INDRAPRASTHA INSTITUTE *of*
INFORMATION TECHNOLOGY
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Department
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Circuit Theory and Devices

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Lab_1: Transformer
Week_1

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Objective: Simulation of Transformer in LTspice and some analysis

Components Used:

- LTSpice as Simulation Software
- Transformer(Ideal Transformer for making a non-ideal Transformer)
- Voltage Source
- Resistors

Diagram:

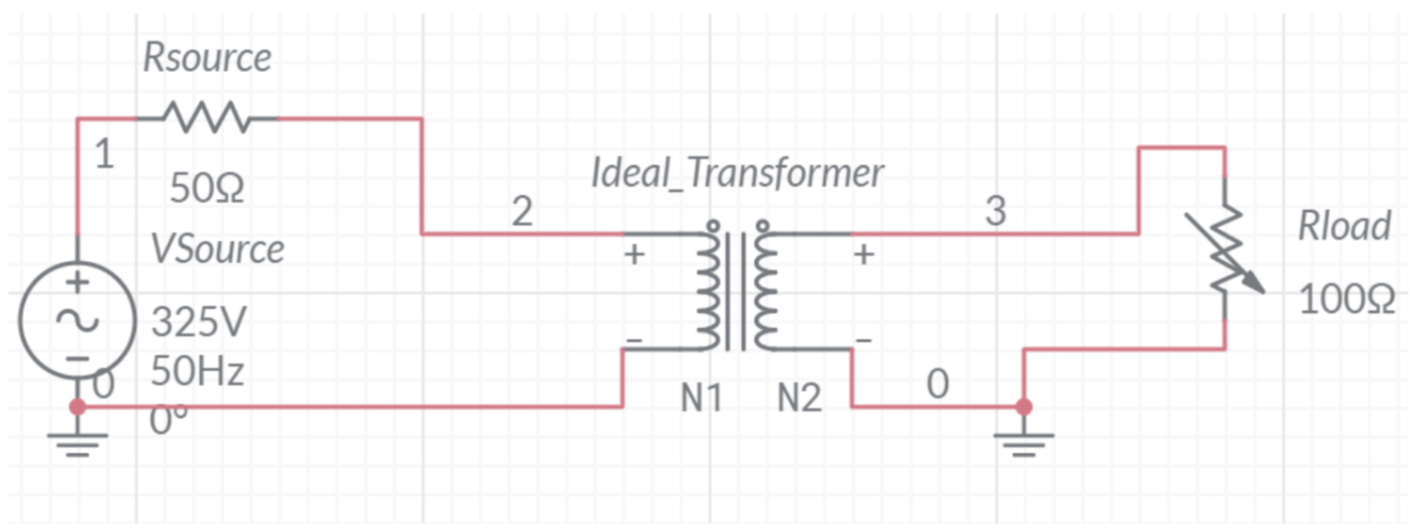


Fig.4 Simulation of the power supply with ideal transformer circuit

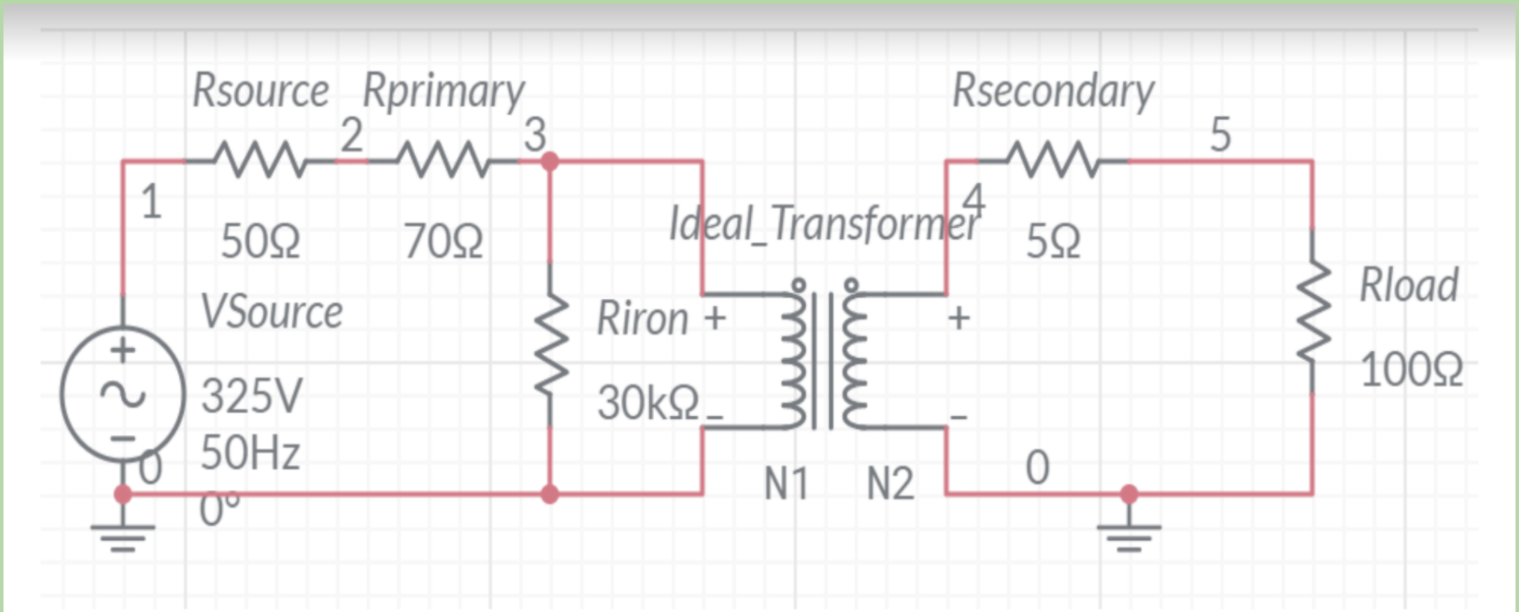


Fig 5 : Simulation of the Non-ideal transformer circuit

Theoretical Calculation:

- For Ideal Transformer :

$$V_{rms} = V_{source} = \frac{V_{peak}}{\sqrt{2}} = \frac{325\ V}{\sqrt{2}} = 229.8097\ V$$

$$I_{rms} = I_{source} = \frac{I_{peak}}{\sqrt{2}} = \frac{13.75\ mA}{\sqrt{2}} = \frac{13.79\ mA}{\sqrt{2}} = 9.751\ mA$$
$$= 0.009751\ A.$$

$$P_{source} = V_{source} \times I_{source} = 229.8097 \times 0.009751$$
$$= 2.24087\ W$$

$$V_{load} = \frac{V_{load\_peak}}{\sqrt{2}} = \frac{21.09\ V}{\sqrt{2}} = 14.9128\ V$$

$$I_{load} = \frac{I_{load\_peak}}{\sqrt{2}} = \frac{210.46\ mA}{\sqrt{2}} = 149.262\ mA$$
$$= 0.149262\ A$$

$$P_{load} = V_{load} \times I_{load} = 14.912\ V \times 0.14926\ A$$
$$= 2.2257\ W$$

$$\text{Efficiency (non-ideal)} = \frac{P_{load}}{P_{source}} \times 100\ \%$$

$$= \frac{2.2257}{2.24087} \times 100$$

$$= 0.993230 \times 100$$

$$= 99.3230\ \%$$

- **For NON_Ideal Transformer:**

$$V_{rms} = V_{source} = \frac{V_{peak}}{\sqrt{2}} = \frac{325}{\sqrt{2}} = 230\ V.$$

$$I_{rms} = I_{source} = \frac{I_{peak}}{\sqrt{2}} = \frac{23.80\ mA}{\sqrt{2}} = 16.829\ mA.$$

$$P_{source} = V_{source} \times I_{source} = 230 \times 0.016829 = 3.8706\ W$$

$$V_{primary} = (1.657/\sqrt{2})\ V = 1.1716\ V$$

$$I_{primary} = \frac{23.74\ mA}{\sqrt{2}} = 16.786\ mA$$

$$P_{primary} = 1.716 \times 0.016786 = 0.02880\ W$$

$$V_{load} = (19.97/\sqrt{2})\ V = 14.12092\ V$$

$$I_{load} = \frac{199.19\ mA}{\sqrt{2}} = 140.848\ mA.$$

$$P_{load} = 14.120 \times 0.14084 = 1.9886\ W$$

$$Eff = \frac{P_{load} \times 100\%}{P_{source}} = \frac{1.9886 \times 100}{3.8706} = 0.51377 = 51.377\%$$

$$\epsilon_1 = \frac{P_{load}}{P_{primary}} = \frac{1.9886}{0.0288} = 69.0486$$

Observations:

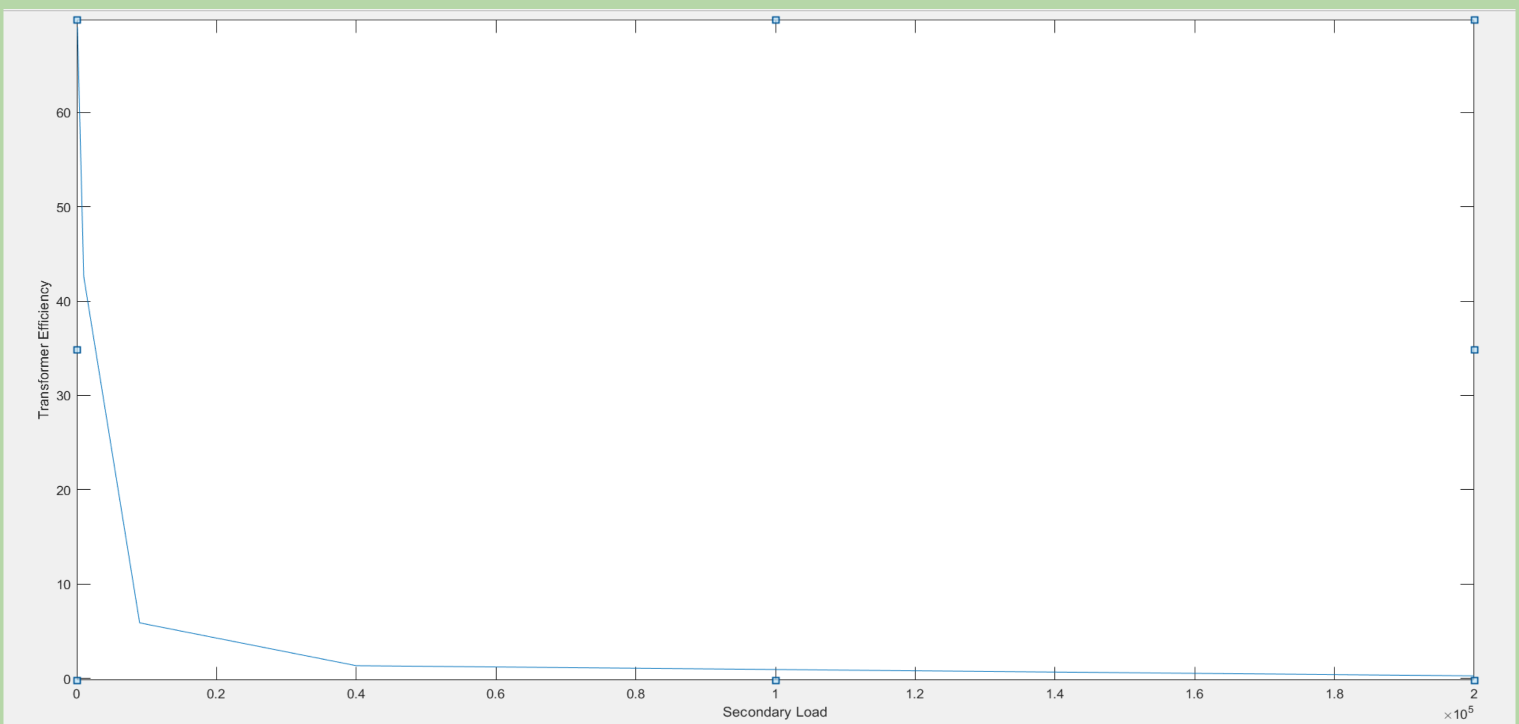
- **FOR Ideal-Transformer::**

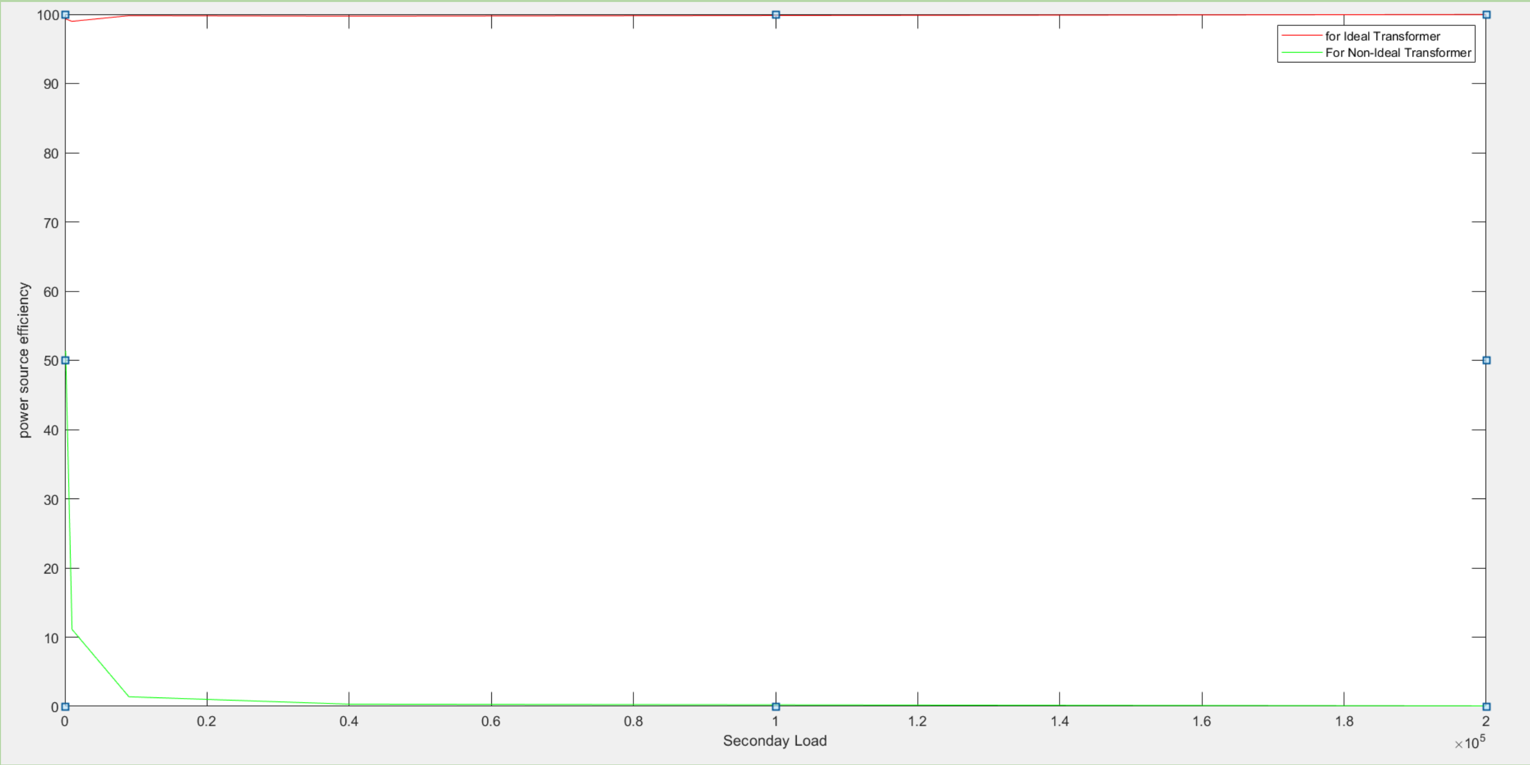
S.No	Secondary R_{LOAD} [Ω]	V_{source} [V]	I_{source} [A]	P_{source} [W]	V_{load} [V]	I_{load} [A]	P_{load} [W]	Efficiency (P_{load} / P_{source})[%]
1	10^2	230	9.751mA	2.2408	14.912	149.26mA	2.225	99.323
2	10^3	230	0.9808 mA	0.2255	14.91	14.97mA	0.2232	98.98
3	9×10^3	230	108.067 uA	0.02505	14.98	1.67 mA	0.025	99.80
4	4×10^4	230	24.37 uA	0.005605	14.97	373.41 uA	0.005589	99.727
5	2×10^5	230	4.865 uA	0.0011189	14.98	74.75 uA	0.0011185	99.97

- **FOR NON-Ideal-Transformer::**

S.No	Secondary R_{LOAD} [Ω]	V_{source} [V]	I_{source} [A]	P_{source} [W]	$V_{primary}$	$I_{primary}$	$P_{primary}$	V_{load} [V]	I_{load} [A]	P_{load} [W]	Efficiency of Transformer (Pload/Pprimary)	Efficiency of power source (P_{load}/P_{source}) [%]
1	10^2	230	16.829 mA	3.8706	1.1716	16.78 mA	0.02880	14.12V	140.84 mA	1.9886	69.0486	51.377 %
2	10^3	230	$\frac{12.123}{\sqrt{2}}$ mA	1.9719	$\frac{0.850}{\sqrt{2}}$	$\frac{12.120\text{mA}}{\sqrt{2}}$	0.005151	$\frac{20.92}{\sqrt{2}}$	$\frac{20.97}{\sqrt{2}}$ (mA)	0.21934	42.5820	11.123 %
3	9×10^3	230	$\frac{10.932}{\sqrt{2}}$ mA	1.777	$\frac{0.7653}{\sqrt{2}}$	$\frac{10.92\text{ mA}}{\sqrt{2}}$	0.004178	$\frac{21.08}{\sqrt{2}}$	$\frac{2.336}{\sqrt{2}}$ (mA)	0.024621	5.89310	1.3848 %
4	4×10^4	230	$\frac{10.798}{\sqrt{2}}$ mA	1.7613	$\frac{0.7537}{\sqrt{2}}$	$\frac{10.77\text{mA}}{\sqrt{2}}$	0.004058	$\frac{20.96}{\sqrt{2}}$	$\frac{524.57}{\sqrt{2}}$ (µA)	0.005497	1.35472	0.31209 %
5	2×10^5	230	$\frac{10.69}{\sqrt{2}}$ mA	1.7437	$\frac{0.7534}{\sqrt{2}}$	$\frac{10.71\text{ mA}}{\sqrt{2}}$	0.004034	$\frac{21.05}{\sqrt{2}}$	$\frac{105.17}{\sqrt{2}}$ (µA)	0.0011069	0.27434	0.06348 %

<u>Plots:</u>





Conclusions:

The suitable range of loads at which the transformer should be operated so that both the efficiencies are within a maximum optimum range are between ***100 ohm to 1000 ohm.***