基本電學-交流串聯電路

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一、交流串聯電路

基本定理：

交流電路中電阻、電容抗、電感抗相位角不同，故會取變化之相量計算，直流與交流運算方式幾乎是一樣地，差別就只是需要相量計算。

電流守恆:沒有接點、節點、元件、電路可以儲存電流，故流入等於流出。

歐姆定理: $\overline{Z}=\frac{\overline{V}}{\overline{I}}$ $\overline{Z}=Z\angle\theta_Z=\frac{V\angle\theta_V}{I\angle\theta_i}=\frac{V}{I}\angle\langle\theta_V-\theta_i\rangle$

一、交流串聯電路

元件取向量

1.R兩端 $\bar{V}$ 與 $\bar{I}$ 相位角相同

$$\overline{Z_R} = R\angle 0^\circ = R$$

2.L兩端 $\bar{V}$ 領先 $\bar{I}$ 90°

$$\overline{Z_L} = X_L\angle 90^\circ = jX_L$$

3.C兩端 $\bar{V}$ 落後 $\bar{I}$ 90°

$$\overline{Z_C} = X_C\angle -90^\circ = -jX_C$$

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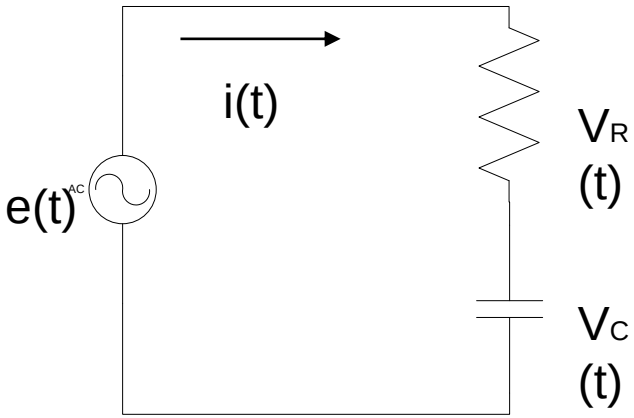
RC串聯電路:

$$\bar{I} = I_m \angle \mathbf{0}°$$



$$\overline{V_R} = \bar{I} \times \overline{Z_R} = \bar{I} \times R = RI_m \angle \mathbf{0}°$$

$$\overline{V_C} = \bar{I} \times \overline{Z_C} = \bar{I} \times (-jX_C) = X_C I_m \angle -90°$$

$$e(t) = \bar{V}_R + \bar{V}_C = \bar{I}(R) + \bar{I}(-jX_C)$$

$$= \bar{I}(R - jX_C)$$

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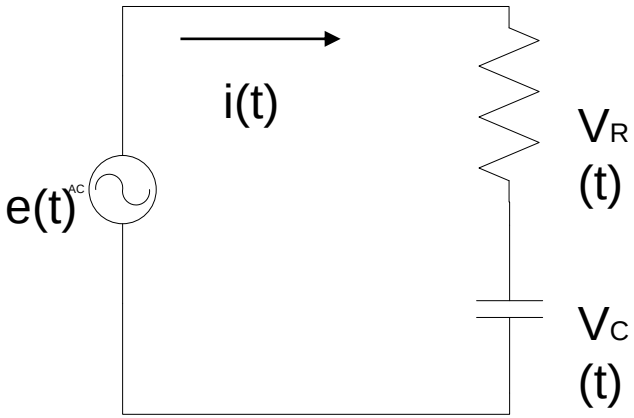
RC串聯電路:



$$\overline{V} = \overline{I}(R - jX_C)$$

阻抗:

$$\overline{Z} = \frac{\overline{V}}{\overline{I}} = R - jX_C$$

相角:

$$\tan\theta = \frac{-X_C}{R} \qquad \theta = -\tan^{-1}\frac{X_C}{R}$$

$$\overline{Z} = \left|\overline{Z}\right| \angle \theta$$

$$= \sqrt{R^2 + {X_C}^2} \angle -\tan^{-1}\frac{X_C}{R}$$

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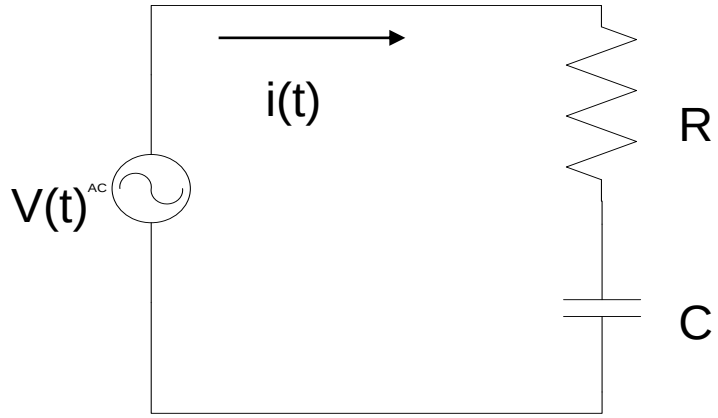

Q. 如左圖所示，R＝3Ω、C的容抗為4Ω，則總阻抗、相角各為多少？

A. 阻抗

$$\overline{Z} = R + \overline{X}_C = 3 - j4(\Omega)$$

相角

$$\theta = -\tan^{-1}\frac{X_C}{R} = -53°$$

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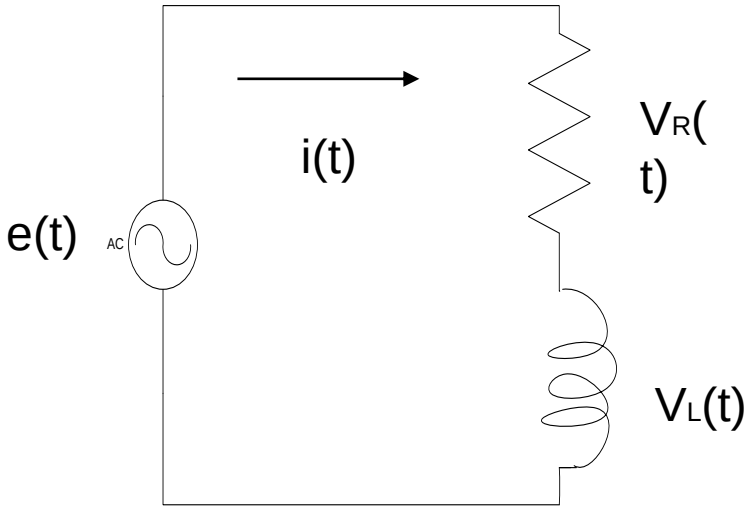
RL串聯電路:



$$\bar{I} = I_m \angle 0°$$

$$\overline{V_R} = \bar{I} \times \overline{Z_R} = \bar{I} \times R = RI_m \angle 0°$$

$$\overline{V_L} = \bar{I} \times \overline{Z_L} = \bar{I} \times (jX_L) = X_L I_m \angle 90°$$

$$e(t) = \bar{V}_R + \bar{V}_L = \bar{I}(R) + \bar{I}(jX_L)$$

$$= \bar{I}(R + jX_L)$$

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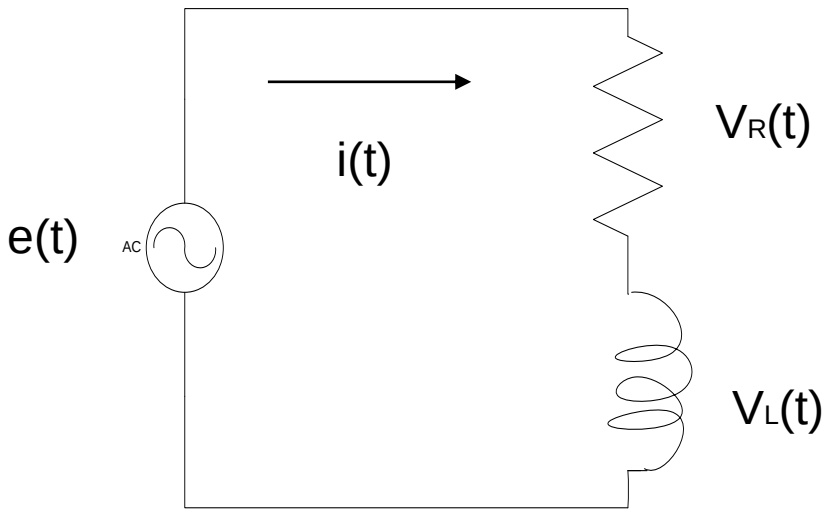
RL串聯電路:



$$\overline{V} = \overline{I}(R + jX_L)$$

$$\overline{Z} = \frac{\overline{V}}{\overline{I}} = R + jX_L$$

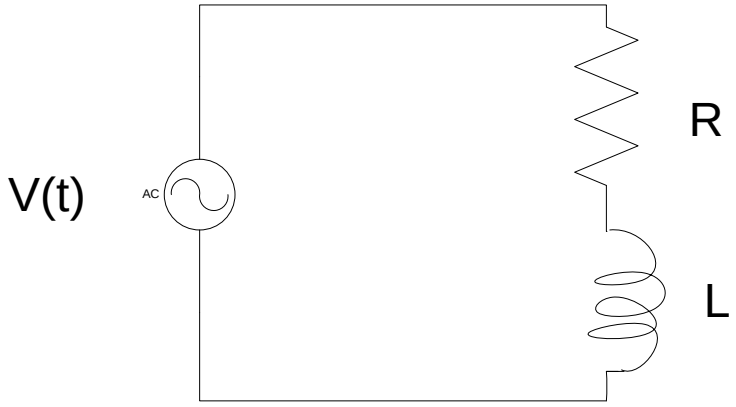
$$\tan\theta = \frac{X_L}{R}$$

$$\theta = \tan^{-1}\frac{X_L}{R}$$

$$\overline{Z} = \left|\overline{Z}\right| \angle\theta$$

$$= \sqrt{R^2 + {X_L}^2} \angle \tan^{-1}\frac{X_L}{R}$$

一、交流串聯電路



Q. 如左圖所示，R＝3Ω、C的容抗為4Ω，則總阻抗、相角各為多少？

A. 阻抗

$$\overline{Z} = R + \overline{X}_C = 3 + j4(\Omega)$$

相角

$$\theta = \tan^{-1}\frac{X_C}{R} = 53°$$

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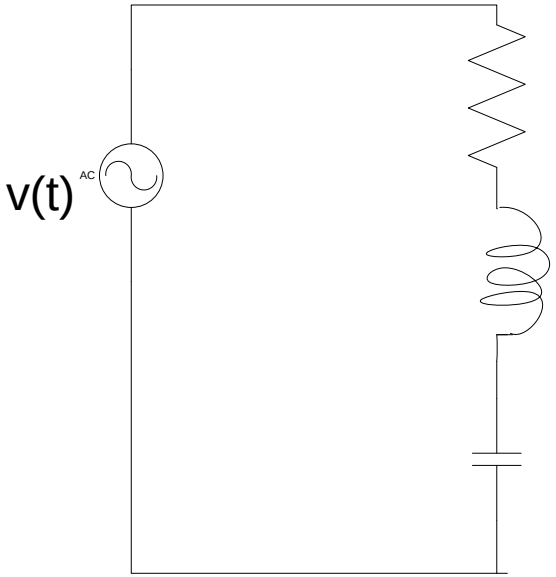
RLC串聯電路:



$$v(t) = i(t) \times \overline{Z}$$

$$\overline{Z} = R + \overline{X}_L + \overline{X}_C = R + j(X_L - X_C)$$

$$\overline{Z} = \sqrt{R^2 + (X_L - X_C)^2} \angle \tan^{-1} \frac{X_L - X_C}{R}$$

$$V = \overline{V}_R + \overline{V}_L + \overline{V}_C = V_R + j(V_L - V_C)$$

$$\overline{V}_R(t) = i(t) \times R$$

$$\overline{V}_L(t) = i(t) \times \overline{X}_L$$

$$\overline{V}_C(t) = i(t) \times \overline{X}_C$$