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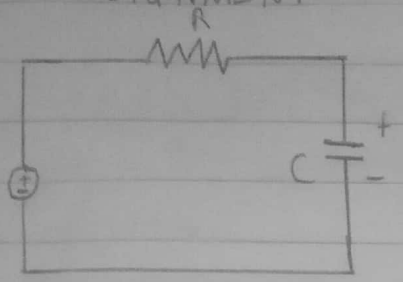
17/ENG05/030

MECHATRONICS ENGINEERING

ENG 322 ASSIGNMENT



Determine the type of filter shown above and show that its cutoff frequency is $W_c = \frac{1}{RC}$

Solution

Converting to Frequency domain

$R = R$

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

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

Using KVL (series connection)

$$H(W) = \frac{V_o}{V_i} = \frac{\frac{1}{jW_c}}{R + \frac{1}{jW_c}} = \frac{\frac{1}{jW_c}}{\frac{RjW_c + 1}{jW_c}}$$

$$H(W) = \frac{1}{1 + jWRC}$$

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 called CUT-OFF FREQUENCY.

W_c, is obtained by setting magnitude of $H(W) = \frac{1}{\sqrt{2}}$

Substituting W_c

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

Square both sides

$$\frac{1^2}{1 + w_c^2 R^2 C^2} = \frac{1}{2}$$

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

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

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

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

Taking square root of both sides

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

$$1 = w_c RC$$

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