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SUBGROUP-1H3

ROLL NUMBER-102016100

Experiment: Single Phase AC Parallel Circuit

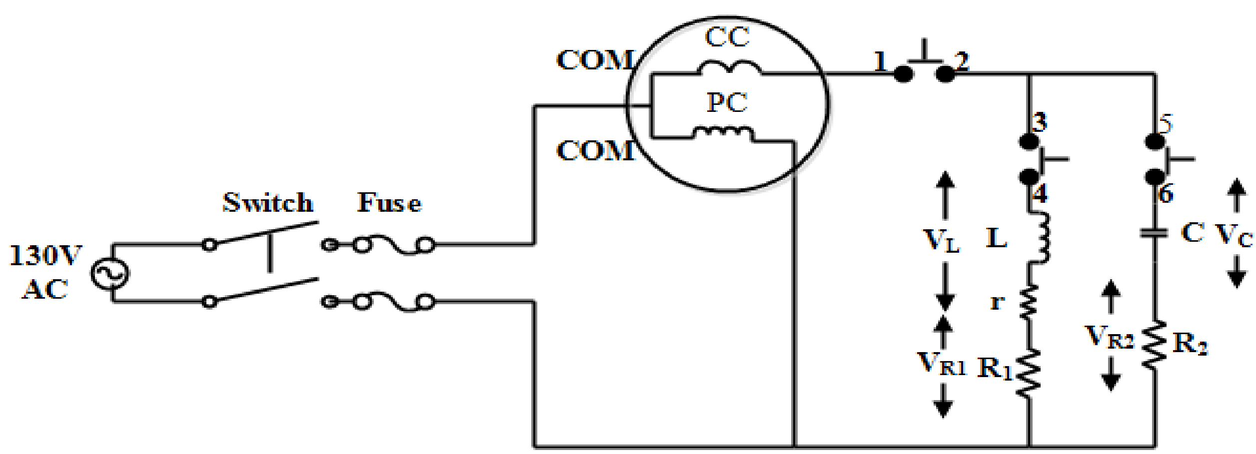
Objective: To determine experimentally:

1. Current distribution in a single phase AC parallel circuit.
2. Power and power factor of the circuit.
3. The value of circuit elements R, L & C.

Equipment: **(1)**Voltmeter: 150V AC **(2)** Ammeter: 3 Amp AC

(3) Wattmeter: 250V, 3 Amp **(4)**Resistor, Choke coil and Capacitor

Circuit Diagram:



Theory: For a given AC parallel circuit, when energized from an AC source, same voltage drops across all parallel connected branches consisting of resistances R_1, choke coil L and capacitor C.

For a given ac current I passing through R, L & C; the voltage drop across

Resistance, $\mathbf{V_R = IR}$,

Pure Inductance, $\mathbf{V_L = I(j\omega L)}$,

Pure capacitance, $\mathbf{V_C = \frac{I}{j\omega C}}$=$\mathbf{IX_c}$

Power dissipated in branch one (RL) for parallel circuit shown in above figure.

1) $\mathbf{P_{RL} = I_1^2(R_1 + r) = V_s I_1 cos\theta_1}$, Power dissipated in branch two (RC)

2) $\mathbf{P_{RC} = I_2^2 R_2 = V_S I_2 cos\theta_2}$, Total power is $\mathbf{P_1 + P_2 = V_S I cos\theta = P_t}$, Total current $\mathbf{I = I_1 + I_2}$ (phasor sum)

3) θ_1, θ_2 and θ are phase angles between supply voltage and current I_1, I_2 and I respectively. R_1, R_2 are the resistances of rheostats connected in branch 1, 2. V_S is the supply voltage.

Power factor of parallel circuit, $\mathbf{cos\theta = \frac{I_1 cos\theta_1 + I_2 cos\theta_2}{I} = \frac{P_t}{V_s I}}$

$$\boldsymbol{cos\theta_1 = \frac{P_{RL}}{V_S I_1} = \frac{R_1 + r}{\sqrt{(R_1 + r)^2 + {X_L}^2}}}$$

$$\boldsymbol{cos\theta_2 = \frac{P_{RC}}{V_S I_2} = \frac{R_2}{\sqrt{{R_2}^2 + {X_C}^2}}}$$

Voltage across resistor R_1, $\boldsymbol{V_{R1} = I_1 R_1}$ **;** Voltage across resistor R_2, $\boldsymbol{V_{R2} = I_2 R_2}$

Voltage across inductor L, $\boldsymbol{V_L = I_1(r + jX_L)}$ **;** Voltage across capacitor C, $\boldsymbol{V_C = I_2(-jX_C)}$

Procedure:

- Connect the experiment set up as shown in the circuit diagram
- Select AC 130 Volt from the supply panel and switch on the supply.
    - (case -1) W_1 = power dissipated in RL branch, keeping switches 1-2 & 3-4 closed, 5-6 open.
    - (case -2) W_2 = power dissipated in RCbranch, keeping switches 1-2 & 5-6 closed, 3-4 open.
    - (case -3) W = Total power consumed in circuit = $W_1 + W_2$, (all switches closed).
- Similarly measure current $\mathbf{I_1}$, $\mathbf{I_2}$ and **I** with help of current measurement board.
- Record the readings of the instruments carefully.

Precautions:

- Always keep measuring instruments in horizontal position. i.e. table mode.
- Select appropriate range of the instruments. i.e. the range of the instruments should always be more than the existing value of current or voltage in the circuit.
- Don't touch the resistance even after switching off the supply as it might have been heated up.

Observations:

CASE	Supply (V_s)	Voltage across elements				Current through switch			Power consumed		
		V_{R1}	V_{R2}	V_L	V_C	1-2 I	3-4 I_1	5-6 I_2	W_1 P_{RL}	W_2 P_{RC}	W P_t
Case 1	**129V**	**108V**	**98V**	**44V**	**78V**	**0.91A**	**0.53A**	**0.48A**	**64W**	**40W**	**112W**
Case 2											
Case 3											

Report:

- Using various relations, calculate R_1, R_2, X_L, X_C, L,C assuming the supply frequency as 50Hz.
- Calculate the value of power and power factor of the circuit from above parameters.
- Draw the phasor for one reading when both switches 5-6 and 3-4 are closed.
- What will be the nature of lagging and leading power factor loads? Draw the position of voltage and current phasor for these loads.

Points to remember:

1. Multification factor of watt meter used =(Voltage range*Current range*pf of wattmeter)/Max scale deflection
2. Actual reading of wattmeter = multification factor * reading of wattmeter

CALCULATIONS:

CALCULATIONS

Multiplication factor = $\frac{\text{Voltage Range} \times \text{Current Range} \times \text{Power factor}}{\text{Max. scale deflection}}$

$$\Rightarrow \frac{250 \times 2.5 \times 1}{156.25} = 4$$

Observed Power

$P_t \Rightarrow 28W = 28 \times$ Multiplication factor $= 28 \times 4 \Rightarrow 112W$

$P_{RC} \Rightarrow 10W = 10 \times 4 \Rightarrow 40W$

$P_{RL} \Rightarrow 16W = 16 \times 4 = 64W.$

Calculated

$V_{R_1} = I_1 \times R_1 \Rightarrow R_1 = \frac{V_{R1}}{I_1} \Rightarrow \frac{108}{0.53A} \Rightarrow 203.773\ \Omega$

$X_L \Rightarrow \frac{V_L}{I_1} \Rightarrow \frac{44}{0.53} \Rightarrow 83.01\ \Omega$

$X_L = L\omega \Rightarrow \frac{83.01}{3.14 \times 2 \times 50} \Rightarrow L$ $\left\{ \begin{array}{l} 50Hz = freq. \\ 2\pi f = \omega. \end{array} \right.$

$\Rightarrow 0.2643H = 264.3\ mH.$

$V_{R_2} \Rightarrow I_2 \times R_2 \quad R_2 = \frac{V_{R2}}{I_2} \Rightarrow \frac{98}{0.48} = 204.166$

$X_C \Rightarrow \frac{V_C}{I_2} \Rightarrow \frac{78}{0.48} = 162.5\ \Omega$

$X_C = \frac{1}{C\omega} \qquad C = \frac{1}{162.5 \times 314} = \frac{1}{51025}$

$\Rightarrow 19.6\ \mu F.$

$Z_1 \Rightarrow \sqrt{(R_1)^2 + (X_L)^2} \Rightarrow \sqrt{(203.773)^2 + (83.01)^2}$

in inductor branch

$\Rightarrow \sqrt{41523.43553 + 6890.6601} = \sqrt{48414.095}$

$= 220.032$ ohm

$$Z_2 = \sqrt{(R_2)^2 + (X_c)^2} = \sqrt{(204.166)^2 + (162.5)^2}$$

$\hookrightarrow$ Capacitor branch

$$= \sqrt{41683.7556 + 26406.25}$$

$$= \sqrt{68090.0056} = 260.940\ \Omega.$$

$$\cos\theta_2 \Rightarrow \frac{R_2}{Z_2} \Rightarrow \frac{204.166}{260.940} = 0.782425$$

$$\theta_2 = 38.51^\circ$$

$$\cos\theta_1 \Rightarrow \frac{R_1}{Z_1} \Rightarrow \frac{203.773}{220.032} \Rightarrow 0.9261062$$

$$\Rightarrow \theta_1 = \cos^{-1}(0.9261)$$

$$\Rightarrow 22.1657$$

$$\cancel{r = (\cos\theta_1 \times Z_1) - R_1 \Rightarrow (0.9261 \times 220.032) - 203.773}$$

$$r \Rightarrow \frac{P_{RL}}{I_1^2} - R_1 \Rightarrow \frac{64}{(0.53)^2} - 203.773$$

$$\Rightarrow \frac{64}{0.2809} - 203.773$$

$$227.839 - 203.773 = 24\ \Omega$$

$$P_2 \Rightarrow I_2^2(R_2) \Rightarrow (0.98)^2 \times 204.166 = 47.04\ W$$

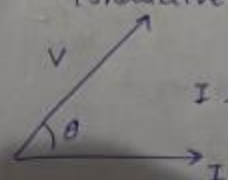
$$P_1 \Rightarrow P_{RL} \Rightarrow I_1^2(R_1 + r) \Rightarrow (0.53)^2(203.773 + 24)$$

$$\Rightarrow 63.98 \simeq 64\ W$$

$$P_t = P_1 + P_2 = 47.04 + 64 = 111.04.$$

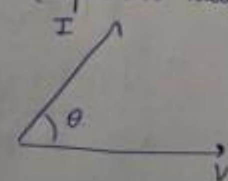
Nature of lagging and leading power factor.

$\rightarrow$ lagging p.f.
(Inductive nature)



I is lagging

$\rightarrow$ leading p.f.
(capacitive nature)



Results.

$R_1 \rightarrow 203.773\ \Omega$

$R_2 \rightarrow 204.116\ \Omega$

$C = 19.6\ \mu F$

$r = 24\ \Omega$

$X_C \rightarrow 162.5\ \Omega$

$\cos\theta_2 \rightarrow 0.782425$

$P_1 = P_{RL} = 64\ W$

$P_2 = P_{RC} \rightarrow 47.04\ W$

$P_t \rightarrow 111.04\ W$

$Z_1 \rightarrow 220.032\ \Omega$

$Z_2 \rightarrow 260.940\ \Omega$

$L \rightarrow 264.3\ mH.$

$X_L \rightarrow 83.01\ \Omega$

$\cos\theta_1 \rightarrow 0.92621^{\circ}$

CONCLUSION: We can see that the calculated values of power and power factor are equal or nearly equal to observed values.

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