K. J. SOMAIYA COLLEGE OF ENGINEERING
DEPARTMENT OF ELECTRONICS ENGINEERING
ELECTRONIC CIRCUITS
DIODE APPLICATIONS

Numerical 1:

Simulate a Half Wave Rectifier circuit with input amplitude V = 150V peak, f = 50 Hz and $R_1 = 110\,\Omega$ using LT spice. Select diode as IN4148. Use 10:1 step down transformer.
Plot the following using LTspice:
a. Primary peak voltage
b. Secondary peak voltage
c. Output voltage across resistor
d. Output voltage across diode
e. Current flowing through the circuit

Also, calculate the efficiency of the Half wave rectifier circuit.

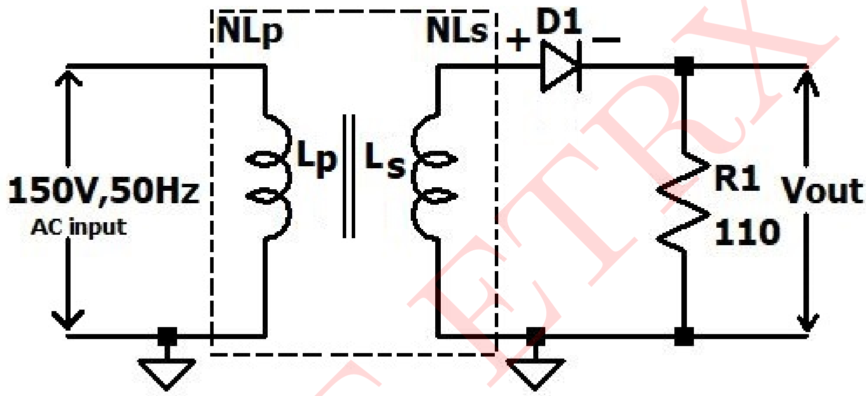

Figure 1: Half Wave Rectifier

Solution:

$\frac{N_{L_s}}{N_{L_p}} = \frac{1}{10}$ $\quad R_1 = 110\Omega, V = 150V, f = 50Hz$ ...(given)

$\frac{V_m}{V} = \frac{N_{L_s}}{N_{L_p}}$

where V_m is secondary voltage and V is input voltage.

$\therefore V_m = \frac{1}{10} \times 150 = \mathbf{15V}$

$$P_{dc} = \frac{V_m^2}{\pi^2 \times R_1} = \frac{(15)^2}{(3.14)^2 \times 110}$$

$\therefore P_{dc} = \mathbf{0.207W}$

$$P_{ac} = \frac{V_m^2}{4 \times (R_s + R_1)} = \frac{(15)^2}{4 \times (0.01 \times 10^{-3} + 110)}$$

$\therefore P_{ac} = \mathbf{0.51136W}$

$$\text{Efficiency}(\eta\%) = \frac{P_{dc}}{P_{ac}} \times 100 = \frac{0.207}{0.51136} \times 100$$

$\therefore \text{Efficiency}(\eta\%) = \mathbf{40.48\%}$

$$I_m = \frac{V_m}{(R_s + R_1)} = \frac{15}{(0.01 \times 10^{-3} + 110)}$$

$\therefore I_m = \mathbf{136.3mA}$

$\text{PIV} = -V_m = \mathbf{-15V}$

SIMULATED RESULTS:

Above circuit is simulated in LTspice. The results are presented below:

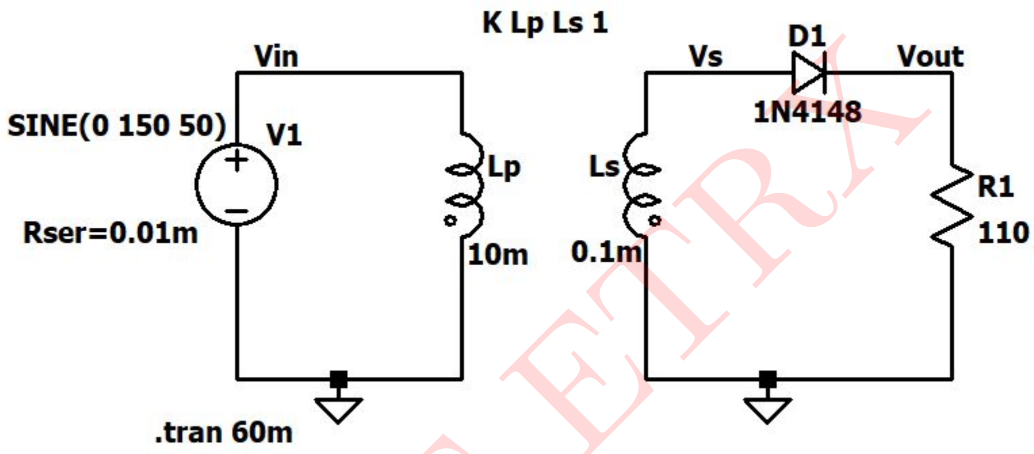

Figure 2: Circuit Schematic for Half Wave Rectifier

Graphs are shown in Figure 3.

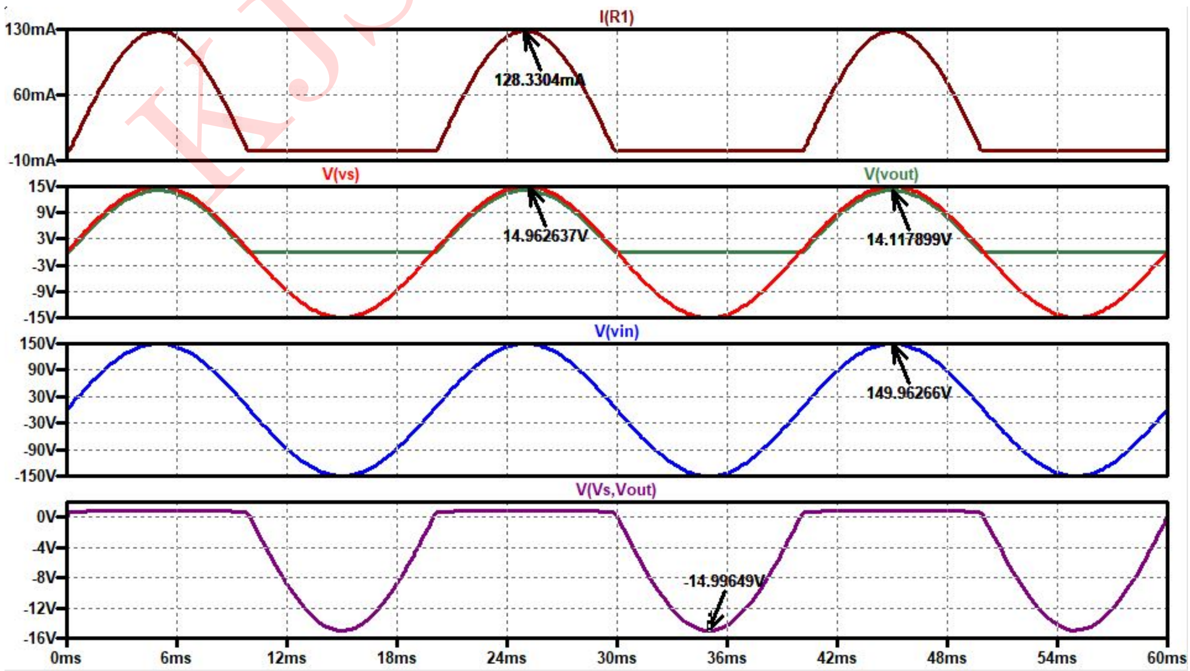

Figure 3: Graphs for Figure 2

For Figure 2,

$V_m = \mathbf{14.96V}, I_m = \mathbf{128.33mA}$ ..(from Figure 3)

$$P_{dc} = \frac{V_m^2}{\pi^2 \times R_1} = \frac{(14.96)^2}{(3.14)^2 \times 110}$$

$\therefore P_{dc} = \mathbf{0.2061W}$

$$P_{ac} = \frac{V_m^2}{4 \times (R_s + R_1)} = \frac{(14.96)^2}{4 \times (0.01 \times 10^{-3} + 110)}$$

$\therefore P_{ac} = \mathbf{0.5086W}$

$$\text{Efficiency}(\eta\%) = \frac{P_{dc}}{P_{ac}} \times 100 = \frac{0.2061}{0.5086} \times 100$$

$\therefore$ Efficiency(η%) = **40.52%**

PIV $= -V_m = \mathbf{-14.96V}$

Comparison of theoretical and simulated values:

Parameters	Theoretical Values	Simulated Values
V_m	15V	14.96V
I_m	136.3mA	128.33mA
P_{ac}	0.51136W	0.5086W
P_{dc}	0.207W	0.2061W
Efficiency(η%)	40.48%	40.52%
PIV rating	−15V	−14.96V

Table 1: Numerical 1

Numerical 2:

Simulate a Full Wave Rectifier circuit with input Amplitude V = 140V peak, f = 50 Hz and $R_1 = 110\,\Omega$ using LT spice. Select diode as IN4148. Use 10:1 step down center tap transformer.

Plot the following using LTspice:

a. Primary peak voltage

b. Secondary peak voltage

c. Output voltage across resistor

d. Output voltage across diodes

e. Current flowing through the diodes

f. Current flowing through the circuit

Also, calculate the efficiency of the Full wave Center tapped rectifier circuit.

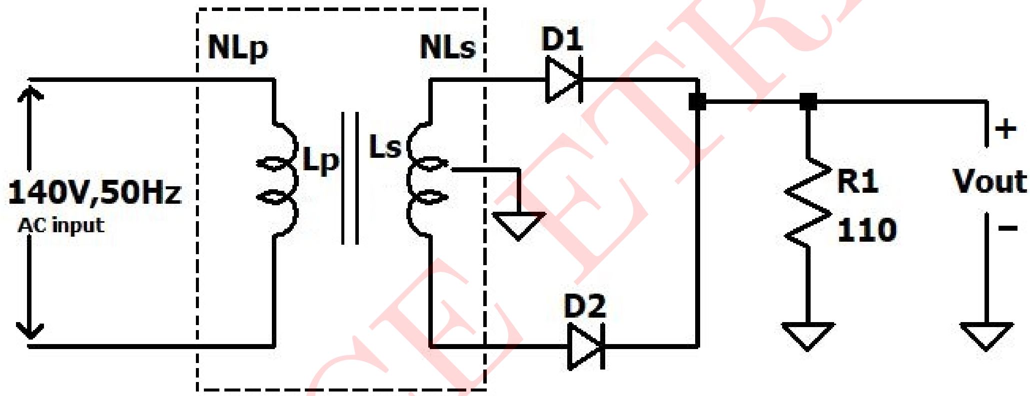

Figure 4: Full Wave Rectifier

Solution:

$$\frac{N_{L_s}}{N_{L_p}} = \frac{1}{10} \qquad R_1 = 110\Omega, V = 140V, f = 50Hz \qquad \text{...(given)}$$

$$\frac{V_m}{V} = \frac{N_{L_s}}{N_{L_p}}$$

where V_m is secondary voltage and V is input voltage.

$$\therefore V_m = \frac{1}{10} \times 140 = \mathbf{14V}$$

$$I_m = \frac{V_m}{(R_s + R_1)} = \frac{14}{(0.01 \times 10^{-3} + 110)}$$

$$\therefore I_m = \mathbf{127.2mA}$$

$$P_{dc} = \frac{(2I_m)^2}{\pi^2} \times R_1 = \frac{(2 \times 127.2 \times 10^{-3})^2 \times 110}{(3.1415)^2}$$

$$\therefore P_{dc} = \mathbf{0.7213W}$$

$$P_{ac} = \frac{I_m^2}{2} \times (R_s + R_1) = \frac{(127.2 \times 10^{-3}) \times (0.01 \times 10^{-3} + 110)}{2}$$

$$\therefore P_{ac} = \mathbf{0.8898W}$$

$$\text{Efficiency}(\eta\%) = \frac{P_{dc}}{P_{ac}} \times 100 = \frac{0.7213}{0.8898} \times 100$$

$$\therefore \text{Efficiency}(\eta\%) = \mathbf{81.063\%}$$

$$\text{PIV} = -V_m = \mathbf{-14V}$$

SIMULATED RESULTS:

Above circuit is simulated in LTspice. The results are presented below:

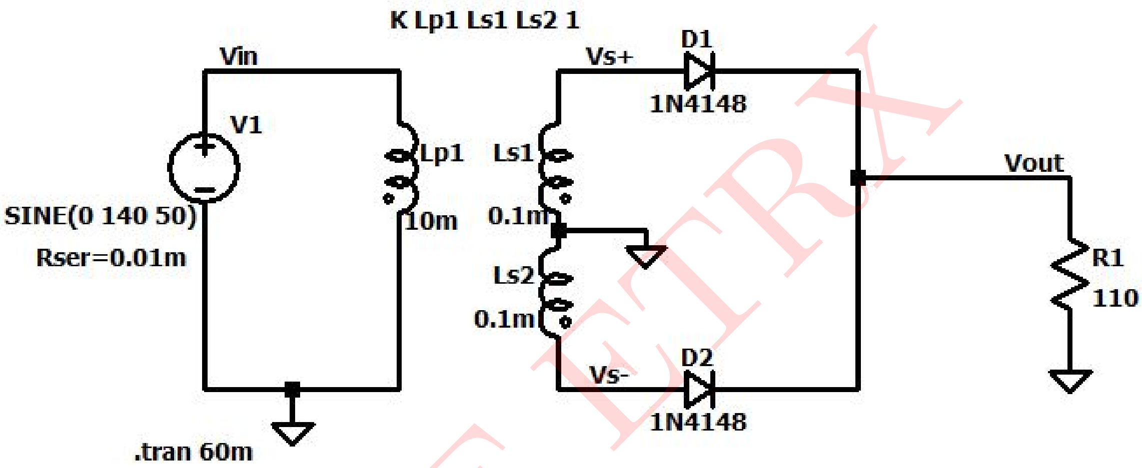

Figure 5: Circuit Schematic for Full Wave Rectifier

Graphs are shown in Figure 6.

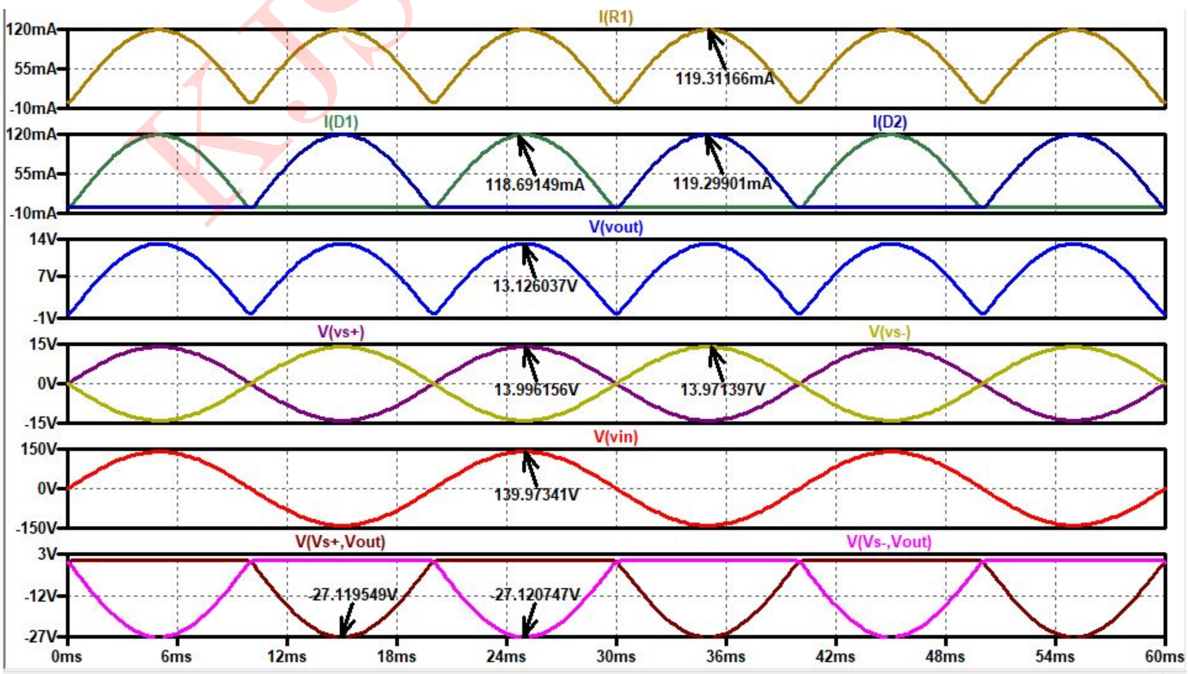

Figure 6: Graphs for Figure 5

For Figure 5,

$V_m = \mathbf{13.126V}, I_m = \mathbf{119.31mA}$ ..(from Figure 6)

$$P_{dc} = \frac{(2I_m)^2}{\pi^2} \times R_1 = \frac{(2 \times 119.31 \times 10^{-3})^2 \times 110}{(3.1415)^2}$$

$\therefore P_{dc} = \mathbf{0.6346W}$

$$P_{ac} = \frac{I_m^2}{2} \times (R_s + R_1) = \frac{(127.2 \times 10^{-3}) \times (0.01 \times 10^{-3} + 110)}{2}$$

$\therefore P_{ac} = \mathbf{0.7829W}$

$$\text{Efficiency}(\eta\%) = \frac{P_{dc}}{P_{ac}} \times 100 = \frac{0.7213}{0.8898} \times 100$$

$\therefore$ Efficiency(η%) $=$ **81.057%**

PIV $= -V_m = \mathbf{-13.126V}$

Comparison of theoretical and simulated values:

Parameters	Theoretical Values	Simulated Values
V_m	14V	13.126V
I_m	127.2mA	119.31mA
P_{ac}	0.8898W	0.7829W
P_{dc}	0.7213W	0.6346W
Efficiency(η%)	81.063%	81.057%
PIV rating	−14V	−13.126V

Table 2: Numerical 2

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