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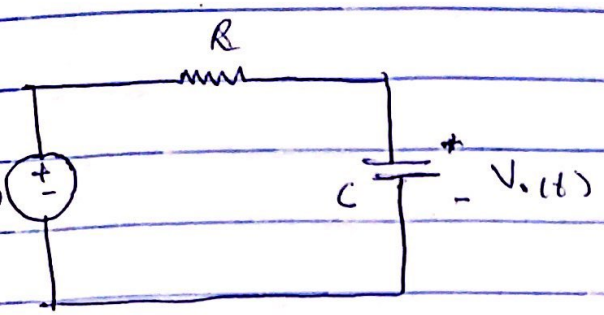
17/ENG04/038
Elect | Elect



Determine the type of filter shown below and show that it is Cut-off frequency is $w_c = \frac{1}{RC}$

Solution.

Converting to frequency domain

$R - R$

$C = \frac{1}{jwc}$

$H(w) = \frac{V_o}{V_i}$

Using Kirchoff voltage law (series connection)

$$H(w) = \frac{V_o}{V_i} = \frac{1/jwc}{R + 1/jwc} = \frac{1/jwc}{\frac{Rjwc+1}{jwc}}$$

$$H(w) = \frac{1}{1 + jwRc}$$

When $H(0) = 1$, $H(\infty) = 0$

The half power frequency which is equivalent to the corner frequency on the Bode plots but in the context of filters is usually known as Cut off frequency w_c, is obtained by setting magnitude of $H(w)$ equal to $1/\sqrt{2}$

Substituting w_c

$$H(wc) = \frac{1}{\sqrt{1 + w_c^2 R^2 C^2}} = \frac{1}{\sqrt{2}}$$

Making W_0 subject of formular

Taking square of both sides

$$\frac{1^2}{1+wc^2R^2C^2} \times^2 \frac{1}{2}$$

Cross multiply

$$2 \cdot 1^2 = 1 + w_c^2 R^2 C^2$$

$$2 = 1 + w_c^2 R^2 C^2$$

$$2 - 1 = w_c^2 R^2 C^2$$

$$1 = w_c^2 R^2 C^2$$

- taking square root of both sides

$$\sqrt{1} = \sqrt{w_c^2 R^2 C^2}$$

$$1 = w_c R_c$$

Divide both sides with R_c

$$w_c = \frac{1}{R_c}$$