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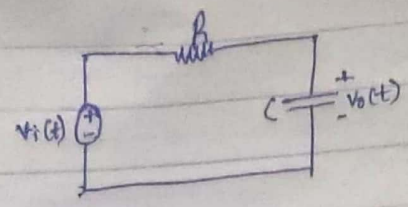
17/ENG05/033
MECHATRONIC
300 LEVEL
CIRCUIT THEORY 2
ASSIGNMENT

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



Solution

It is a low pass filter. It can be created when the output of a RC circuit is taken of the capacitor.

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

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

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

$$H(0) = 1$$

$$H(\infty) = 0$$

The cut-off frequency which is obtained by setting the magnitude of $H(\omega)$ equals to $1/\sqrt{2}$

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

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

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

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

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

$$\omega = \frac{1}{RC}$$