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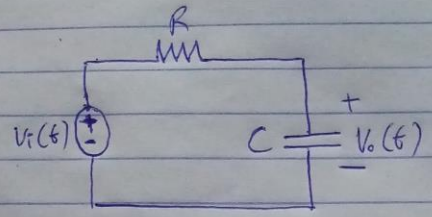
Demonstrate the type of filter shown below, and show that its cut-off frequency $\omega_c = 1/RC$



Sol

It is a low pass filter

$$H(\omega) = \frac{V_o}{V_i} = \frac{\frac{1}{j\omega C}}{R + \frac{1}{j\omega C}}$$

$$\frac{1}{j\omega C} \times \frac{1}{R + \frac{1}{j\omega C}}$$

$$= \frac{1}{1 + Rj\omega C}$$

$$H(0) = 1$$

$$H(\infty) = 0$$

The cut off frequency, ω_c

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

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

$$= \frac{1}{\sqrt{1 + (\omega^2 R^2 C^2)}} = \frac{1}{\sqrt{2}}$$

$$\sqrt{2} = \sqrt{1 + \omega^2 R^2 C^2}$$

$$2 = 1 + \omega^2 R^2 C^2 \quad \therefore \quad 1 = \omega^2 R^2 C^2 \quad \therefore \quad \omega = \frac{1}{RC}$$