EEL1010 Introduction to Electrical Engineering
Lab Report

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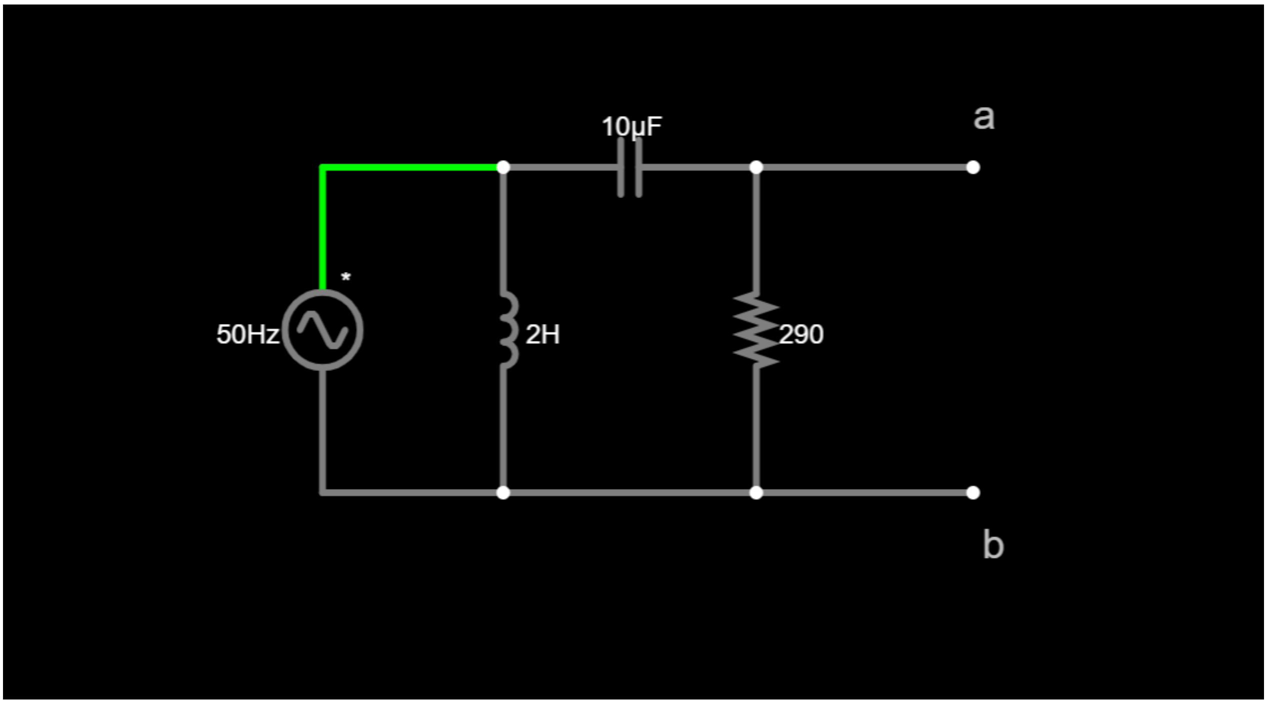
Experiment Number	7
Experiment Title	Thevenin's Theorem in AC Circuits

Objective

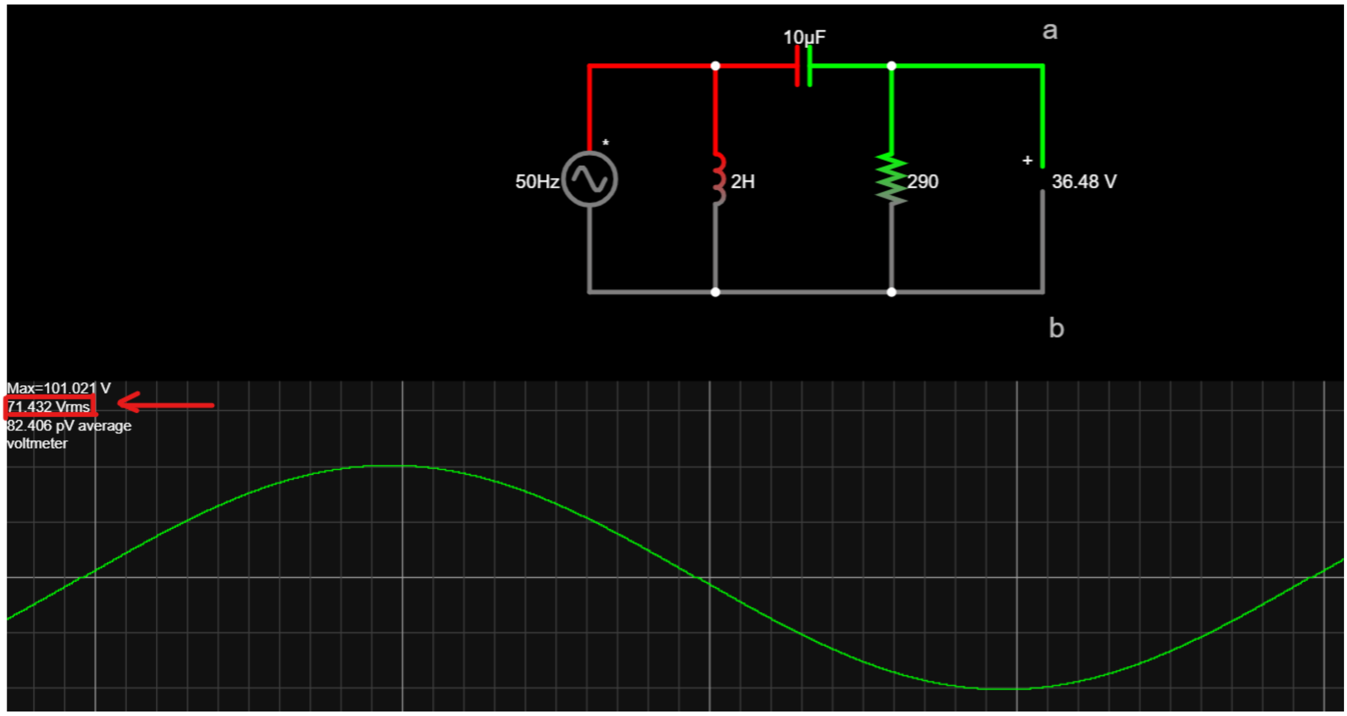
To verify the Thevenin's Theorem in AC circuits (on Falstad simulator)

Circuit Diagram



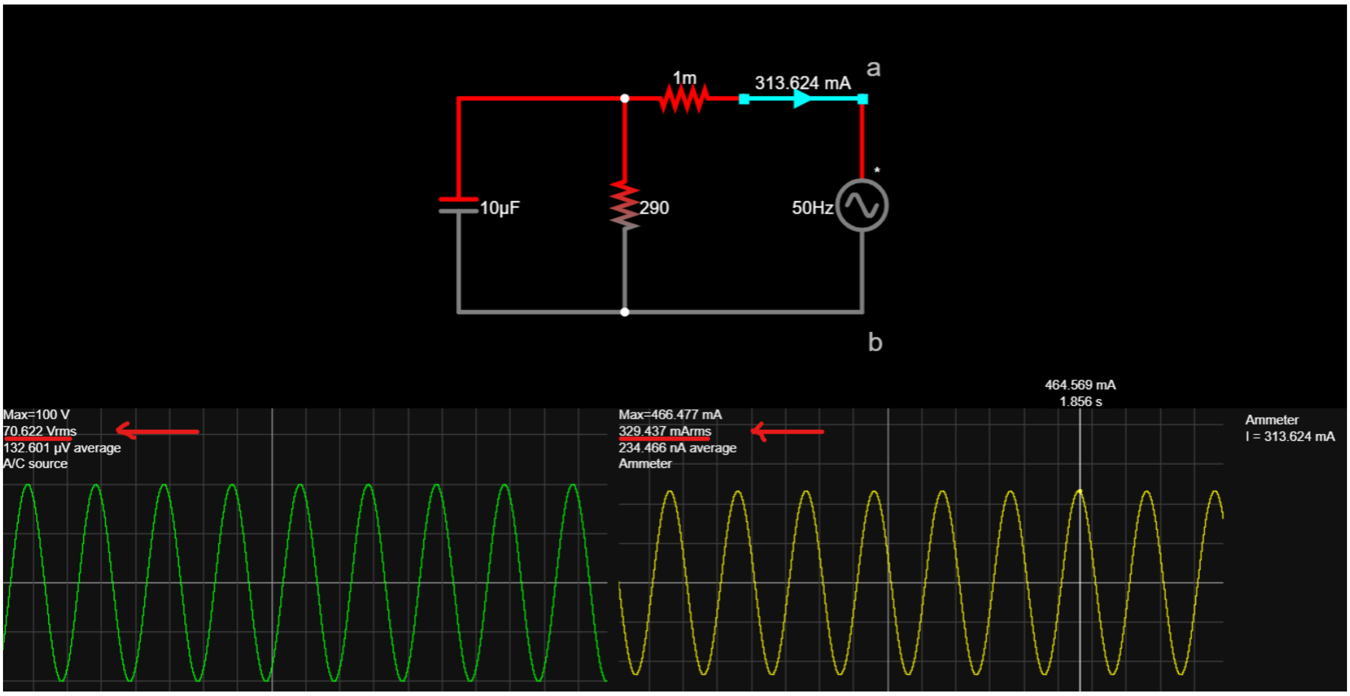
Step 1: Measurement of V_{Th}

From the voltage probe, RMS value of V_{Th} is found to be 71.432V.



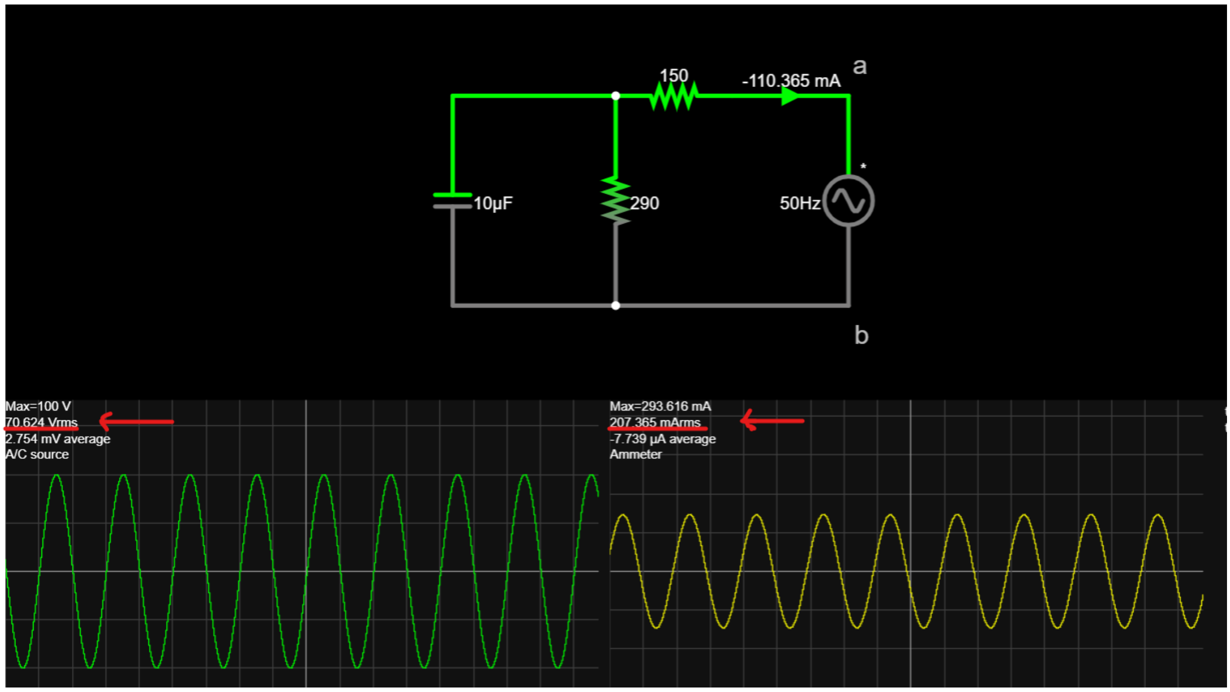
Step 2: Measurement of $|Z_{Th}|$

From the voltage probe and ammeter in falstad, RMS value of V_{Test} and I_{Test} is found to be 70.622V and 329.437mA. Hence $|Z_{Th}|$= **V_{Test}/I_{Test} = 214.371 Ω**



Step 3: Measurement of ∠Z_{Th}

From the voltage probe and ammeter in falstad, RMS value of V'_{Test} and I'_{Test} is found to be 70.624V and 207.365mA. Hence $|Z'_{Th}|$= V'_{Test}/I'_{Test} = 340.578 Ω. After simultaneously solving equations 1 and 2, we get **∠Z_{Th} = 42.3°** (Calculations below).



Exp-7

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(1) $\frac{V_{test}}{I_{test}} = \sqrt{(R')^2 + (X')^2} = 214.37$

(2) $\frac{V'_{test}}{I'_{test}} = \sqrt{(R'+150)^2 + (X')^2} = 340.58$

$(2)^2 - (1)^2 \Rightarrow$

$(R'+150)^2 - (R')^2 = 70,040.24$

$150\,(2R'+150) = 70,040.24$

$\therefore R' = \frac{\frac{70,040.24}{150} - 150}{2}$

$\therefore \boxed{R' = 158.47\,\Omega}$

$\therefore X' = \sqrt{(214.37)^2 - (R')^2}$

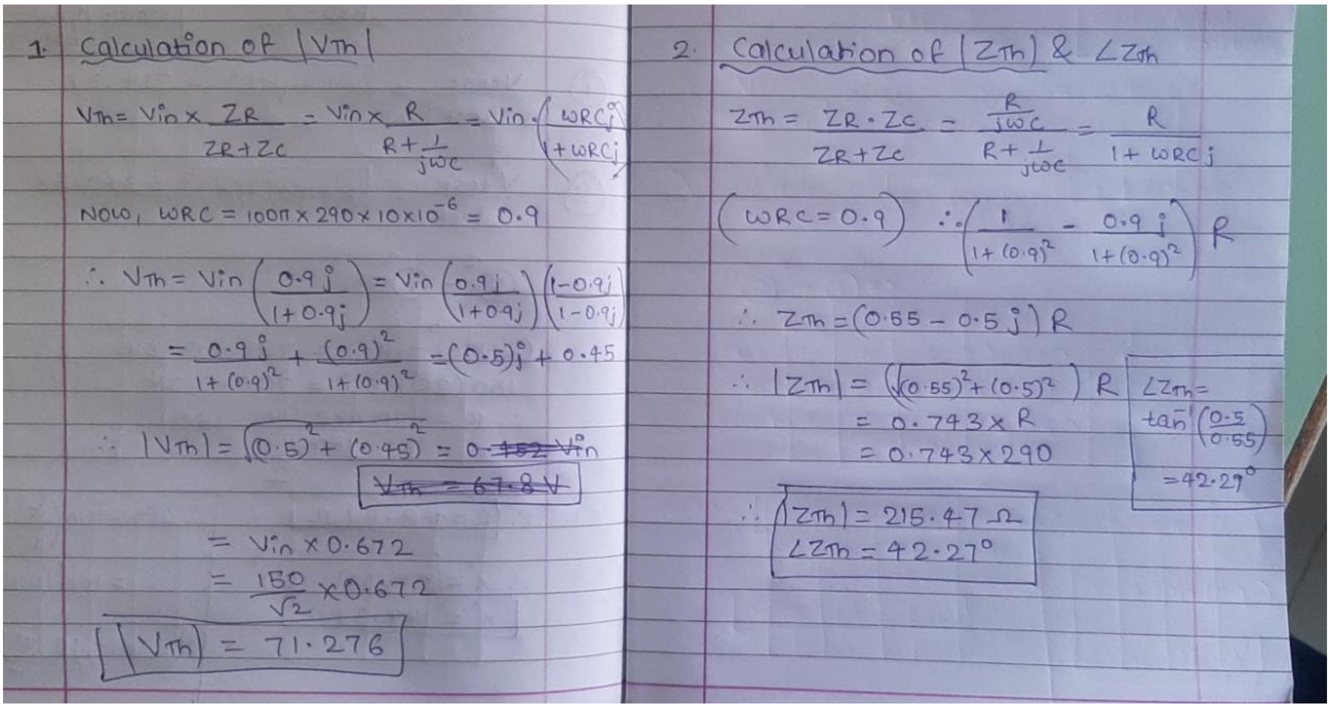
$\boxed{X' = 144.37\,\Omega}$

$\therefore \angle Z_{Th} = \tan^{-1}\left(\frac{X'}{R'}\right)$

$= \tan^{-1}(0.91)$

$\therefore \boxed{\angle Z_{Th} = 42.3^\circ}$

Step 4: Calculation of Theoretical Values



1. Calculation of $|V_{Th}|$

$$V_{Th} = V_{in} \times \frac{Z_R}{Z_R + Z_C} = V_{in} \times \frac{R}{R + \frac{1}{j\omega C}} = V_{in} \left(\frac{\omega RCj}{1 + \omega RCj} \right)$$

Now, $\omega RC = 100\pi \times 290 \times 10 \times 10^{-6} = 0.9$

$$\therefore V_{Th} = V_{in} \left(\frac{0.9j}{1 + 0.9j} \right) = V_{in} \left(\frac{0.9j}{1 + 0.9j} \right) \left(\frac{1 - 0.9j}{1 - 0.9j} \right)$$

$$= \frac{0.9j}{1 + (0.9)^2} + \frac{(0.9)^2}{1 + (0.9)^2} = (0.5)j + 0.45$$

$$\therefore |V_{Th}| = \sqrt{(0.5)^2 + (0.45)^2} = 0.\cancel{452}\ V_{in}$$

$$\boxed{\cancel{V_{Th} = 67.8\ V}}$$

$$= V_{in} \times 0.672$$

$$= \frac{150}{\sqrt{2}} \times 0.672$$

$$\boxed{|V_{Th}| = 71.276}$$

2. Calculation of $|Z_{Th}|$ & $\angle Z_{Th}$

$$Z_{Th} = \frac{Z_R \cdot Z_C}{Z_R + Z_C} = \frac{\frac{R}{j\omega C}}{R + \frac{1}{j\omega C}} = \frac{R}{1 + \omega RCj}$$

$$(\omega RC = 0.9) \quad \therefore \left(\frac{1}{1 + (0.9)^2} - \frac{0.9j}{1 + (0.9)^2} \right) R$$

$$\therefore Z_{Th} = (0.55 - 0.5j) R$$

$$\therefore |Z_{Th}| = \sqrt{(0.55)^2 + (0.5)^2}\ R = 0.743 \times R = 0.743 \times 290$$

$$\boxed{\angle Z_{Th} = \tan^{-1}\left(\frac{0.5}{0.55}\right) = 42.29^\circ}$$

$$\therefore \boxed{\begin{array}{l} |Z_{Th}| = 215.47\ \Omega \\ \angle Z_{Th} = 42.27^\circ \end{array}}$$

$|V_{Th}|$= 71.276V

$|Z_{Th}|$= 215.47 Ω

$\angle Z_{Th}$= 42.27°

Observation Table and Conclusion

Quantity	Theoretical (Calculated)	Experimental (Measured)	Error (%) ((Measured – Theoretical)/Theoretical)×100
$\lvert V_{Th}\rvert$	71.276 V	71.432V	0.21%
$\lvert Z_{Th}\rvert$	215.470 Ω	214.371Ω	-0.51%
$\angle Z_{Th}$	42.27°	42.30°	0.07%

As measured and calculated values are almost same, **Thevenin's theorem is verified**