Course Project Report

EEL3340 : Measurement and Instrumentation

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Hardware circuit Video Link :

https://drive.google.com/file/d/1Ww4dNdNvD7yM40wxVPw3czWuiiToE5FD/view?usp=sharing

Project Details:

- To prepare a **hardware** circuit and **simulation** of **De Sauty's Bridge** and perform experimental verification of formulas.
- To prepare a **simulation** of **Schering bridge** and perform experimental verification of formulas.
- To prepare a simulation of **RC phase shift oscillator** and perform proof of concept of theoretical concepts.

Abstract

This project report describes the implementation of De Sauty's bridge using both hardware and simulation, simulation of Schering bridge and simulation of RC phase shift oscillator. The first 2 circuits are used for measuring unknown capacitors. The RC phase shift oscillator is an electronic circuit that generates sinusoidal signals. It uses an RC network consisting of resistors and capacitors to produce a phase shift of 60 degrees per stage, with a total phase shift of 180 degrees.

Equipments Used

- **For hardware circuit of De Sauty's Bridge:**

S. No.	Component Name	Quantity
1.	10μF Capacitor (C1)	1
2.	100μF Capacitor (C2)	1
3.	Variable Resistor (R3)	1
4.	10Ω Resistor (R4)	1
5.	Multimeter	1
6.	Function Generator	1
7.	Breadboard	1

- **For simulation:**
  - MATLAB/Simulink

Theory

1. **De Sauty's Bridge**

   De Sauty's bridge is an electrical circuit used to measure the capacitance of an unknown capacitor. It works based on the principle of a balanced bridge circuit, where the resistance and reactance components of two legs are adjusted until the voltage difference between the other two legs is zero. The De Sauty bridge consists of a standard capacitor, an adjustable resistor, a galvanometer, and an unknown capacitor. The galvanometer measures the difference in potential between the two sides of the bridge. The balance point is obtained when the current through the galvanometer becomes zero, indicating that the potential difference across the bridge is zero.

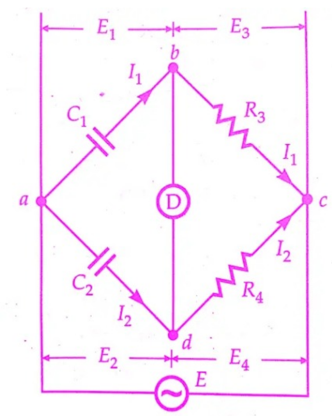
$$Z_1Z_4 = Z_2Z_3$$

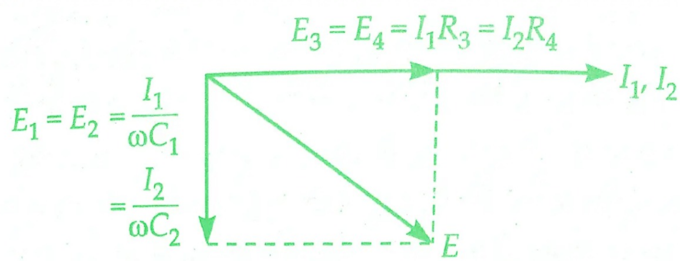
$$\left(\frac{1}{j\omega C_1}\right) \times R_4 = \left(\frac{1}{j\omega C_2}\right) \times R_3$$

$$\frac{R_4}{C_1} = \frac{R_3}{C_2}$$

$$C_1 = \frac{R_4}{R_3} \times C_2$$

De Sauty's bridge is a very accurate and precise method of measuring capacitance and is widely used in electronic laboratories. However, it requires precise adjustment of the resistors, and it is not suitable for measuring very low capacitance values.





2. **Schering Bridge**

Schering bridge is an AC bridge circuit used to measure the capacitance of an unknown capacitor. The circuit consists of four arms, two of which are fixed and two of which are adjustable. The fixed arms include a capacitor, known as the standard capacitor, and a resistor, while the adjustable arms include a variable capacitor, known as the test capacitor, and a resistor. The bridge is balanced when the galvanometer reads zero, indicating that the voltage across the bridge is zero.

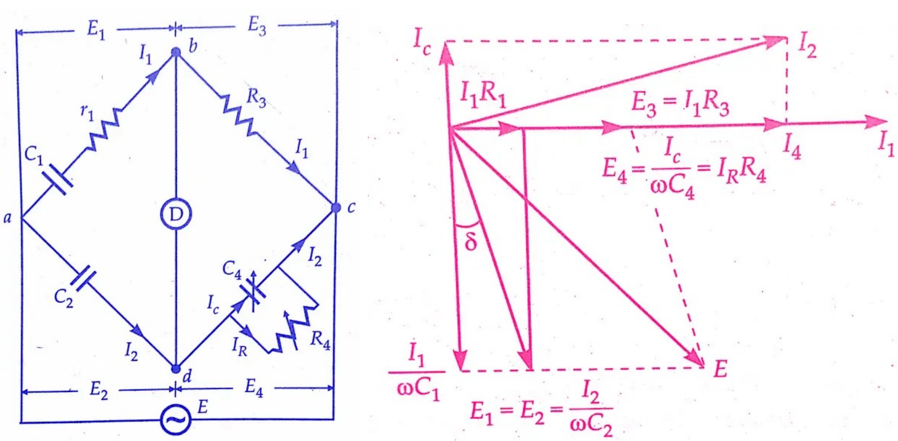
At balance,

$$\left(r_1 + \frac{1}{j\omega C_1}\right)\left(\frac{R_4}{1 + j\omega C_4 R_4}\right) = \frac{1}{j\omega C_2} \cdot R_3$$

$$\left(r_1 + \frac{1}{j\omega C_1}\right) R_4 = \frac{R_3}{j\omega C_2}(1 + j\omega C_4 R_4)$$

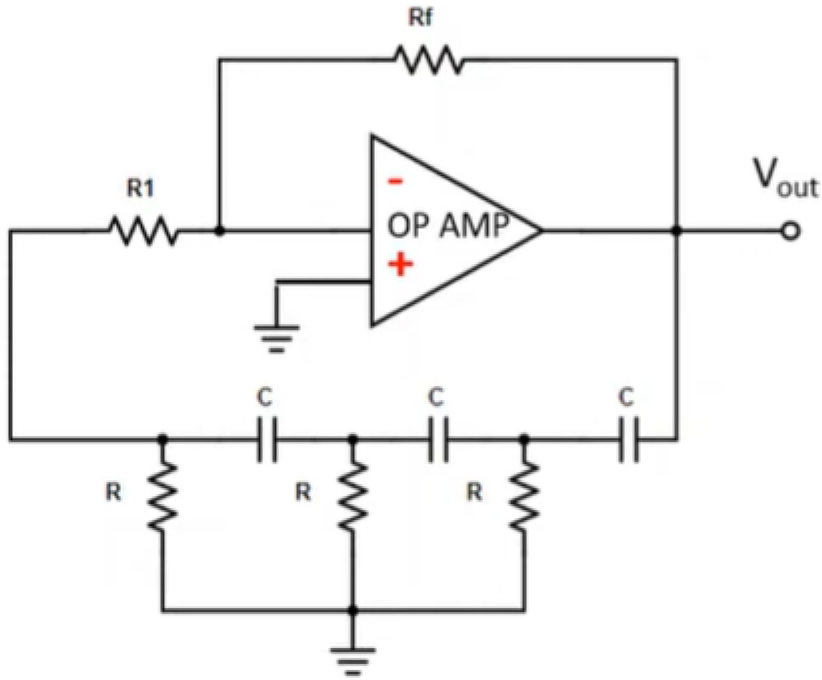
$$r_1 R_4 - \frac{jR_4}{\omega C_1} = -j\frac{R_3}{\omega C_2} + \frac{R_3 R_4 C_4}{C_2}$$

The Schering bridge is known for its accuracy and is commonly used in the measurement of high-value capacitances in electrical power systems and telecommunication networks. However, it requires precise adjustment of the resistors and the capacitor, and it is not suitable for measuring very low capacitance values.



3. RC phase shift Oscillator

The RC phase shift oscillator is an electronic circuit that generates sinusoidal signals. It uses an RC network consisting of resistors and capacitors to produce a phase shift of 60 degrees per stage, with a total phase shift of 180 degrees. The oscillator also includes an amplifier and a feedback loop to provide the necessary gain to sustain oscillations. The feedback loop is created by feeding the output signal back to the input through a network of resistors and capacitors, which causes the signal to be phase-shifted again.

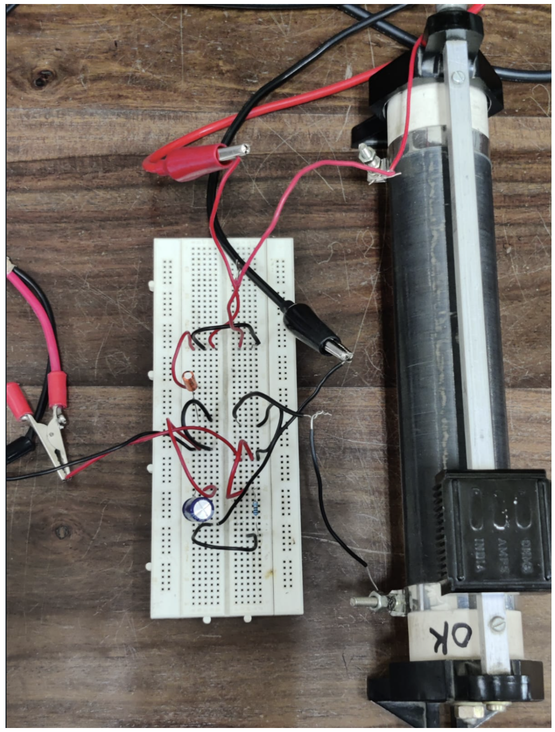


The frequency of the oscillator is determined by the values of the resistors and capacitors in the RC networkr The RC phase shift oscillator is a simple and low-cost circuit and is commonly used in audio and radio frequency applications. However, it is not suitable for high-frequency applications due to the limitations of the RC network.

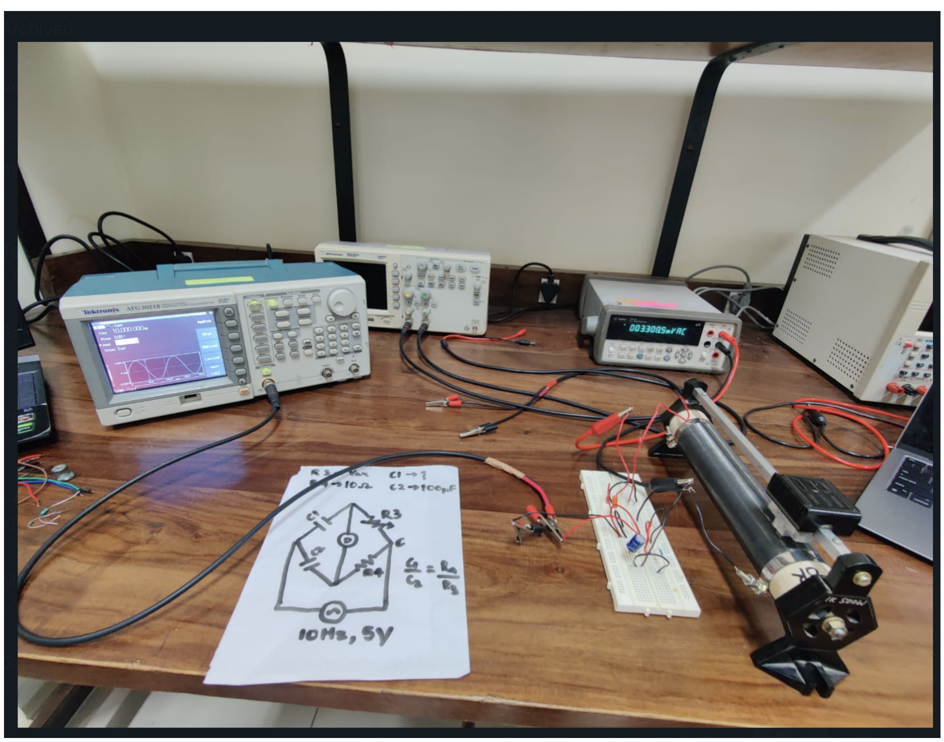
Results

I. Hardware implementation based results:

- **Circuit connections**



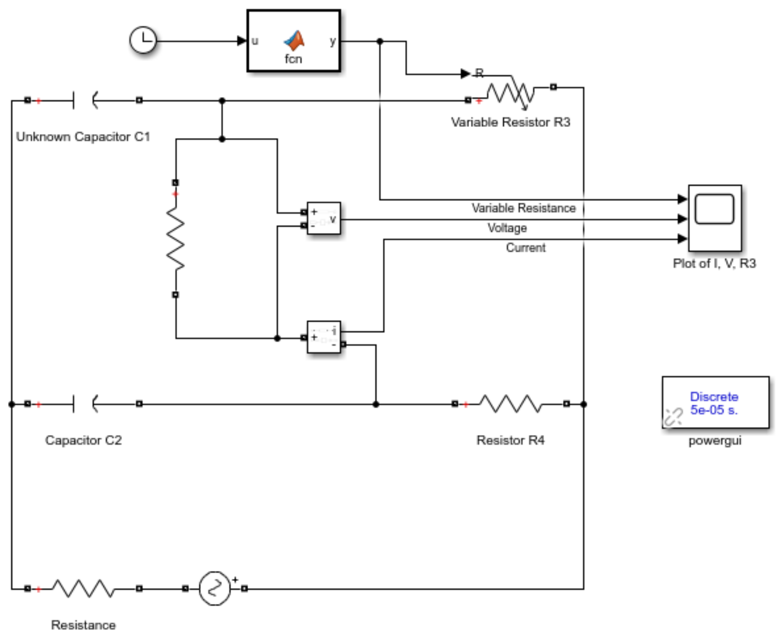
- **Multimeter output under balanced conditions**

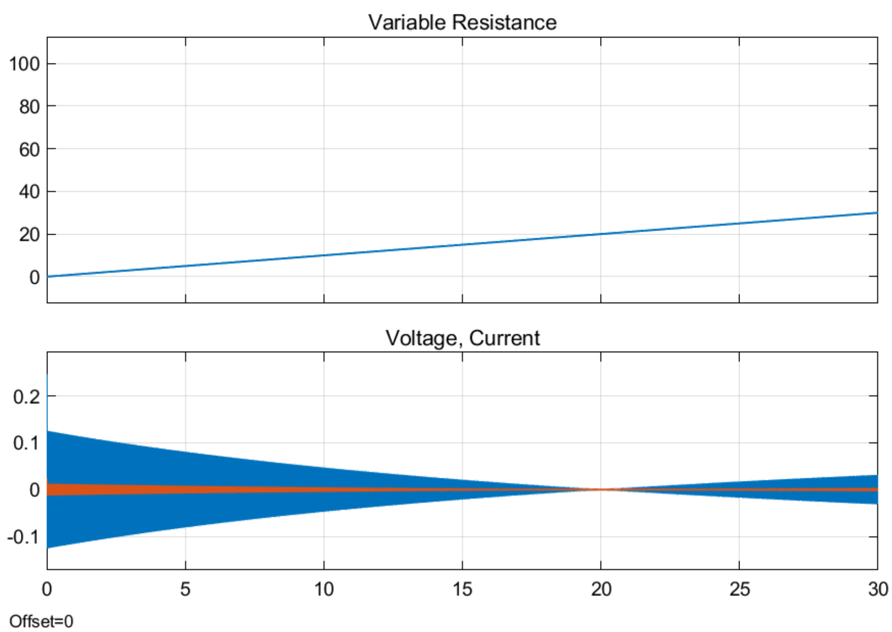


[Video link]

II. Simulation based results:

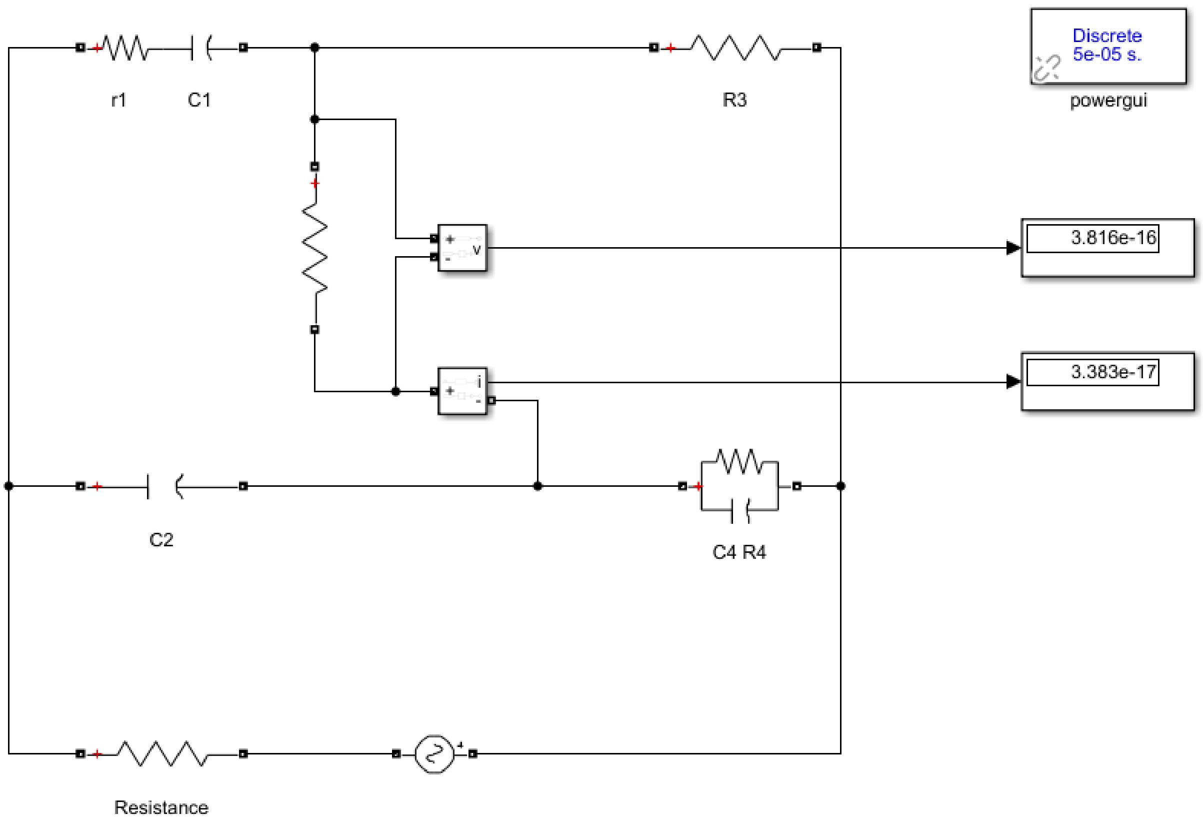
- **For De Sauty's Bridge**





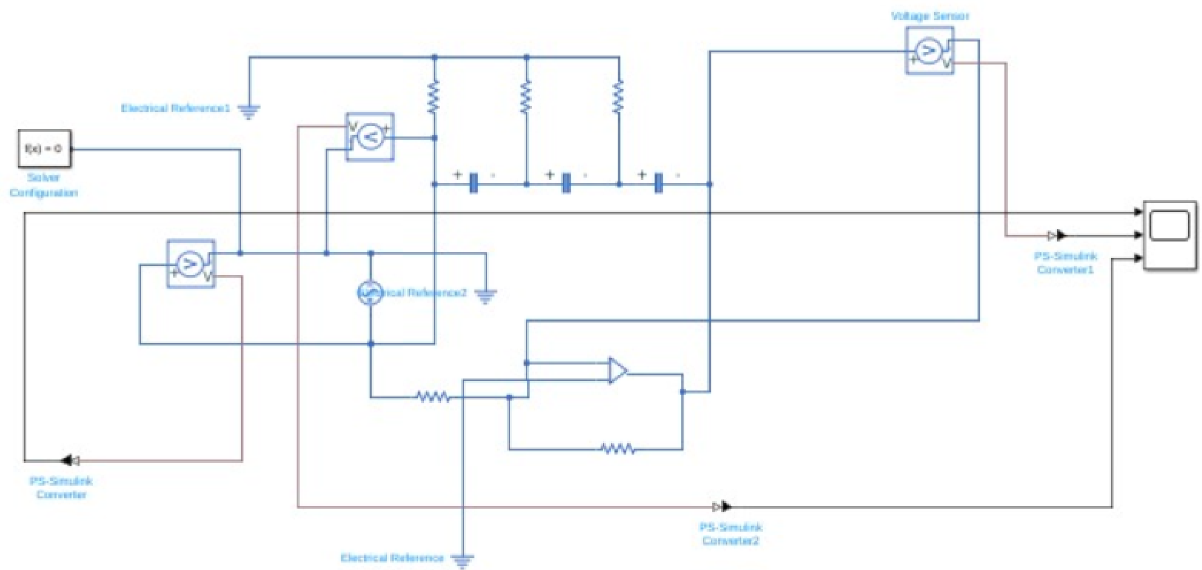
We observe that as the value of variable resistor changes and comes closer to the balanced condition, the value of current and voltage across the resistor tends to zero, thus proving the theoretical results

- **For Schering Bridge**

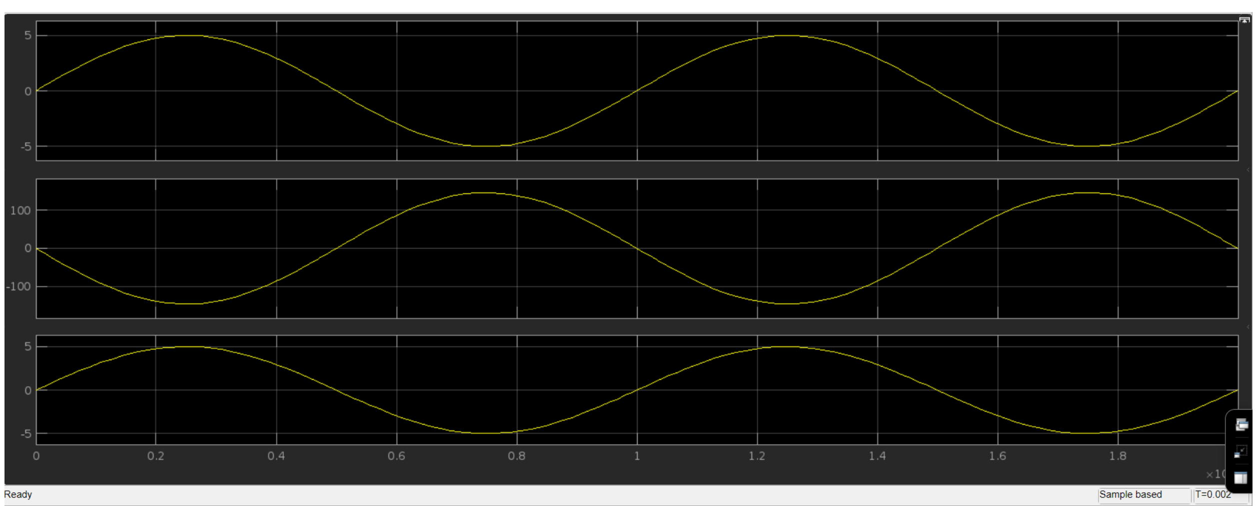


We observe that under balanced conditions, the value of current and voltage across the resistor connected in the bridge is negligible, thus proving the theoretical results.

- **For RC phase shift oscillator**



In this experiment the transistor applies a phase shift of 180, after which the RC circuit applies another phase shift of 180 degree finally giving an output voltage with 0 phase change.



Conclusion

In conclusion, this project aimed to implement and analyze three different electronic circuits - De Sauty's Bridge, Schering Bridge, and RC Phase Shift Oscillator. The first circuit, De Sauty's Bridge, was implemented using both hardware and simulation methods, while the Schering Bridge and RC Phase Shift

Oscillator were simulated using MATLAB Simulink. Through this project, we gained practical knowledge about the working principles and applications of these circuits. We successfully constructed and tested the De Sauty's Bridge using hardware, while the simulations of Schering Bridge and RC Phase Shift Oscillator on MATLAB Simulink produced accurate results. The implementation and analysis of these circuits gave us valuable insights into their design, functionality, and limitations. Overall, this project was a valuable learning experience that helped us develop practical skills in electronic circuit design and analysis.