ELEMENTS OF ELECTRICAL ENGINEERING (UE24EE141B)

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Unit 2 – Lectures 32 & 33 - Analysis of Parallel RLC circuit ; Numerical examples

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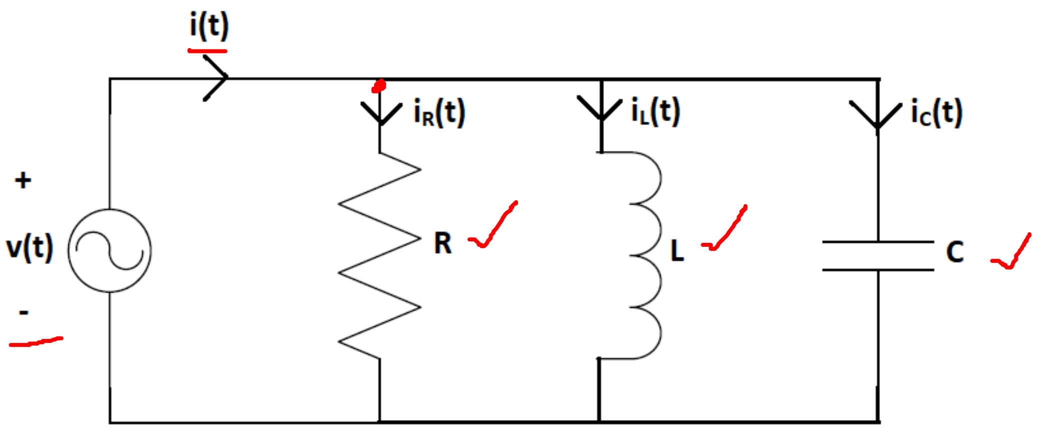
Parallel RLC Circuit



By KCL, $i(t) = i_R(t) + i_L(t) + i_c(t)$

In Phasor form, $\bar{I} = \bar{I}_R + \bar{I}_L + \bar{I}_C$

$\bar{I}_R = \bar{V} * G \qquad \bar{I}_L = \bar{V} * (-jB_L) \qquad \bar{I}_C = \bar{V} * (jB_C)$

$\bar{I} = \bar{V} * (G - jB_L + jB_C)$

$Y_T = \frac{\bar{I}}{\bar{V}} = (G - jB_L + jB_C) = \sqrt{G^2 + (B_C - B_L)^2} \angle Tan^{-1}\left(\frac{B_C - B_L}{G}\right)$

$\phi = -Tan^{-1}\left(\frac{B_C - B_L}{G}\right)$

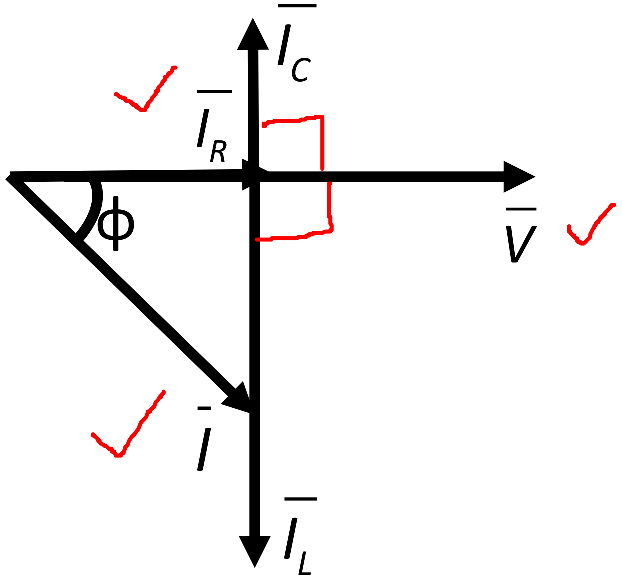
Case 1: $B_L > B_C$

If $B_L > B_C$ then $VB_L > VB_C$

i.e., $|\bar{I}_L| > |\bar{I}_C|$

The circuit behaves effectively as inductive circuit i.e., parallel RL type.

Phasor Diagram:



$$\phi = Tan^{-1}\left(\frac{B_L - B_C}{G}\right)$$

ϕ = positive

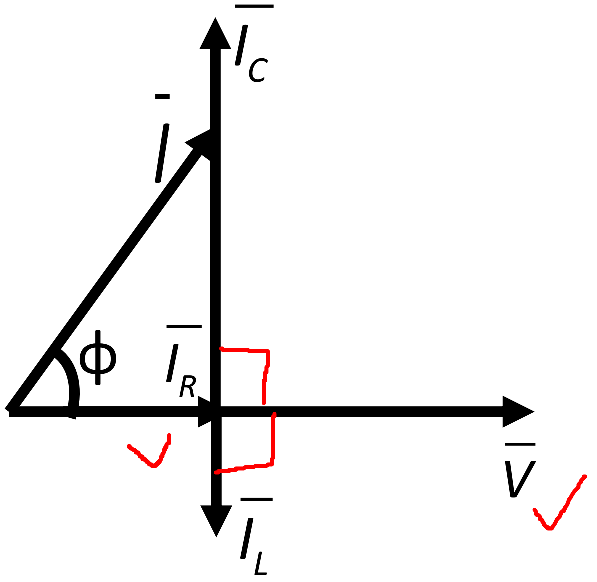
Case 2: $B_C > B_L$

If $B_C > B_L$ then $VB_C > VB_L$

i.e., $|\bar{I}_C| > |\bar{I}_L|$

The circuit behaves effectively as a capacitive circuit i.e., parallel RC type.

Phasor Diagram:



$$\phi = -\mathrm{Tan}^{-1}\left(\frac{B_C - B_L}{G}\right)$$

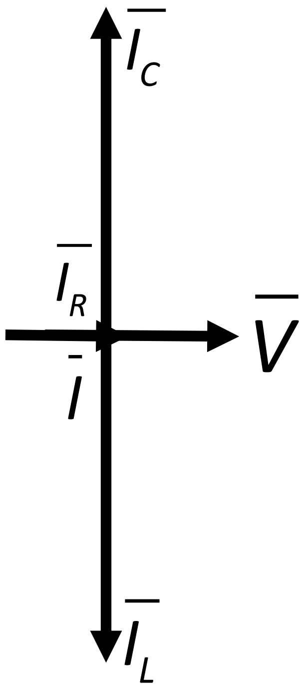
Note: ϕ will be negative in this case since $B_L < B_C$

Case 3: $B_L = B_C$

If $B_L = B_C$ then $VB_L = VB_C$ i.e., $|\bar{I}_L| = |\bar{I}_C|$

The circuit behaves effectively as a purely resistive circuit. This case is called **'Parallel Resonance'** case.

Phasor Diagram:



$$\bar{I} = \bar{I}_R$$

$$Y = G$$

$$\phi = 0^\circ$$

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Numerical Example

Question:

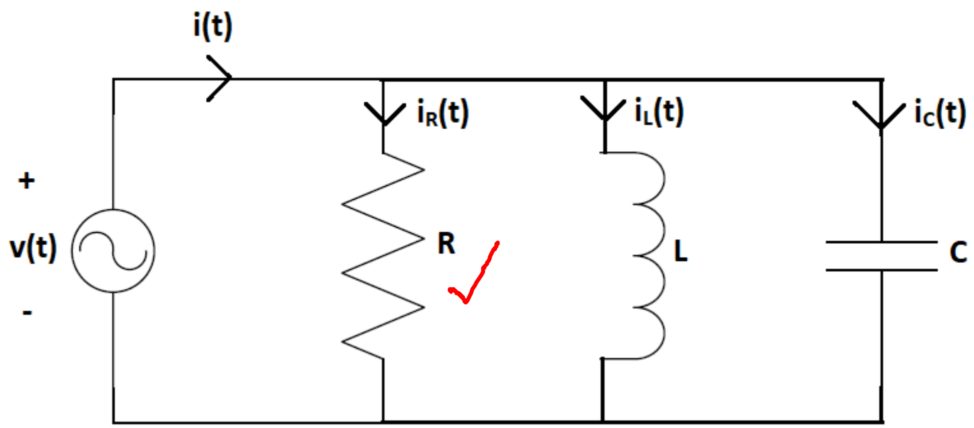
Three circuit elements $R=2.5\Omega$, $X_L=4\Omega$ and $X_C=10\Omega$ are connected in parallel, the reactances being at 50Hz.

a) Determine the admittance of each element and hence obtain the input admittance.

b) If this circuit is connected across a 10V, 50Hz AC source, determine the current in each branch and the total input current.

Numerical Example

Solution:



i) Admittance of branch1, $Y_1 = \dfrac{1}{Z_1} = \dfrac{1}{R} = G = 0.4S$

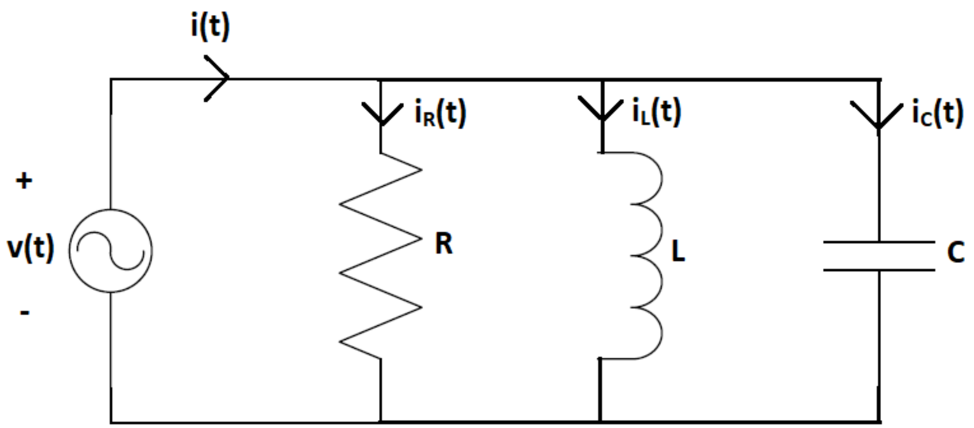
Admittance of branch2, $Y_2 = \dfrac{1}{Z_2} = \dfrac{1}{jX_L} = -jB_L = -j0.25S$

Admittance of branch3, $Y_3 = \dfrac{1}{Z_3} = \dfrac{1}{-jX_C} = jB_C = j0.1S$

Input Admittance $Y_{in} = Y_T = Y_1 + Y_2 + Y_3 = (0.4 - j0.15)S$

Numerical Example

Solution (Continued..) :



ii) Taking supply voltage as reference, $\bar{V} = 10\angle 0° V$

current in branch 1, $\bar{I}_R = \dfrac{\bar{V}}{Z_1} = \bar{V}Y_1 = 10\angle 0° * 0.4 = 4\angle 0° A$

current in branch 2, $\bar{I}_L = \bar{V}Y_2 = 10\angle 0° * (-j0.25) = 2.5\angle -90° A$

current in branch 3, $\bar{I}_C = \bar{V}Y_3 = 1\angle 90° A$

Input current, $\bar{I}_S = \bar{I}_R + \bar{I}_L + \bar{I}_C = 4.27\angle -20.55° A$

Numerical Example

Q10. The admittance of a circuit is (0.05-j0.08)S. Find the values of the resistance and inductive reactance of the circuit if they are a) in parallel b) in series.

Rectangular Snip

Impedance of a two-element parallel AC network is (6+j8) Ω. Determine the elements and their values if the supply frequency is 50Hz.	4M

ask this
answer to
atharva

Text Book & References

Text Book:

"Electrical and Electronic Technology" E. Hughes (Revised by J. Hiley, K. Brown & I.M Smith), 11th Edition, Pearson Education, 2012.

Reference Books:

1. "Basic Electrical Engineering - Revised Edition", D. C. Kulshreshta, Tata- McGraw-Hill, 2012.
2. "Basic Electrical Engineering", K Uma Rao, Pearson Education, 2011.
3. "Engineering Circuit Analysis", William Hayt Jr., Jack E. Kemmerly & Steven M. Durbin, 8th Edition, McGraw-Hill, 2012.

THANK YOU

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