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 = 220V peak, $f = 50$ Hz and $R_L = 50$ 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:

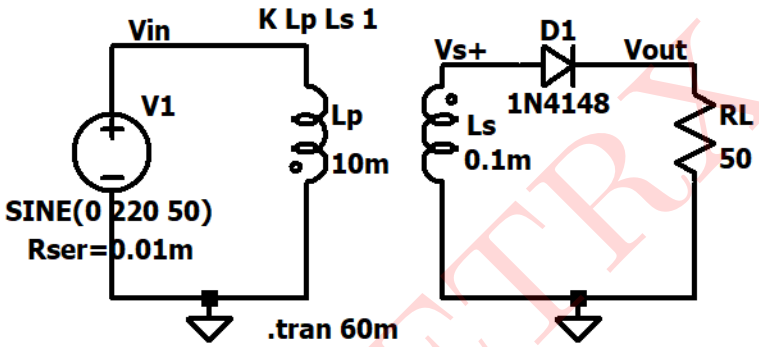

Figure 1: Circuit 1

Given: $R_L = 50\ \Omega$, $R_f = 0.01\ m\Omega$, $f = 50$ Hz, $V_1 = 220$ V
Due to 10:1 step down transformer :

$$\therefore V_m = \frac{V_1}{10} = \frac{220}{10} = 22 \text{ V}$$

$$I_m = \frac{V_m}{R_f + R_L} = \frac{22}{0.01 \times 10^{-3} + 50} = 0.439999\ A = 439.999\ mA$$

DC Power Output :

$$P_{DC} = \frac{(V_{DC})^2}{R_L} = \frac{(V_m)^2}{(\pi)^2} \times \frac{1}{R_L}$$
$$= \frac{(22)^2}{(\pi)^2} \times \frac{1}{50} = 0.9807 \text{ W}$$

AC Power Input :

$$P_{AC} = \frac{(V_{rms})^2}{R_f + R_L} = \frac{(V_m)^2}{4 \times (R_f + R_L)}$$
$$= \frac{(22)^2}{4 \times (0.01 \times 10^{-3} + 50)}$$
$$= 2.4199 \text{ W}$$

Efficiency of half wave rectifier :

$$\% \ \eta_{HWR} = \frac{\text{DC Power Output}}{\text{AC Power Input}} \times 100$$
$$= \frac{P_{DC}}{P_{AC}} \times 100 = \frac{0.9807}{2.4199} \times 100 = 40.5248 \ \%$$

PIV rating of $D_1 = -V_m = -22$ V

SIMULATED RESULTS:

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

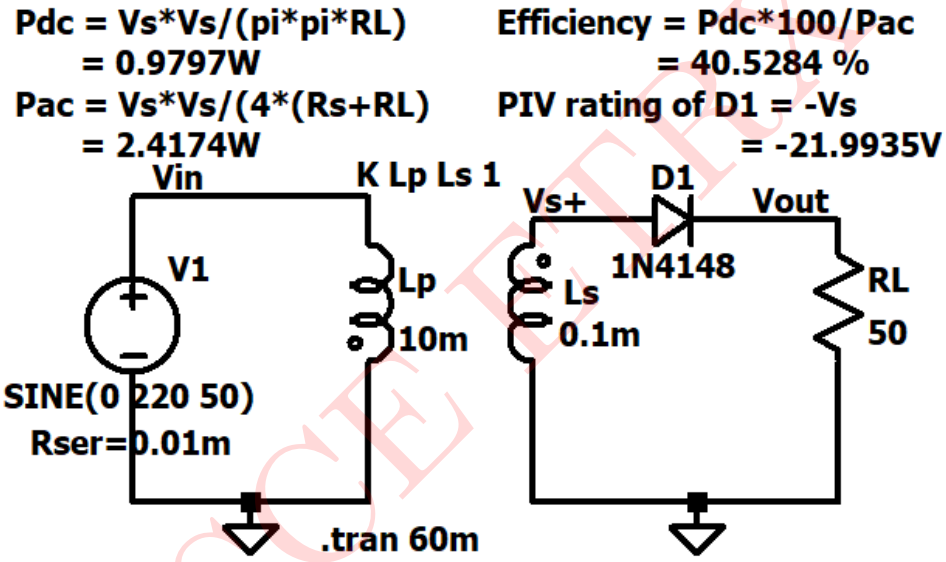

Figure 2: Circuit Schematic for P_{DC}, P_{AC}, Efficiency, and PIV rating of D_1

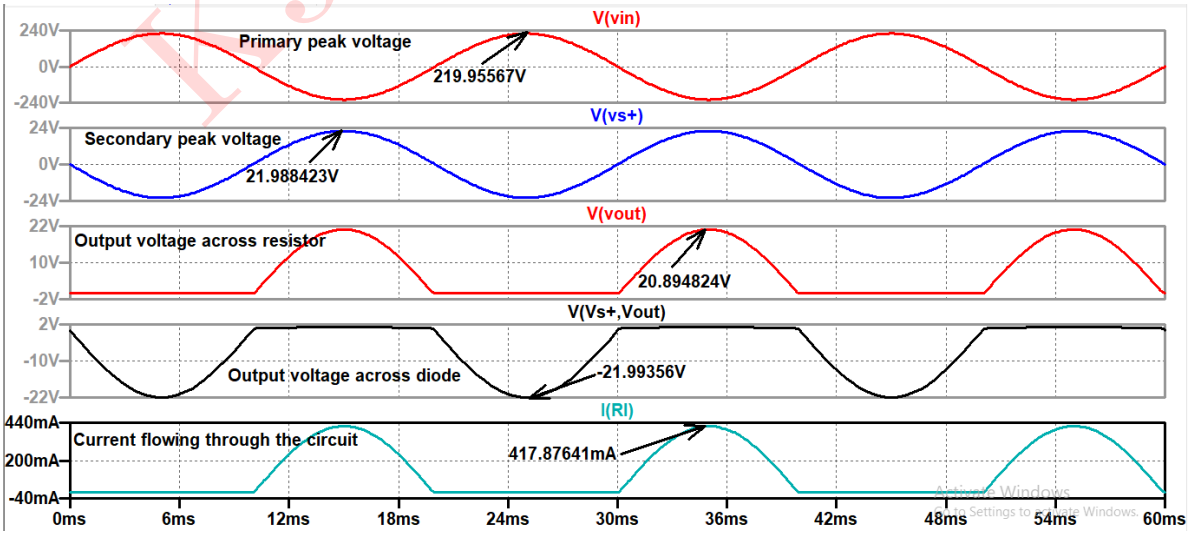

Figure 3: Simulated Results for V_1, V_m, Output voltage across resistor, Output voltage across diode and Current flowing through the circuit

Comparison of Theoretical and Simulated Values:-

Parameters	**Theoretical Values**	**Simulated Values**
Output Peak Voltage(V_m)	22 V	21.9884 V
Output Peak Current(I_m)	439.999 mA	417.8764 mA
DC Power Output(P_{DC})	0.9807 W	0.9797 W
AC Power Output(P_{AC})	2.4199 W	2.4174 W
Efficiency	40.5248 %	40.5284 %
PIV rating	-22 V	-21.9884 V

Table 1: Numerical 1

Numerical 2: Simulate a Full wave rectifier circuit with input Amplitude = 180 V peak, f = 50 Hz and $R_1 = 80\ \Omega$ 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 circuit
Also, calculate the efficiency of the Full Wave Center tapped rectifier circuit.

Solution:

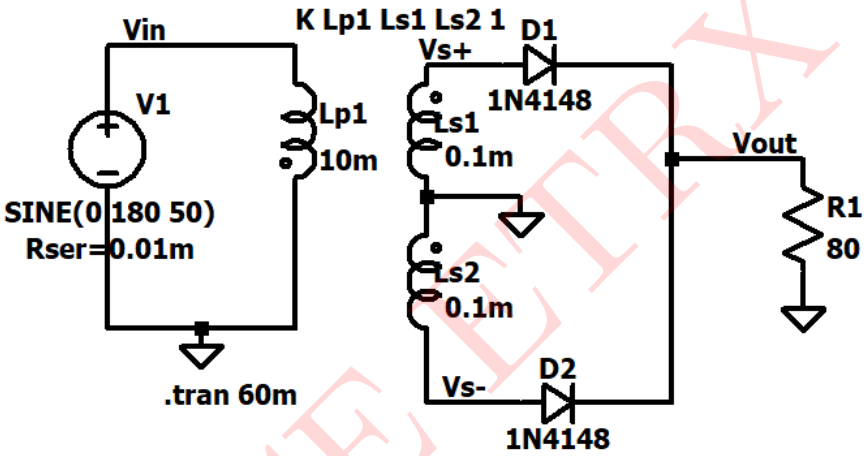

Figure 4: Circuit 2

Given: $R_L = 80\ \Omega$, $R_f = 0.01\ m\Omega$, $f = 50$ Hz, $V_1 = 180$ V
Due to 10:1 step down transformer :

$$\therefore V_m = \frac{V_1}{10} = \frac{180}{10} = 18 \text{ V}$$

$$I_m = \frac{V_m}{R_f + R_L} = \frac{18}{0.01 \times 10^{-3} + 80} = 224.999mA$$

Voltage across diode :
$V_D = V_{D1} = V_{D2} = -2 \times V_m = -36$ V

DC Power Output :

$$P_{DC} = (I_{DC})^2 \times R_L = \frac{(2I_m)^2}{(\pi)^2} \times R_L$$
$$= \frac{(2 \times 224.999 \times 10^{-3})^2}{(\pi)^2} \times 80 = 1.6399 \text{ W}$$

AC Power Input :

$$P_{AC} = (I_{rms})^2 \times (R_f + R_L) = \frac{(I_m)^2 \times (R_f + R_L)}{2}$$
$$= \frac{(224.999 \times 10^{-3})^2 \times (0.01 \times 10^{-3} + 80)}{2} = 2.0232 \text{ W}$$

Efficiency of full wave rectifier :

$$\% \ \eta_{HWR} = \frac{\text{DC Power Output}}{\text{AC Power Input}} \times 100$$
$$= \frac{P_{DC}}{P_{AC}} \times 100 = \frac{1.6599}{2.0232} \times 100 = 81.0569 \ \%$$

PIV rating of $D_1 = -2V_m = -36$V

SIMULATED RESULTS:

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

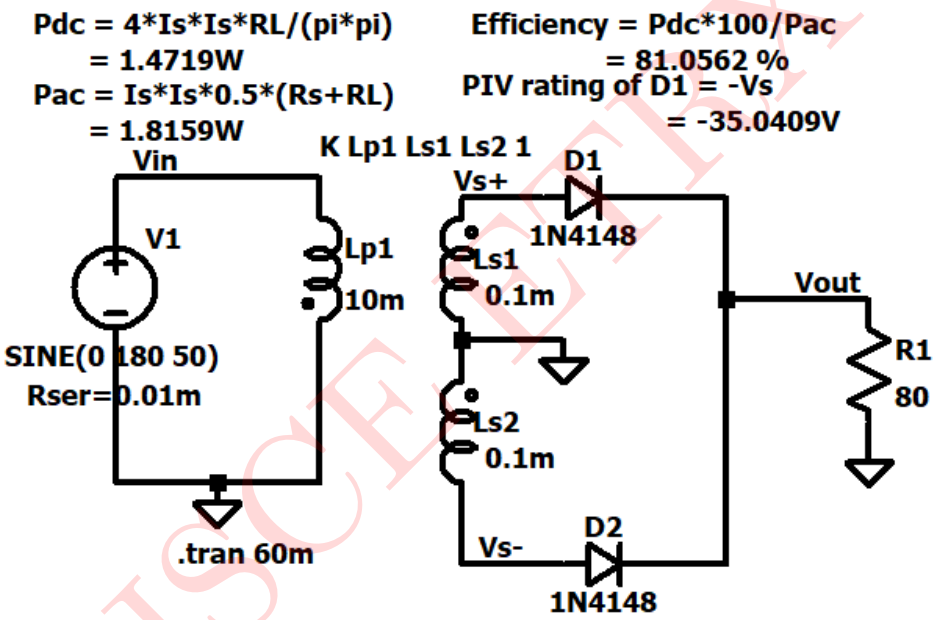

Figure 5: Circuit Schematic for P_{DC}, P_{AC}, Efficiency, and PIV rating of D_1

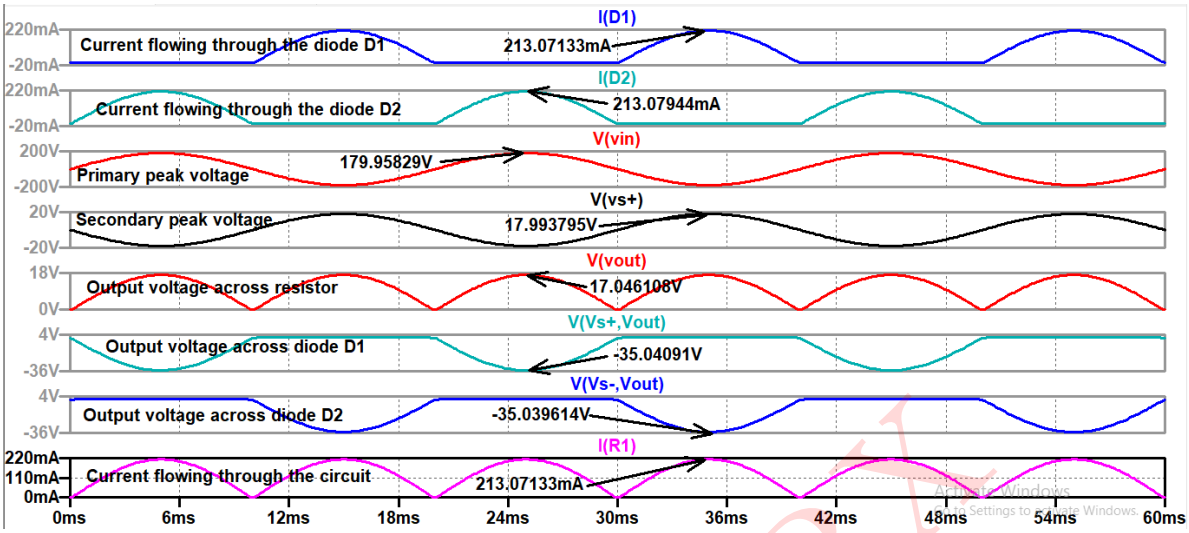

Figure 6: Simulated Results for V_1, V_m, Output voltage across resistor, Output voltage across diode D_1, Output voltage across diode D_2, Current flowing through the diode D_1, Current flowing through the diode D_2 and Current flowing through the circuit

Comparison of Theoretical and Simulated Values:-

Parameters	Theoretical Values	Simulated Values
Output Peak Voltage(V_m)	18 V	17.9937 V
Output Peak Current(I_m)	224.999 mA	213.0713 mA
DC Power Output(P_{DC})	1.6399 W	1.4719 W
AC Power Output(P_{AC})	2.0232 W	1.8159 W
Efficiency	81.0569 %	81.0562 %
PIV rating	-36 V	-35.0409 V

Table 2: Numerical 2

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