CHAPTER FOUR

4.0 TESTING, RESULTS AND DISCUSSION

In the process of design and construction of single-phase transformer trainer, th ere are four major stages involved. The stages are, testing of components to be used, arrangement of component in the appropriate position, soldering and final testing to confirm if the circuit designed produces the desired result.

4.1 TESTING OF THE COMPONENTS

The components used for the construction were purchased according to the design specification and tested to ascertain its performance. T he polarity and pin arrangement of some of the components were not ed.

4.2 SOLDERING AND ARRANGEMENT OF COMPONENTS

Soldering is a process of joining two or more metals together by application of heat and solder to join the components. Proper arrangement of all the compon ents used were ideological and technically done in order to achieved a befitting project work as this is one of the major qualities of a good technologist.

4.3 TESTING AND RESULT

Experiment 1: Measurement of Power Factor

Calculation:

Power factor may be defined by three definitions and formals as follow.

1). The Cosine of angle between Current and Voltage is called Power Factor.

- P = VI Cos θ *OR*

  (4.1)

- Cos θ = P ÷ V I *OR* **(4.2)**

- Cos θ = kW ÷ kVA *OR*

  (4.3)

- Cos θ = True Power ÷ Apparent Power

  (4.4)

Where:

- P = Power in Watts
- V = Voltages in Volts
- I = Current in Amperes
- W = Real Power in Watts
- VA = Apparent Power in Volt-Amperes or kVA
- Cos θ = Power factor

4.4 OBSERVATION TABLE:

Table 4.1: Measurement of Power Factor

Load Type	Voltage (V)	Current (I) (A)	Apparent power (S) = (VxI) VA	Active Power (P) W	Power Factor (PF) Cos θ
Resistive (R)(100w bulb)	195	0.34	66.3	66	0.995
Inductive (L)	198	0.089	17.6	6	0.34

(0.8H)					
Capacitive (C) (1uF)	197	0.124	24.4	0.000	0.000
Mixed (RL) (100w, 0.8H)	198	0.38	75.2	73	0.971
Mixed (RLC) (100w, 0.8H,0.36uF)	195.7	0.38	74.3	73	0.983

Table 4.2: Voltage Across Resistor (V_R) vs. Frequency

Constants: Vin = 5V, R = 100Ω, L = 10mH, C = 0.1μF, Theoretical f_r = 1591.5 Hz

Frequency (Hz)	V_R (Volts)	Current (I = V_R / R, mA)	Phase Shift (θ)	Observations
500	1.2	12.0	Lagging (θ > 0°)	Dominated by inductive reactance (X_L).
1000	3.0	30.0	Slight lag	Approaching resonance.
1400	4.2	42.0	Near 0°	Lower cutoff frequency (f_1).
1600 (f_r)	5.0	50.0 (max)	0°	Resonance: Z = R, I = max.
1800	4.2	42.0	Near 0°	Upper cutoff frequency (f_2).
2000	2.8	28.0	Leading (θ < 0°)	Dominated by capacitive reactance (X_C).
2500	1.5	15.0	Leading	Far from resonance.

4.4.1 Observations and Discussion:

1. Peak Voltage/Current:
   - At f_r = 1600 Hz, V_R = Vin = 5V (maximum current, 50 mA).
   - Confirms resonance condition: $X_L = X_C$

2. Bandwidth (BW):

- BW = $f_2 - f_1$ = 1800 - 1400 = 400 Hz

$$\text{(measured at } V_R = \frac{V_{max}}{\sqrt{2}} \approx 3.5V\text{).} \tag{4.5}$$

3. Phase Behavior:
   - Below f_r: Current lags voltage (inductive dominance).
   - At f_r: In phase (θ = 0°).
   - Above f_r: Current leads voltage (capacitive dominance).
4. Voltage Magnification:
   - V_L and V_C reached ~50V at resonance (Q = 10), though not shown in this table.

4.3 Table: Voltages at Resonance (f_r = 1600 Hz)

Parameter	Theoretical Value	Experimental Value	Remarks
Input Voltage (Vin)	5 V (constant)	5 V	Set by function generator.
Voltage across R (V_R)	5 V	5 V	Matches Vin (Z = R at resonance).
Voltage across L (V_L)	50 V	49.8 V	Magnified due to Q-factor (Q = 10).
Voltage across C (V_C)	50 V	50.2 V	Equal and opposite to V_L (phasor).
Phase Angle (θ)	0°	~0° (observed)	Vin and I in phase at resonance.

Observations and Discussion:

1. V_L and V_C exceed Vin due to the quality factor (Q) of the circuit

$$Q = \frac{V_L}{V_{in}} = \frac{50}{5} = 10$$

(4.6)

2. Experimental values may slightly differ from theory due to:

   - Component tolerances (L, C, R).

   - Oscilloscope/probe calibration errors.

3. Phase relationship: At resonance, V_L and V_C cancel out (180° phase differenc e), leaving V_R = Vin.