EXPERIMENT: To find the impedance of an A.C. circuit.

APPARATUS

A variable transformer, an A.C. milliammeter of range 0-500 milliamp, an A.C. voltmeter of range 0-250 volt, an A.C. voltmeter of range 0-25 volt, an inductance coil, capacitor, lamp resistance, (60watt) bulb and connecting flexible wires.

THEORY

The impedance Z on an A.C. circuit containing a resistance R, an inductance C is given by

$$Z = \sqrt{R^2 + (X_l - X_c)^2}$$

Where $X_l = \omega L = 2\pi nL$ is the reactance due to inductance and

$$X_c = \frac{1}{\omega C} = \frac{1}{2\pi nC}$$

is the reactance due to capacitance, n being the frequency of the alternating current and $\omega = 2\pi n$ the angular frequency.

PRECEDURE

1. Draw a diagram showing the scheme of connections as shown in Fig. And use a 60-watt lamp for the resistance R.

2. Connect the output terminals of the variable transformer to the lamp resistance R, the capacitor C and an inductance coil L through the milliammeter in series. Connect the voltmeter of 0-250 volt range across all these between the points A and B. Note the zero errors in the milliammeter and both the voltmeters, if any.

3. Connect the in put terminals of the transformer to the mains supply plug and adjust the voltage so that a current of about 150-200 milliamp flows through the circuit. Note the reading be E_v and milliammeter reading I_v.

4. Switch off the current, disconnect the voltmeter and connect it between A and D i.e. across the inductance coil L and capacitor C combined. If the current changes adjust it to the previous value and note the voltmeter reading. Let it be E. E_{LC}.

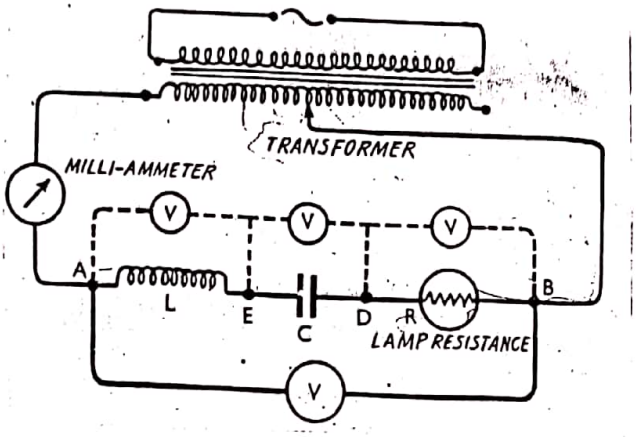
5. Switch off the current, disconnect the voltmeter and connect it across the resistance R, between the points B and D. If the current changes adjust it to the previous value and note the voltmeter reading. Let it be Er.

6. Switch off the current and connect the voltmeter across the capacity C between the terminals E and D and adjust the value of current if necessary to the previous value. Note the voltmeter reading and let it be Ec.

7. Switch off the current and connect the voltmeter of range 0 -25 volt across the inductance L between the points A and E and adjust the value of the current to the previous value if necessary. Note the voltmeter reading. Let it be E_L.

8. Repeat the above observations by changing the current in the circuit to another convenient value.

9. Using a D.C. ammeter, a D.C. voltmeter and a battery of about 4-5 volt find the D.C. resistance r of the inductance coil L as well, if not marked on it.



OBSERVATIONS:

Zero error of the milliammeter = milliamp
Zero error of the voltmeter (0-250 range) = volt
Zero error of the voltmeter (0-25 range) = volt
Resistance of inductance coil r = 19 Ω

No.	Current I_v (mA)	E_v Voltage Across		Volt			Reactance due to (Ω)			Impedance $Z=E_v/I_v$ (Expt.)	Impedance $Z=\sqrt{R^2+(X_L-X_c)^2}$ (Theoretical)
		AB E_v	AD E_{LC}	R_1 E_r	C E_c	L E_L	R_1	C X_c	L X_L		
1.											
2.											
3.											

CALCULATIONS:

A.C. resistance of the lamp $R_1 = \frac{E_r}{I_v}$

Total resistance of the circuit $R = R_1 + r$

Reactance due to capacitance $X_c = \frac{E_c}{I_v}$

Reactance due to inductance $X_L = \frac{E_L}{I_v}$

In reality this reactance X_L is the total resistance due to inductance and resistance of the coil. The reactance due to inductance X_L is given by

or $$X_L = \sqrt{X_L^2 + r^2}$$

$$X_L = \sqrt{X_L^2 - r^2}$$

Impedance of the circuit

% Error

$$Z = \sqrt{R^2 + (X_L - X_c)^2}$$

PRECAUTIONS:

1. Only well insulated pieces of flexible wire should be used.
2. Naked parts of the circuit should not be touched when the current is passing.
3. Suitable values of R,L and should be chosen.
4. The current in the circuit should remain constant white measuring the voltage across R and L or across R and C.