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Electric Circuit Theory II · EEE 322

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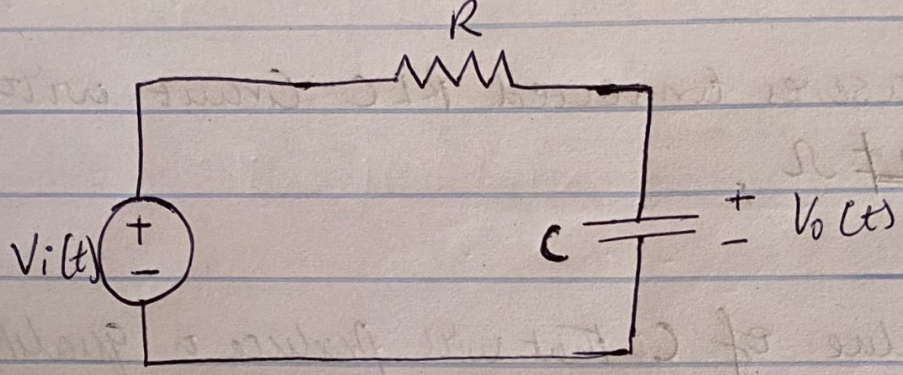
⇒ Determine the type of filter shown below, and show that it is cut-off frequency is: $W_c = \frac{1}{RC}$



Soln

recall: $H(\omega) = \frac{V_0}{V_i}$

but $V_0 = \frac{1}{SC}$, $V_i = R + \frac{1}{SC}$ but $S = j\omega$

Hence $H(\omega) = \frac{\frac{1}{SC}}{R + \frac{1}{SC}}$ ⇒ $\cancel{\frac{V_0}{V_i} = \left[\frac{\frac{1}{SC}}{R + \frac{1}{SC}}\right] \times V_i}$

$\cancel{\frac{RSC + 1}{SC}} \times \cancel{\frac{SC}{1}}$

$\frac{V_0}{V_i} = \frac{1}{Sc} \times \frac{Sc}{RSC + 1} = \frac{1}{RSC + 1}$

$\therefore \quad H(\omega) = \dfrac{1}{RSC+1}$ recall: $s = j\omega$

$H(0) = 1$

$H(\infty) = 0$

$\Rightarrow$ Hence: The cutoff frequency, ω_c is obtained by setting the magnitude of $H(\omega)$ to $\dfrac{1}{\sqrt{2}}$

$$|H(\omega)| = \left| \frac{1}{SRC+1} \right| = \frac{1}{\sqrt{2}}$$

$$|H(\omega)| = \frac{\sqrt{1^{\cancel{2}}}}{\sqrt{1^2 + (j\omega RC)^2}} = \frac{1}{\sqrt{2}}$$

$$|H(\omega)| = \frac{1}{\sqrt{1 + \cancel{j}\omega^2 R^2 C^2}} \times \frac{1}{\sqrt{2}}$$

$$\sqrt{2} = \sqrt{1 + \omega^2 R^2 C^2} \quad \text{(squaring both sides)}$$

$$2 = 1 + \omega^2 R^2 C^2$$

$$2 - 1 = \omega^2 R^2 C^2 \Rightarrow 1 = \omega^2 R^2 C^2$$

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$$W^2 = \frac{1}{R^2 C^2}$$

$$\therefore W_c = \frac{1}{RC}$$

Therefore it is a low pass filter