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, $f = 50Hz$, and $R_L = 50$ using LTspice. Select diode as IN4148. Use a 10:1 step down transformer. Calculate the efficiency of the Half wave rectifier circuit.
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

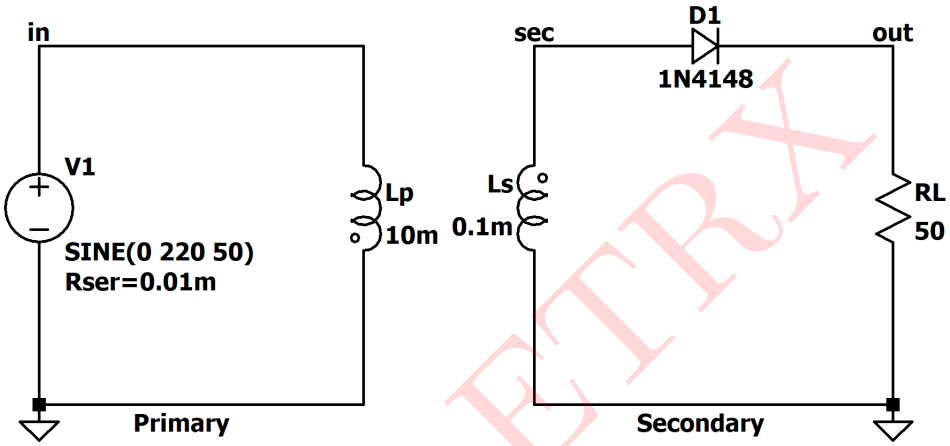

Figure 1: Circuit 1

Solution:

Since the transformer is a 10:1 step down transformer:

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

$$V_S = \frac{220}{10}$$

$$V_S = 22V$$

Current in the secondary winding:

$$I_S = \frac{V_s}{R_s} = \frac{V_s}{R_L}$$

$$I_S = \frac{22}{50}$$

$$I_S = 0.44A$$

AC Power in the transformer for a half wave rectifier, P_{AC}:

$$P_{AC} = \frac{V_S^2}{4\,(R_S + R_L)}$$

$$P_{AC} = \frac{22^2}{4\,(10^{-5} + 50)}$$

$$P_{AC} = 2.4119W$$

DC Power in the transformer for a half wave rectifier, P_{AC}:

$$P_{DC} = \frac{V_S^2}{\pi^2 R_L}$$

$$P_{DC} = \frac{22^2}{\pi^2 \times 50}$$

$$P_{DC} = 0.9808W$$

% Efficiency of the transformer, η:

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

$$\eta = \frac{0.9808}{2.4119} \times 100$$

$$\eta = 40.66\%$$

SIMULATED RESULTS:

The following circuit has been simulated in LTspice and the readings obtained are as follows:

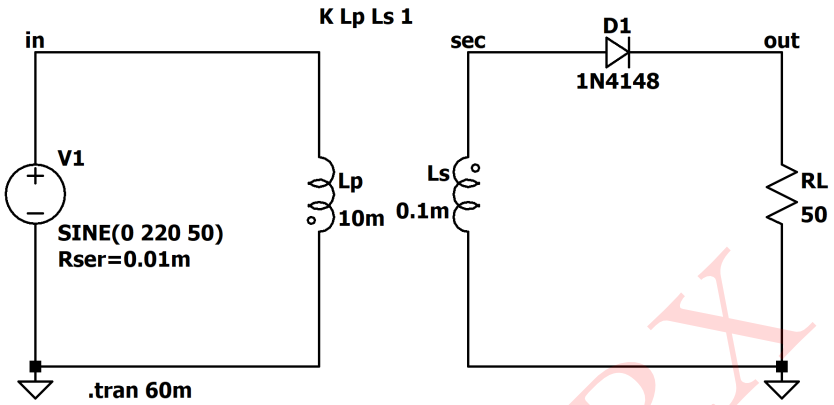

Figure 2: Circuit Schematic

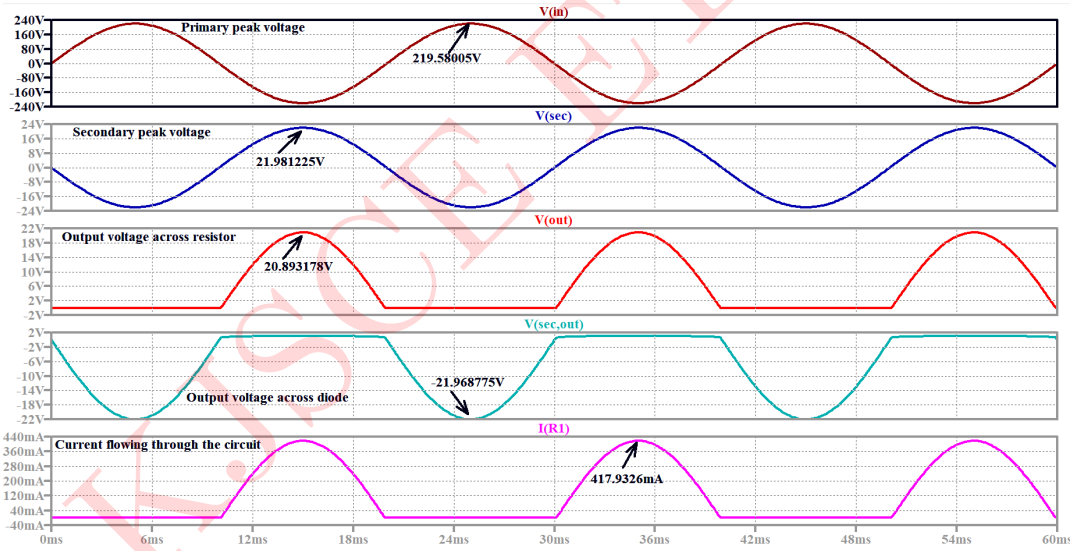

Figure 3: Simulated Results

Verifying the Calculated Values with Simulated Values:

Quantity	Calculated Value	Simulated Value
$(V_P)_{max}$	$220V$	$219.58V$
$(V_S)_{max}$	$22V$	$21.98V$
$(V_R)_{max}$	$21.3V$	$20.89V$
$(I_S)_{max}$	$440mA$	$417.93mA$
P_{DC}	$0.9808W$	$0.979W$
P_{AC}	$2.4119W$	$2.4156W$
η	40.66%	40.528%
PIV rating	$-22V$	$-21.97V$

Table 1: Numerical 1

Numerical 2: Simulate a Full wave rectifier circuit with input Amplitude = $180V$ peak, $f = 50Hz$, and $R_L = 80$ using LTspice. Select diode as IN4148. Calculate the efficiency 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

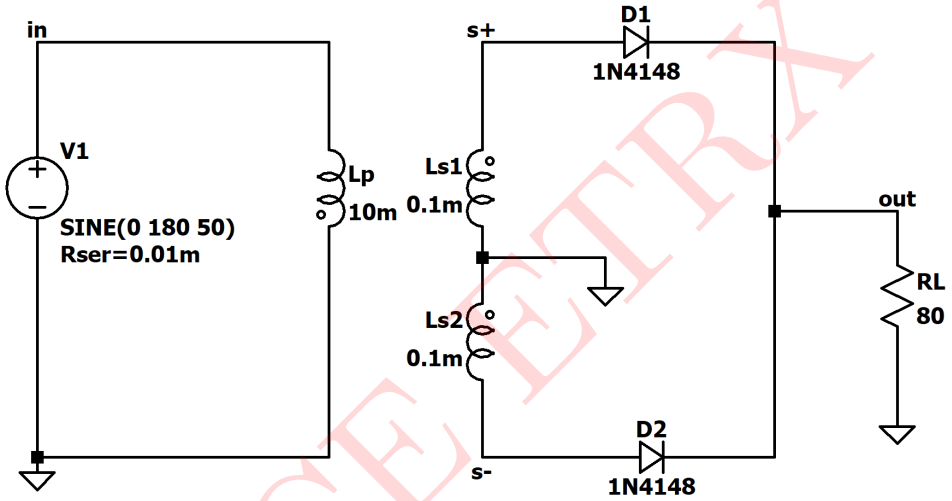

Figure 4: Circuit 2

Solution:

Since the transformer is a 10:1 step down transformer:

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

$$V_S = \frac{180}{10}$$

$$V_S = 18V$$

Current in the secondary winding:

$$I_S = \frac{V_s}{R_s} = \frac{V_s}{R_L}$$

$$I_S = \frac{18}{80}$$

$$I_S = 0.225A$$

AC Power in the transformer for a full wave rectifier, P_{AC}:

$$P_{AC} = \frac{I_S^2}{2} \times (R_S + R_L)$$

$$P_{AC} = \frac{0.225^2}{2} \times 80$$

$$P_{AC} = 2.025W$$

DC Power in the transformer for a full wave rectifier, P_{AC}:

$$P_{DC} = \left(\frac{2I_S}{\pi}\right)^2 \times R_L$$

$$P_{DC} = \left(\frac{2 \times 0.225}{\pi}\right)^2 \times 80$$

$$P_{DC} = 1.641W$$

% Efficiency of the transformer, η:

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

$$\eta = \frac{1.641}{2.025} \times 100$$

$$\eta = 81.037\%$$

SIMULATED RESULTS:

The following circuit has been simulated in LTspice and the readings obtained are as follows:

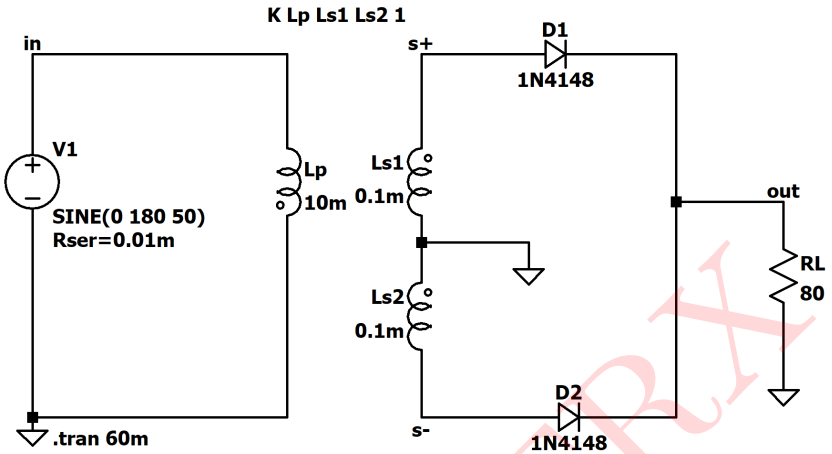

Figure 5: Circuit Schematic

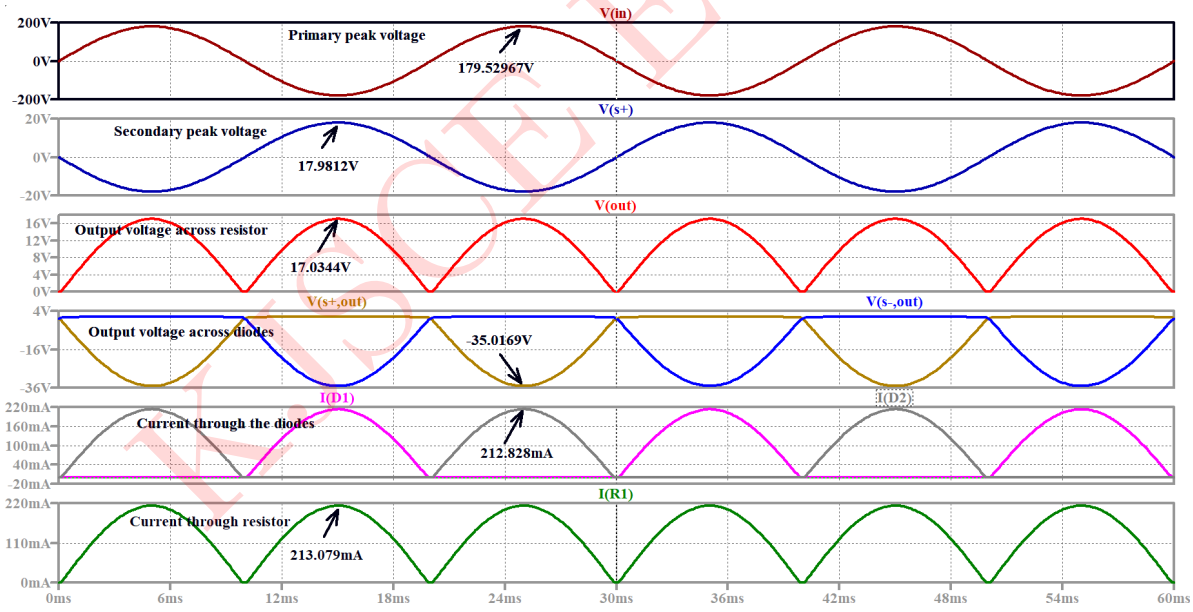

Figure 6: Simulated Results

Verifying the Calculated Values with Simulated Values:

Quantity	Calculated Value	Simulated Value
$(V_P)_{max}$	$180V$	$179.53V$
$(V_S)_{max}$	$18V$	$17.98V$
$(V_R)_{max}$	$17.3V$	$17.03V$
$(I_S)_{max}$	$225mA$	$213mA$
P_{DC}	$1.641W$	$1.471W$
P_{AC}	$2.025W$	$1.815W$
η	81.037%	81.046%
PIV rating	$-36V$	$-35.01V$

Table 2: Numerical 2