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 = 100V peak, f = 50 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:

From the given data, the half wave rectifier can be represented as shown in Circuit 1.

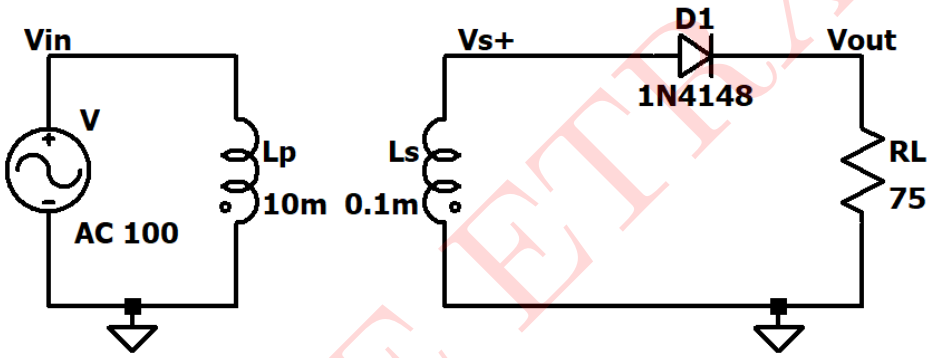

Figure 1: Circuit 1

Given:

$V_P = 100V, f = 50Hz, R_L = 75\Omega$

Transformer is a 10:1 step down transformer

The transformer consists of a primary coil L_P and a secondary coil L_S. The ratio of the transformer is given as 10:1

$$\frac{V_P}{V_S} = \frac{10}{1}$$

$$\therefore \mathrm{V}_S = V_m = \frac{100}{10} = 10$$

$$\therefore \mathrm{V}_m = 10V$$

The DC Output Power is given by:

$$P_{DC} = \frac{V_{DC}^2}{R_L} = \frac{V_m^2}{\pi^2 \times R_L} = \frac{10^2}{\pi^2 \times 75} = 0.135$$

$$\therefore \ \mathrm{P}_{DC} = 0.135W$$

The AC Output Power is given by:

$$P_{AC} = \frac{V_{RMS}^2}{R_F + R_L} = \frac{V_m^2}{4 \times (R_F + R_L)} = \frac{10^2}{4 \times (75 + 0.01)} = 0.33$$

$\therefore$ $P_{AC} = 0.33W$

Efficiency of the transformer is given by:

$$\eta = \frac{P_{DC}}{P_{AC}} \times 100 = \frac{0.135}{0.33} \times 100 = 40.91$$

$\therefore \eta = 40.91\%$

The Peak Inverse Voltage Rating (PIV Rating) of the transformer is given by:

PIV Rating $= -V_m = -10V$

The current through the secondary can be calculated as:

$$I_m = \frac{V_m}{R_F + R_L} = \frac{10}{0.01 + 75} = 0.133$$

$\therefore$ $I_m = 0.133A$

SIMULATED RESULTS

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

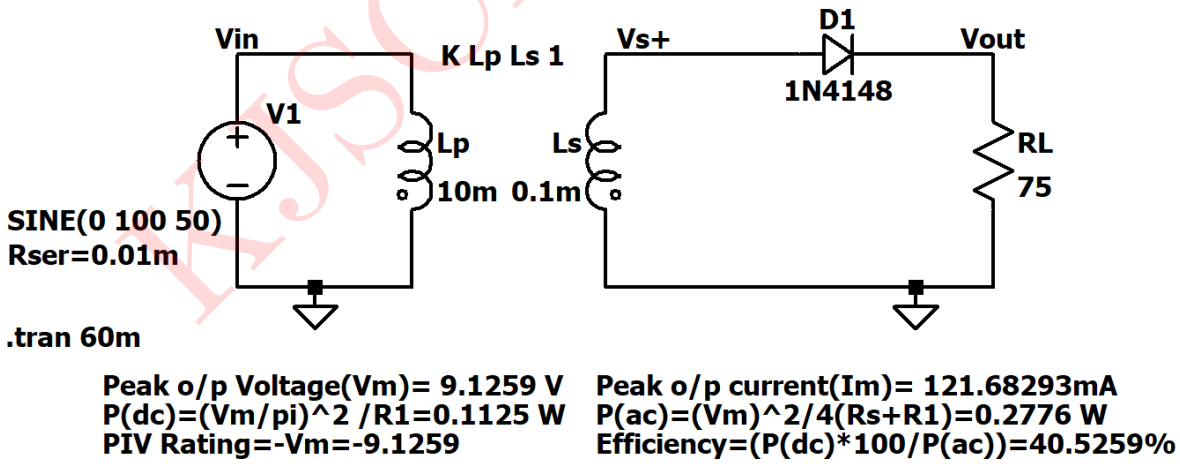

Figure 2: Circuit Schematic

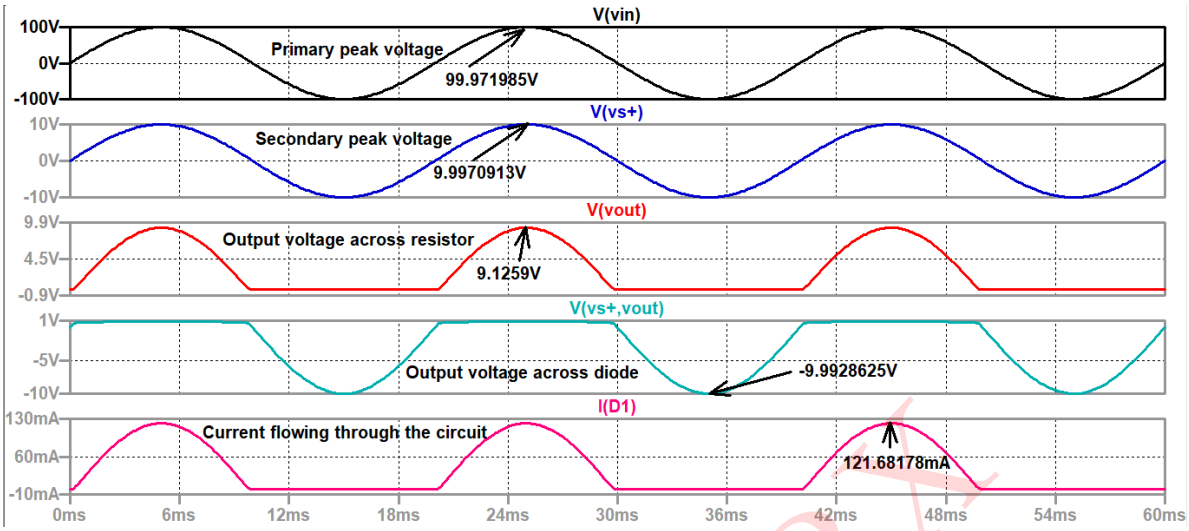

Figure 3: Simulated Results

Comparison of calculated and simulated values:

Parameter	Calculated Value	Simulated Value
V_m	10V	9.1259V
I_m	0.133A	0.12168A
P_{DC}	0.33W	0.2776W
P_{AC}	0.135W	0.1125W
η	40.91%	40.5259%
PIV Rating	$-10V$	$-9.1259V$

Table 1: Numerical 1

Numerical 2: Simulate a Full wave rectifier circuit with input Amplitude = 150V peak, f = 50 Hz, and $R_L = 150\Omega$ 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.

Solution:

From the given data, the centre-tapped full wave rectifier can be represented as shown in Circuit 2.

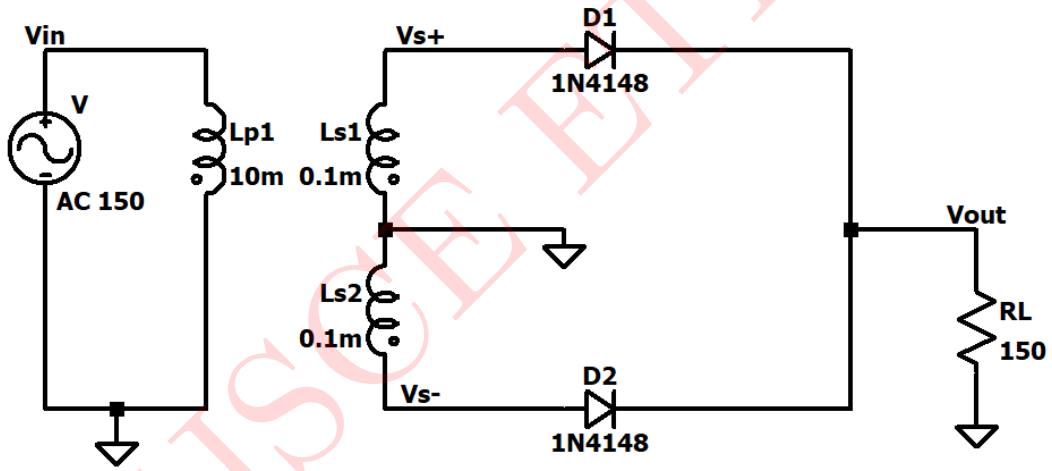

Figure 4: Circuit 2

Given:
$V_P = 150V, f = 50Hz, R_L = 150\Omega$
Transformer is a 10:1 step down transformer

The transformer consists of a primary coil L_{P1} and two secondary coils L_{S1} and L_{S2} which are centre-tapped. The ratio of the transformer is given as 10:1

$$\frac{V_P}{V_S} = \frac{10}{1}$$

$$\therefore \mathrm{V}_S = V_m = \frac{V_P}{10} = \frac{150}{10} = 15$$

$$\therefore \mathrm{V}_m = 15V$$

The current through the secondary can be calculated as:

$$I_m = \frac{V_m}{R_F + R_L} = \frac{15}{0.01 + 150} = 99.99$$

$$\therefore \ \mathrm{I}_m = 99.99A$$

The DC Output Power is given by:

$$P_{DC} = \left(\frac{2 \times I_m}{\pi}\right)^2 \times R_L = \left(\frac{2 \times 99.99}{\pi}\right)^2 \times 150 = 0.6078$$

$\therefore$ $P_{DC} = 0.6078W$

The AC Output Power is given by:

$$P_{AC} = \frac{I_m^2 \times (R_F + R_L)}{2} = \frac{99.99^2 \times (0.01 + 150)}{2} = 0.7499$$

$\therefore$ $P_{AC} = 0.7499W$

Efficiency of the transformer is given by:

$$\eta = \frac{P_{DC}}{P_{AC}} \times 100 = \frac{0.6078}{0.7499} \times 100 = 81.05$$

$\therefore \eta = 81.05\%$

The Peak Inverse Voltage Rating (PIV Rating) of the transformer is given by:

PIV Rating $= -2V_m = -(2 \times 15) = -30V$

$\therefore$ PIV Rating = -30V

SIMULATED RESULTS

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

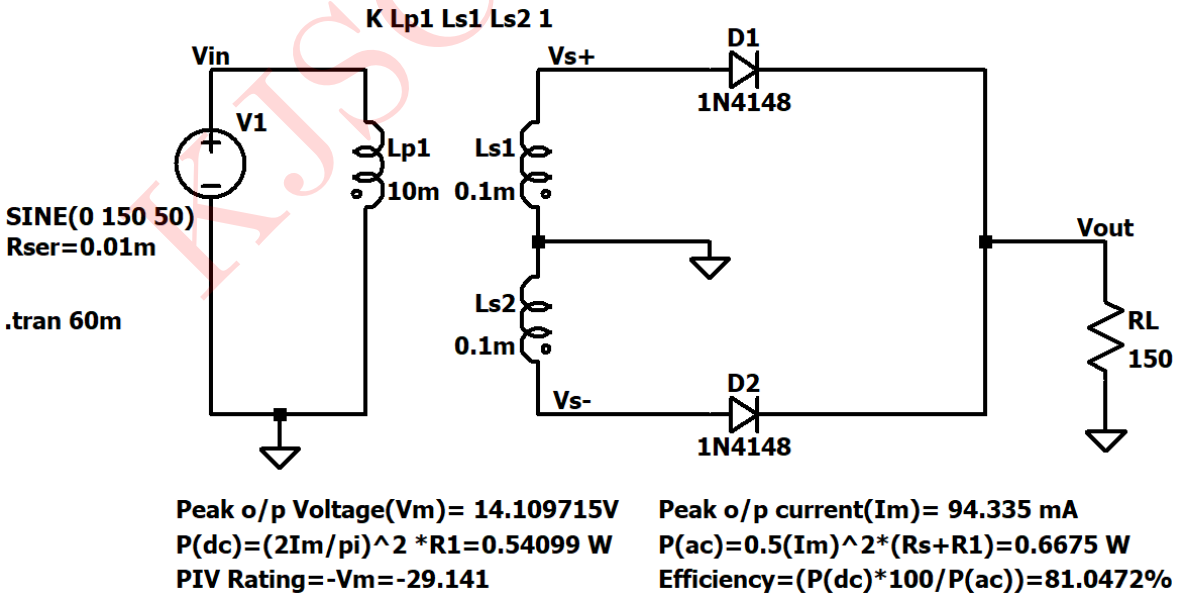

Figure 5: Circuit Schematic

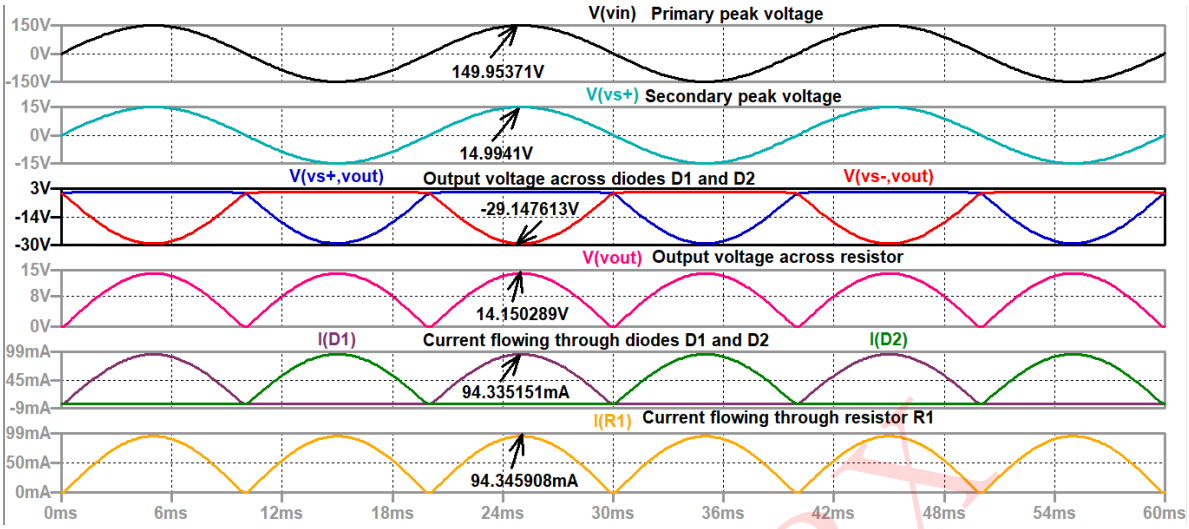

Figure 6: Simulated Results

Comparison of calculated and simulated values:

Quantity	Calculated Value	Simulated Value
V_m	15V	14.1097V
I_m	99.99mA	94.335mA
P_{DC}	0.6078W	0.54099W
P_{AC}	0.7499W	0.6675W
η	81.05%	81.0472%
PIV Rating	$-30V$	$-29.141V$

Table 2: Numerical 2