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 = 200V peak, f = 50 Hz and $R_L = 120\Omega$ 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.

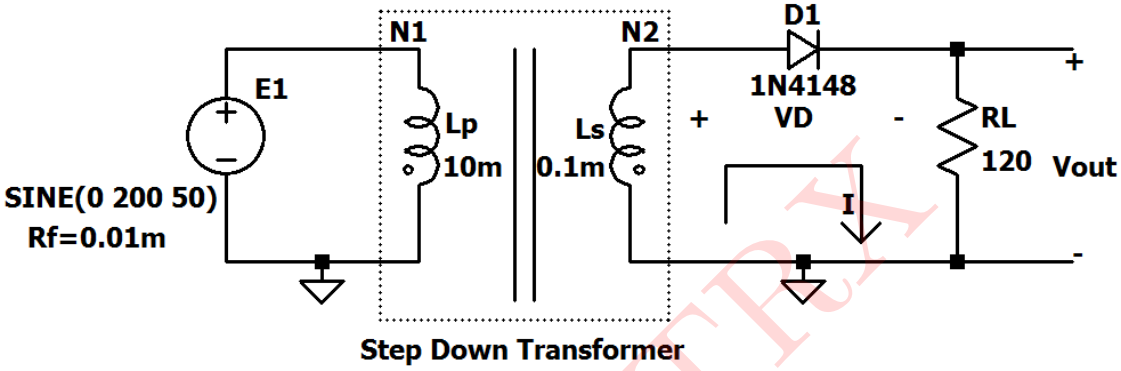

Figure 1: Circuit 1

Solution:

Finding primary peak voltage (E_1):-

From the figure we can see that,

$E_1 = 200V$

Finding secondary peak voltage (E_2):-

The turn ratio is given as:

$$\frac{N_1}{N_2} = \frac{10}{1}$$

But $\frac{N_1}{N_2} = \frac{E_1}{E_2}$

$$\therefore \frac{E_1}{E_2} = \frac{10}{1}$$

$$\therefore E_2 = \frac{E_1 \times 1}{10}$$

$$= \frac{200 \times 1}{10}$$

$$= 20V$$

Finding output voltage across resistor V_m:-

$$\begin{aligned} V_m &= E_2 - V_D \\ &= 20 - 0.7 \\ &= 19.3V \end{aligned}$$

Finding output current flowing through the circuit I_m:-

$$\begin{aligned} I_m &= \frac{V_m}{R_L + R_f} \\ &= \frac{19.3}{120 + 0.01 \times 10^{-3}} \\ &= 160.833mA \end{aligned}$$

Finding output DC Power (P_{dc}) :-

$$\begin{aligned} P_{dc} &= \frac{(V_m)^2}{\pi \times R_L} \\ &= \frac{(19.3)^2}{\pi \times 120} \\ &= 0.314509W \end{aligned}$$

Finding input AC Power (P_{ac}) :-

$$\begin{aligned} P_{ac} &= \frac{(V_m)^2}{4 \times (R_L + R_F)} \\ &= \frac{(19.3)^2}{4 \times (120 + 0.01 \times 10^{-3}} \\ &= 0.776021W \end{aligned}$$

Finding Efficiency (η) :-

$$\begin{aligned} \eta &= \frac{P_{dc}}{P_{ac}} \times 100 \\ &= \frac{0.314509}{0.776021} \times 100 \\ &= 40.5284\ \% \end{aligned}$$

PIV rating of diode $= -V_m = -19.3V$

$\therefore$ **Primary peak voltage = E_1 = 200 V**

$\therefore$ **Secondary peak voltage = E_2 = 20 V**

$\therefore$ **Output voltage across resistor = V_m = 19.3 V**

$\therefore$ **Output current through circuit = I_m = 160.833 mA**

$\therefore$ **DC Power = P_{dc} = 0.314509 W**

$\therefore$ **AC Power = P_{ac} = 0.776021 W**

$\therefore$ **Efficiency = η = 40.4284 %**

$\therefore$ **PIV rating of diode = −19.3 V**

SIMULATED RESULTS:

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

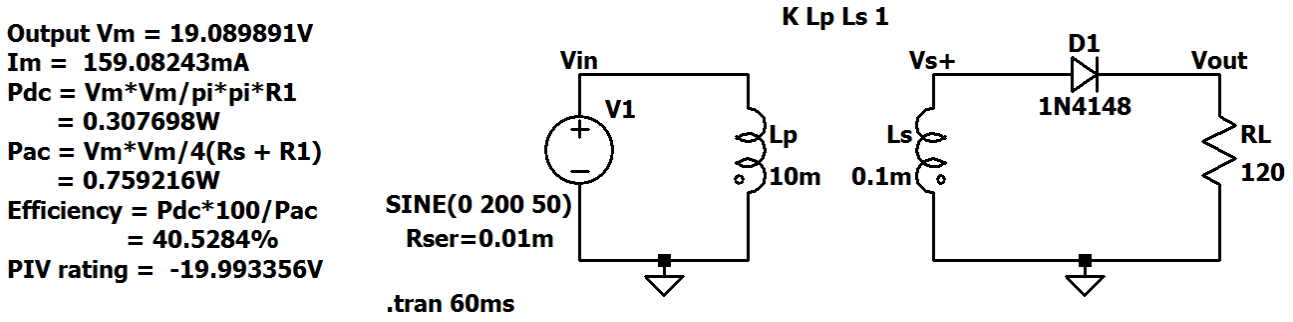

Figure 2: Circuit Schematic for circuit 1

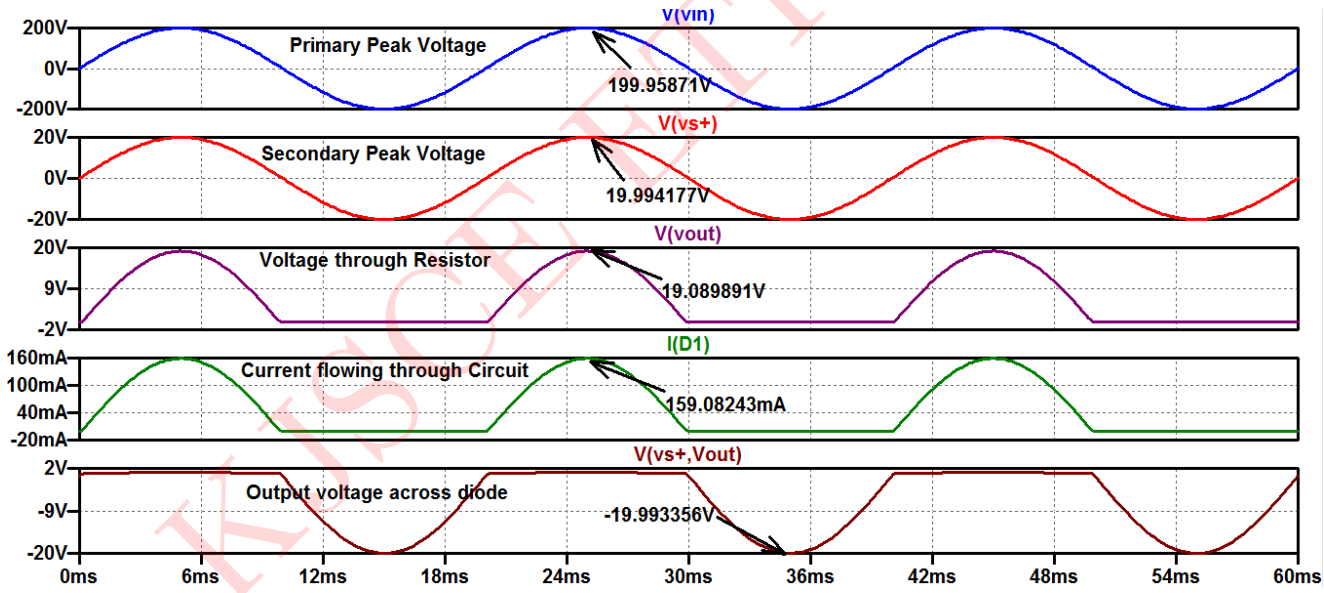

Figure 3: Simulated results for figure 2

Comparison of Theoretical and Simulated values:-

Parameters	**Theoretical values**	**Simulated values**
Output Peak Voltage (V_m)	19.3V	19.089531V
Output Peak Current (I_m)	160.833mA	159.08243mA
AC power	0.776021W	0.759216W
DC Power	0.314509W	0.307698W
Efficiency	40.5284%	40.5284%
PIV rating of diode	−19.3V	−19.993356V

Table 1: Numerical 1

Numerical 2: Simulate a Full wave rectifier circuit with input amplitude = 200V peak, f = 50 Hz and $R_L = 120\Omega$ 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 diodes
e) Current flowing through the diodes
f) Current flowing through the circuit

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

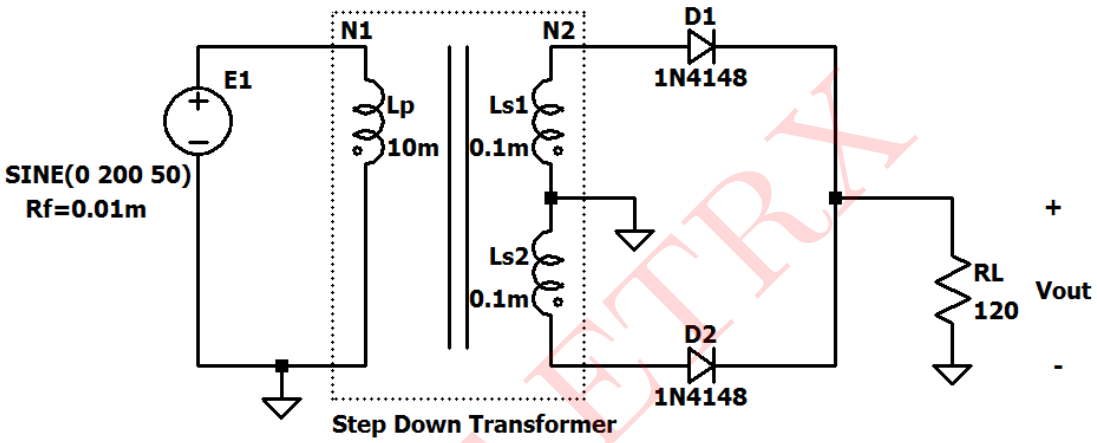

Figure 4: Circuit 2

Solution:

Finding primary peak voltage (E_1):-

From the figure we can see that,

$E_1 = 200V$

Finding secondary peak voltage (E_2):-

The turn ratio is given as:

$$\frac{N_1}{N_2} = \frac{10}{1}$$

But $\frac{N_1}{N_2} = \frac{E_1}{E_2}$

$$\therefore \frac{E_1}{E_2} = \frac{10}{1}$$

$$\therefore E_2 = \frac{E_1 \times 1}{10}$$

$$= \frac{200 \times 1}{10}$$

$$= 20V$$

Finding output voltage across resistor V_m:-

$$V_m = E_2 - V_D$$
$$= 20 - 0.7$$
$$= 19.3V$$

Finding output current flowing through the circuit I_m:-

$$I_m = \frac{V_m}{R_L + R_f}$$
$$= \frac{19.3}{120 + 0.01 \times 10^{-3}}$$
$$= 160.833mA$$

Finding current through diodes :-

Current through diode 1 = Current through diode 2 = I_m

Current through diode 1 = 160.833mA
Current through diode 2 = 160.833mA
Finding output DC Power (P_{dc}) :-

$$P_{dc} = \frac{4 \times (I_m)^2}{\pi^2} \times R_L$$
$$= \frac{4 \times (0.160833)^2}{\pi^2} \times 120$$
$$= 1.258032W$$

Finding input AC Power (P_{ac}) :-

$$P_{ac} = \frac{(I_m)^2}{2}(R_L + R_F)$$
$$= \frac{(0.160833)^2}{2}(120 + 0.01 \times 10^{-3})$$
$$= 1.552035W$$

Finding Efficiency (η) :-

$$\eta = \frac{P_{dc}}{P_{ac}} \times 100$$
$$= \frac{1.258032}{1.552035} \times 100$$
$$= 81.0569\ \%$$

When the diodes are not conducting, the voltage across the diodes is $-2V_m$. This is because the applied reverse voltage (V_m) and voltage across R_L (V_m) get developed across the resistor. So net voltage is $-2V_m$.

PIV rating of Diode 1 = $-\ 2V_m = -2\times\ 19.3V = -\ 38.6V$

PIV rating of Diode 2 = $-\ 2V_m = -2\times\ 19.3V = -\ 38.6V$

$\therefore$ **Primary peak voltage = E_1 = 200 V**

$\therefore$ **Secondary peak voltage = E_2 = 20 V**

$\therefore$ **Output voltage across resistor = V_m = 19.3 V**

$\therefore$ **Output current through circuit = I_m = 160.833 mA**

$\therefore$ **Current through diode 1 = I_m = 160.833 mA**

$\therefore$ **Current through diode 2 = I_m = 160.833 mA**

$\therefore$ **DC Power = P_{dc} = 1.258032 W**

$\therefore$ **AC Power = P_{ac} = 1.552035 W**

$\therefore$ **Efficiency = η = 81.0569 %**

$\therefore$ **PIV rating of diode 1 = −38.6 V**

$\therefore$ **PIV rating of diode 2 = −38.6 V**

SIMULATED RESULTS:

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

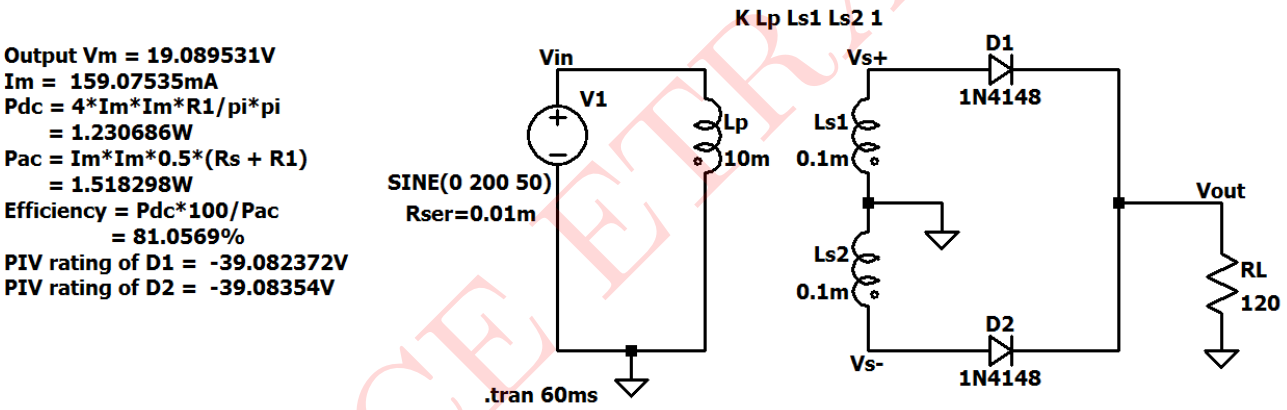

Figure 5: Circuit Schematic for circuit 2

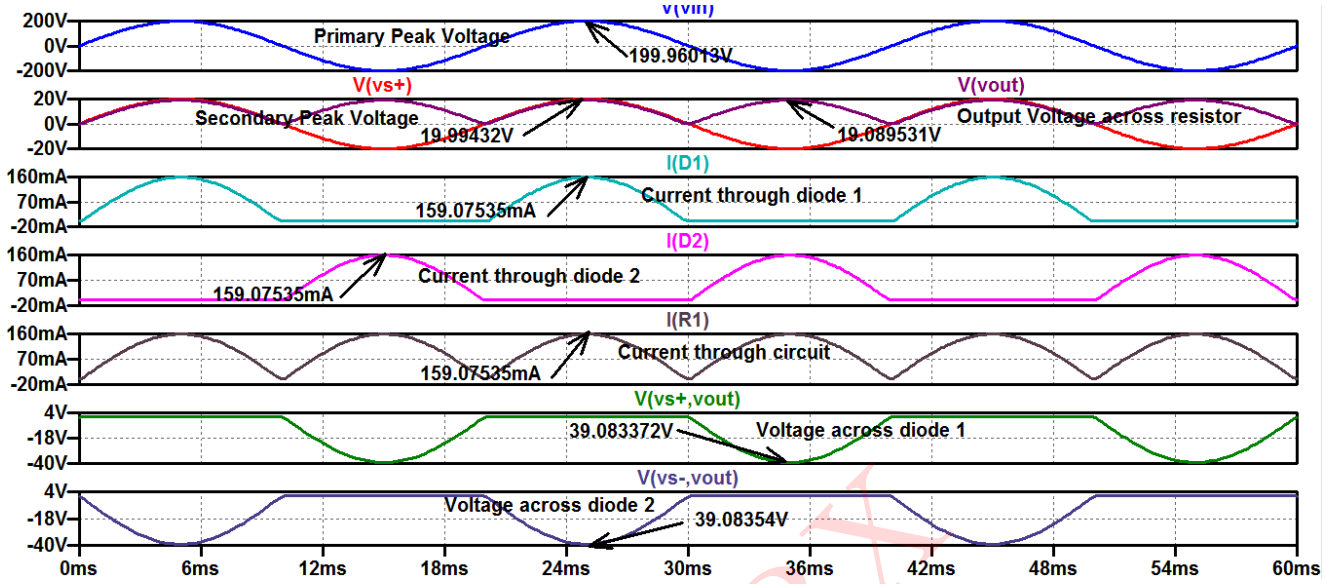

Figure 6: Simulated results for figure 5

Comparison of Theoretical and Simulated values:-

Parameters	Theoretical values	Simulated values
Output Peak Voltage (V_m)	19.3V	19.089531V
Output Peak Current (I_m)	160.833mA	159.07535mA
AC power	1.552035W	1.518298W
DC Power	1.258032W	1.230686W
Efficiency	81.0569%	81.0569%
PIV rating of diode 1	−38.6V	−39.082372V
PIV rating of diode 2	−38.6V	−39.08354V

Table 2: Numerical 2