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 = 110V peak, f = 60 Hz and $R_L = 75\Omega$ 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.

Solution:

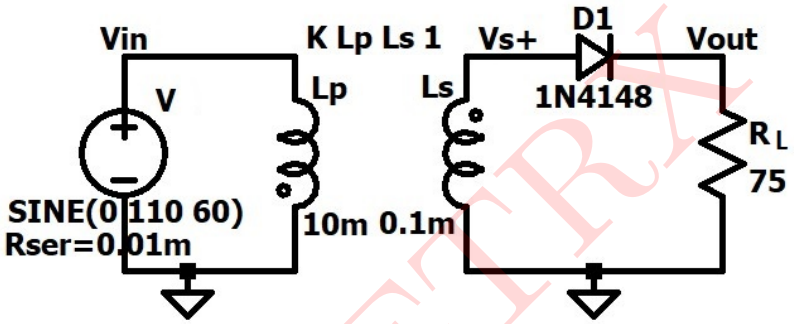

Figure 1: Circuit 1

$$\frac{N_1}{N_2} = \frac{E_1}{E_2}$$
$$\frac{N_1}{N_2} = \frac{10}{1}$$
$V_{in} = E_1 = 110\text{V}$
$V_{out} = E_2 = 11\text{V}$

Current through the circuit $I_M = \dfrac{V_M}{R_f + R_L}$
$= \dfrac{10.3}{0.00001 + 75}$
$= 0.1373\text{A}$

I_M **= 0.1373A**

Output voltage across resistor $(V_M) = E_2 - V_{D,ON}$
= 11 - 0.7
= 10.3V

V_M **= 10.3V**

$$\text{DC Power } (P_{DC}) = \frac{V_M^2}{\pi^2 \times R_L}$$
$$= \frac{10.3^2}{\pi^2 \times 75}$$
$$= 0.1433\text{W}$$

$$\text{AC Power } (P_{AC}) = \frac{V_M^2}{4(R_f + R_L)}$$
$$= \frac{10.3^2}{4(0.00001 + 75)}$$
$$= 0.3536\text{W}$$

$P_{DC} = \mathbf{0.1433W}$
$P_{AC} = \mathbf{0.3536W}$

$$\text{Efficiency } (\eta) = \frac{P_{DC} \times 100}{P_{AC}}$$
$$= \frac{0.1433 \times 100}{0.3536}$$
$$= 40.526\%$$

$\eta = \mathbf{40.526\%}$

PIV rating on D $= -V_M = -11\text{V}$

Waveforms:

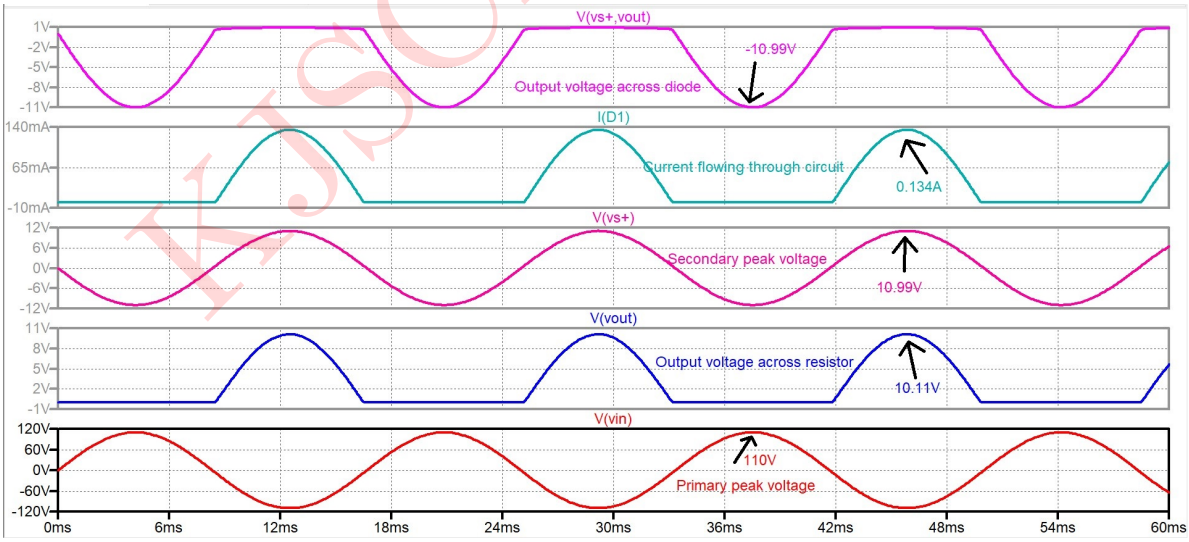

Figure 2: Circuit Waveforms

SIMULATED RESULTS:

The given circuit is simulated in LTspice and the results obtained are as follows:

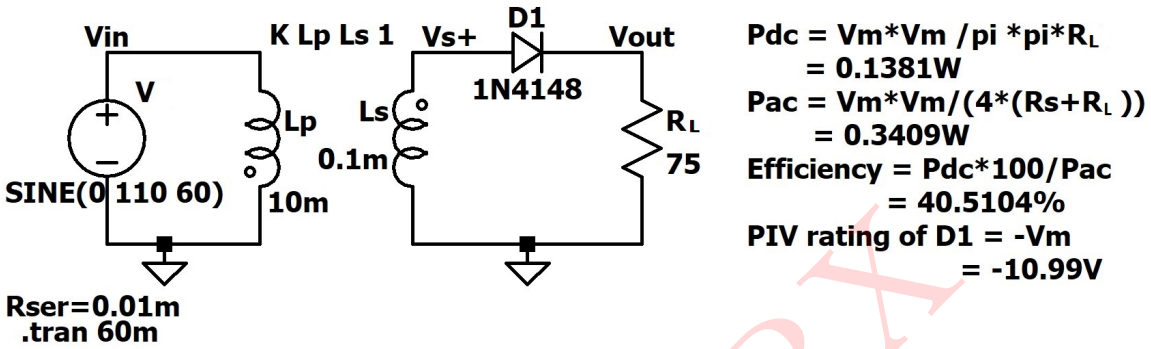

Figure 3: Circuit Schematic and Simulated Results

Comparison of theoretical and simulated values:

Parameters	Theoretical Values	Simulated Values
Output peak voltage (V_M)	10.3V	10.11V
Output peak current (I_M)	0.1373A	0.134A
AC Power	0.3536W	0.3409W
DC Power	0.1433W	0.1381W
Efficiency (η)	40.526%	40.5104%
PIV rating	-11V	-10.99V

Table 1: Numerical 1

Numerical 2: Simulate a full wave rectifier circuit with input Amplitude = 1210V peak, f = 50 Hz and $R_L = 50\Omega$ 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 diodes
(f) Current flowing through the circuit
(g) Efficiency of the full wave rectifier circuit.

Solution:

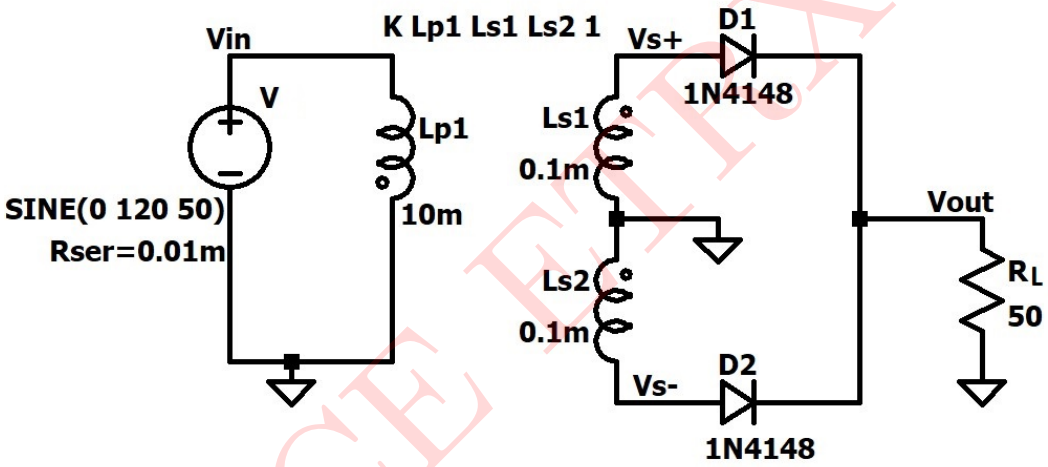

Figure 4: Circuit 2

$$\frac{N_1}{N_2} = \frac{E_1}{E_2}$$
$$\frac{N_1}{N_2} = \frac{10}{1}$$
$V_{in} = E_1 = 120\text{V}$
$V_{out} = E_2 = 12\text{V}$

Current through the circuit $I_M = \dfrac{V_M}{R_f + R_L}$
$= \dfrac{11.3}{0.00001 + 50}$
$= 0.226\text{A}$

I_M **= 0.226A**

Output voltage across resistor $(V_M) = E_2 - V_{D,ON}$
= 10 - 0.7
= 11.3V

V_M **= 11.3V**

$I_{D1} = I_{D1} = I_M = 0.226\text{A}$

$$\text{DC Power } (P_{DC}) = \frac{(2I_M)^2 \times R_L}{\pi^2}$$
$$= \frac{(2 \times 0.226)^2 \times 50}{\pi^2}$$
$$= 1.035\text{W}$$

$$\text{AC Power } (P_{AC}) = \frac{I_M^2(R_f + R_L)}{2}$$
$$= \frac{0.226^2(0.00001 + 50)}{2}$$
$$= 1.276\text{W}$$

$P_{DC} = \mathbf{1.035W}$
$P_{AC} = \mathbf{1.276W}$

$$\text{Efficiency } (\eta) = \frac{P_{DC} \times 100}{P_{AC}}$$
$$= \frac{1.035 \times 100}{1.276}$$
$$= 81.112\%$$

$\eta = \mathbf{81.112\%}$

PIV rating on D1 $= -2V_M = -22.6\text{V}$
PIV rating on D2 $= -2V_M = -22.6\text{V}$

Waveforms:

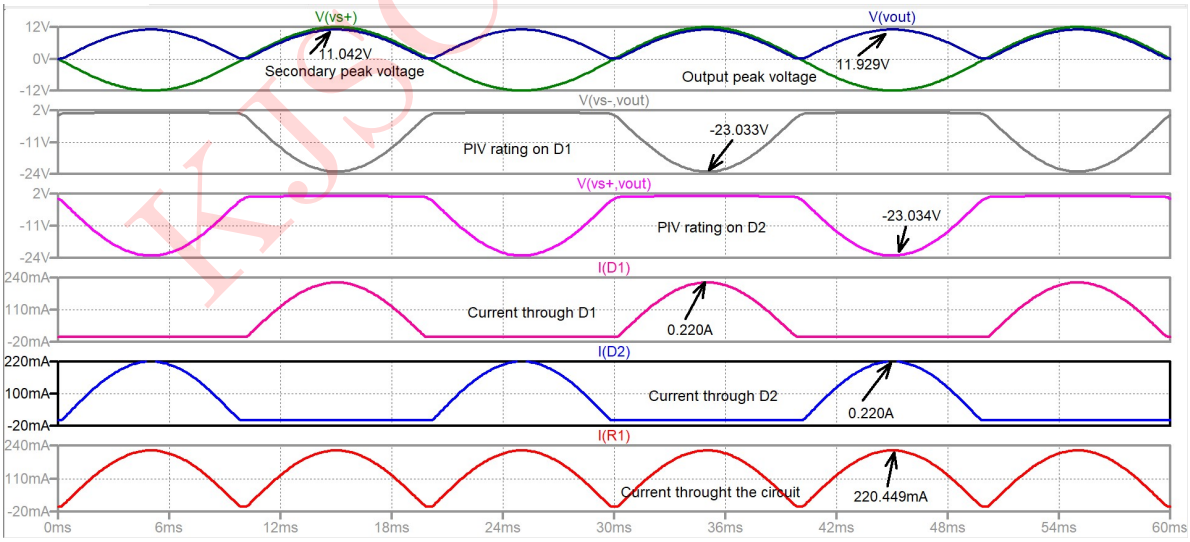

Figure 5: Circuit Waveforms

SIMULATED RESULTS:

The given circuit is simulated in LTspice and the results obtained are as follows:

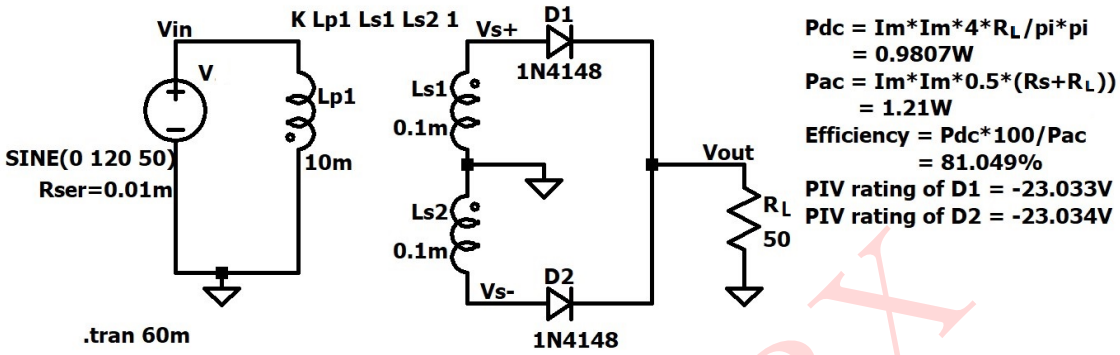

Figure 6: Circuit Schematic and Simulated Results

Comparison of theoretical and simulated values:

Parameters	Theoretical Values	Simulated Values
Output peak voltage (V_M)	11.3V	11.04V
Output peak current (I_M)	0.226A	0.220A
AC Power	1.276W	1.219W
DC Power	1.035W	0.9807W
Efficiency (η)	81.112%	81.049%
PIV rating on D1	−22.6V	−23.033V
PIV rating on D2	−22.6V	−23.034V

Table 2: Numerical 2