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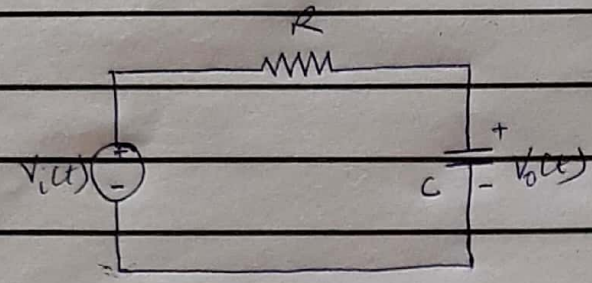
17/ENG04/043 Electrical Electronics Engineering

EEE 328 ELECTRICAL CIRCUIT THEORY



$C = 1/sC$

$R = R$

$V_i(t) = V_i(s)$

$V_o(t) = V_o(s)$

This is a low pass filter.

$$H(s) = \frac{V_o}{V_i} = \frac{\frac{1}{sC}}{R + \frac{1}{sC}}$$

$$\frac{\frac{1}{sC}}{\frac{RsC+1}{sC}}$$

$$\frac{1}{sC} \times \frac{sC}{RsC+1}$$

$$H(\omega) = \frac{1}{RsC+1} \quad ; \quad s = j\omega$$

Cut off frequency ω_c is obtained by setting the magnitude of $H(\omega)$ to $1/\sqrt{2}$

Therefore:

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

recall $s = j\omega$ $\quad j^2 = -1$

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

recall $H(\omega) = 1/\sqrt{2}$

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

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

Squaring both sides

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

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

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

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

Square root both sides

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

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

$$= 2$$