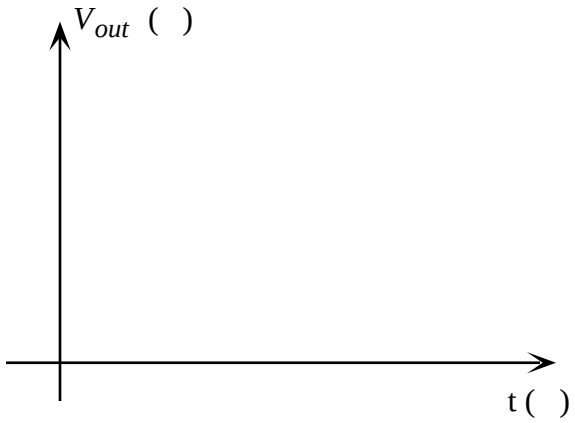
R_L: _____

Figure 1.4 Half-wave Rectifier Circuit



$V_{out,dc}$ using DVM: _____

$V_{out,dc}$ using SCOPE: _____



b) Measure the peak inverse voltage (P.I.V) across the diode; i.e., the maximum voltage drop across the diode when it is reverse biased.

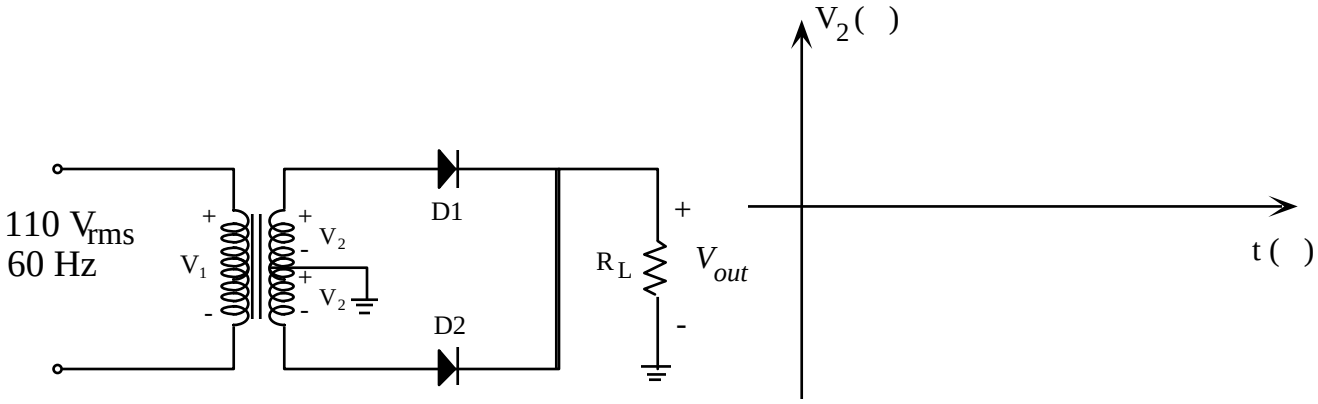
i. Measured P.I.V =

ii. Calculated P.I.V =

II. Full-Wave Rectifier Using a Center-tapped Transformer:

Set up the circuit shown in Fig. 1.5. Measure $V_{out,dc}$ using the DVM and oscilloscope.
Note : Do not make R_L = 0 at any time.

a) Sketch the oscilloscope patterns of V_2 and V_{out}.

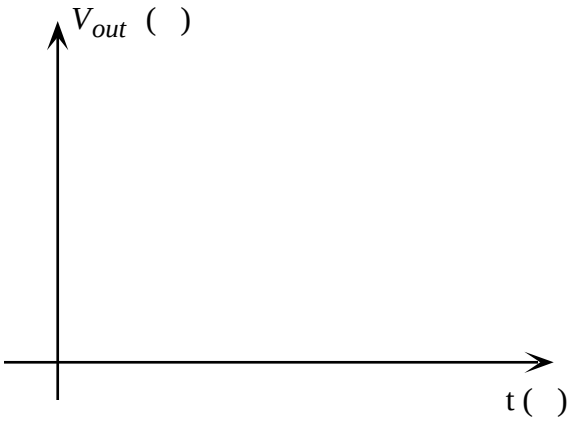


R_L : _____

Figure 1.5 Full-wave Rectifier with Center-tapped Transformer

$V_{out,dc}$ using DVM: _____

$V_{out,dc}$ using SCOPE: _____



b) Measure the peak inverse voltage (P.I.V) across diodes D1 or D2; i.e., the maximum voltage drop across the diode when it is reverse biased.

i. Measured P.I.V. =

ii. Calculated P.I.V. =

III. Full-wave Bridge Rectifier:

Set up the circuit shown in Fig. 1.6. **Do not make R_L = 0 at any time**. Use only one ground clip in the circuit.

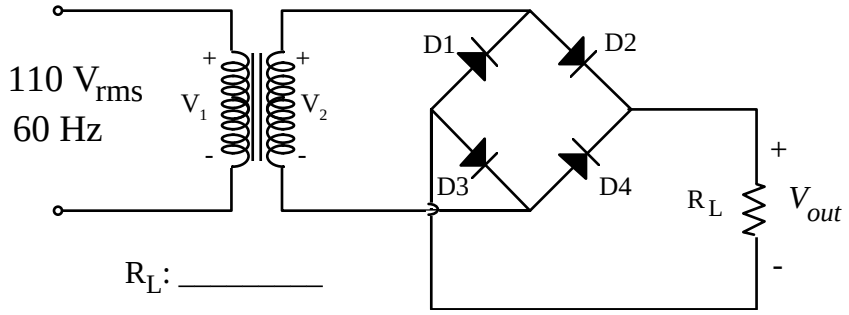
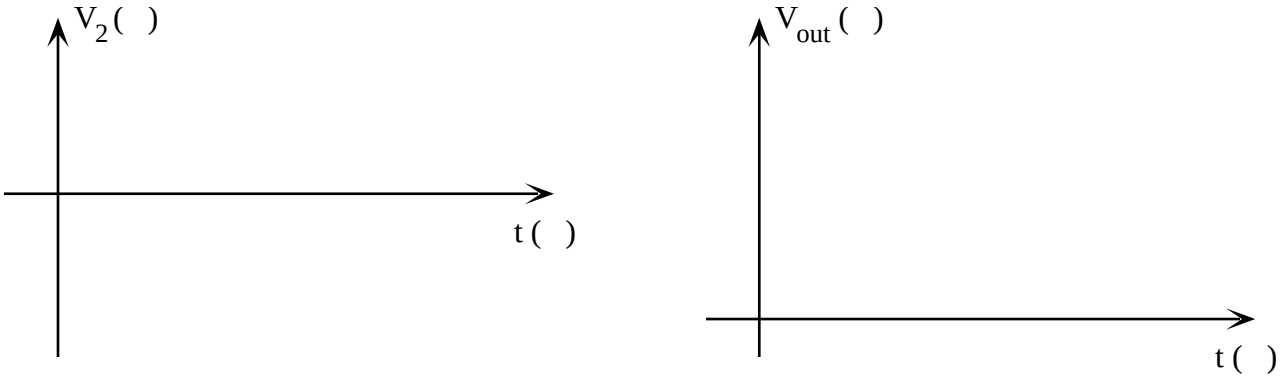


Figure 1.6 Full-wave Bridge Rectifier Circuit.

a) Sketch the oscilloscope patterns of V_2 and V_{out}. Measure $V_{out,dc}$ using the DVM and oscilloscope.



$V_{out,dc}$ using DVM: _____

$V_{out,dc}$ using SCOPE: _____

b) Measure the peak inverse voltage (P.I.V) across diodes D1 or D2; i.e., the maximum voltage drop across the diode when it is reverse biased.

i. Measured P.I.V. =

ii. Calculated P.I.V. =

IV. Full-wave Rectifier with Capacitor Filter:

Design the circuit in Fig. 1.7 for a ripple voltage V_r less than 5% of the peak output voltage. Remember that given the frequency f_o of the source, the voltage ripple is given by

$$V_r = \frac{V_m}{2f_o R_L C}$$

Where V_m is the maximum amplitude at the output of the transformer.

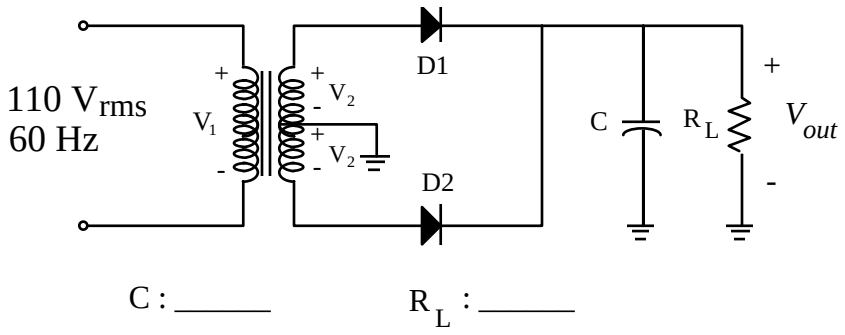
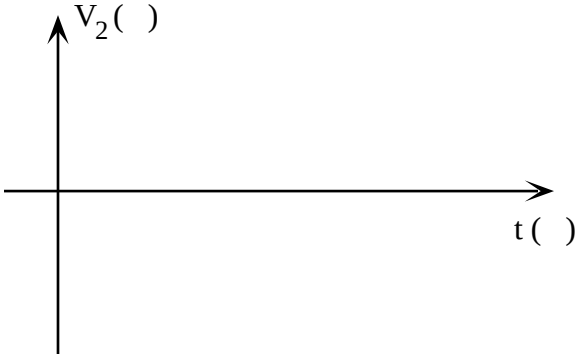


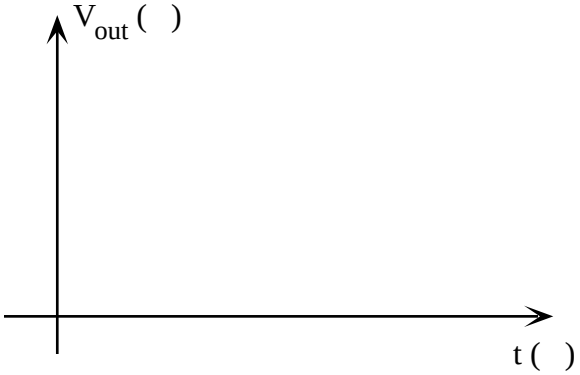
Figure 1.7 FWR Circuit with Capacitor Filter

a) Sketch the oscilloscope patterns of V_2 and V_{out}. Show the ripple **clearly**. Measure $V_{r,p\text{-}p}$ and $V_{out,dc}$.

$V_{r,p\text{-}p}$ = _____

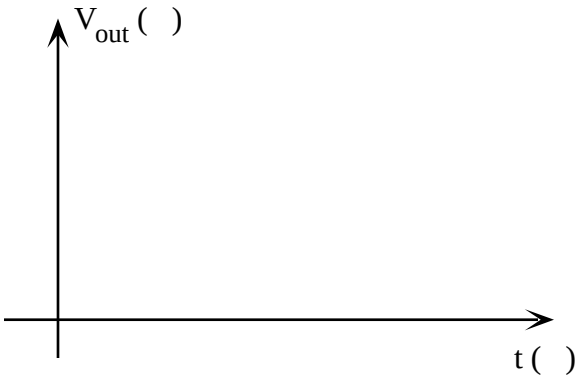
$V_{out,dc}$ = _____



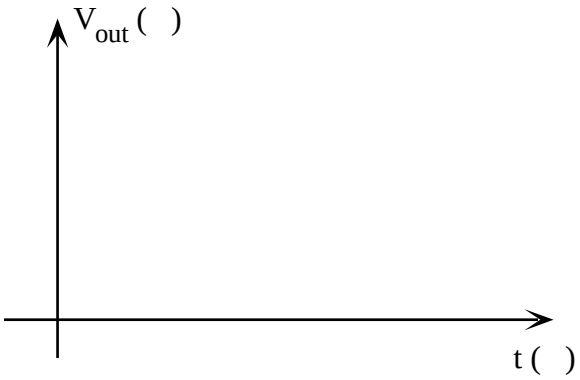


b) Observe the effects of varying R_L. Sketch the resulting output waveforms when R_L is

i) increased, and
ii) decreased from its design value.



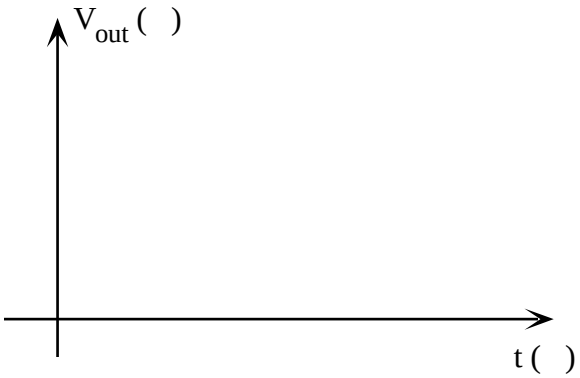
i) V_{out} with $R_L > R_{Lo}$



ii) V_{out} with $R_L < R_{Lo}$

R_{Lo} = Design value

c) Disconnect D2 and sketch the resulting waveform.



SPICE

Write a SPICE program to plot the voltage across R_L and the current through one of the diodes for the circuit of Fig. 1.2. Talk about the results in your conclusion.

Discussion of Results

1. a) Calculate the dc output voltage of the half-wave rectifier used in part I. Compare this value to the DVM and oscilloscope measurements by finding the percentage error for each case.
   b) Repeat (a) for the full-wave rectifiers in parts II and III.

2. Calculate the maximum current that flows through the diode in part I.

3. a) Calculate the dc output voltage of the full-wave rectifier with capacitor filter in part IV and compare this to the measured value by finding the percentage error.
   b) Explain the results of part IV.b.
   c) Explain the results of part IV.c.

4. Write a conclusion.