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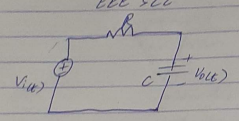
EEE 322



Determine the type of filter shown below and show that its cut-off frequency is

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

Sol

Converting to frequency domain

$R \rightarrow R$

$C \Rightarrow \frac{1}{j\omega C}$

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

Using Kirchoff voltage law (series connection)

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

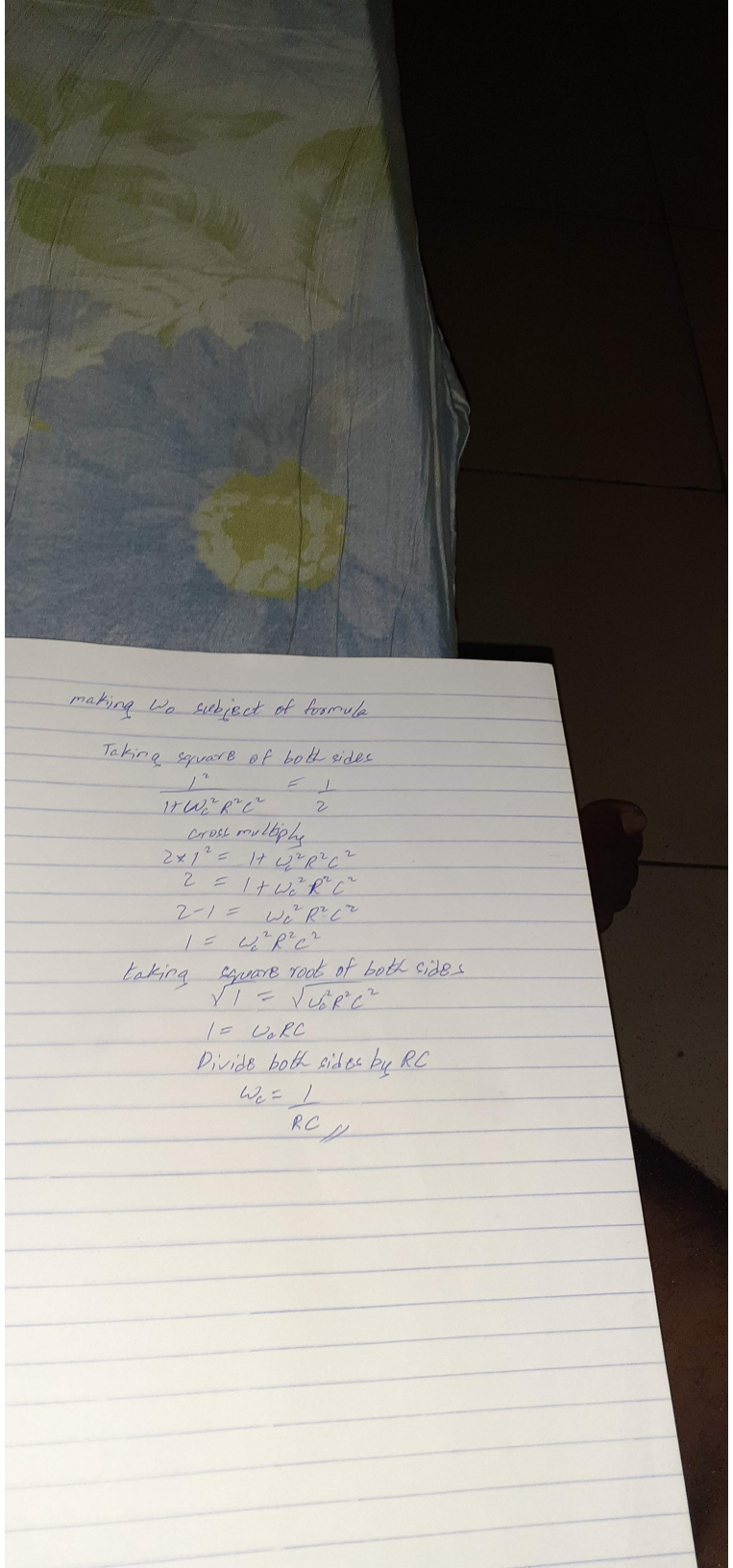
$$H(\omega) = \frac{1}{1 + j\omega RC}$$

when $H(\omega) = 1$, $H(\infty) = 0$

The half power frequency which is equivalent to the carrier frequency on the Bode plots but in the context of filters is usually known as cut off frequency ω_c, is obtained by setting magnitude of $H(\omega)$ equal to $\frac{1}{\sqrt{2}}$ of maximum

substituting ω_c

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



making ω_c subject of formula

Taking square of both sides

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

cross multiply

$$2 \times 1^2 = 1 + \omega_c^2 R^2 C^2$$

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

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

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

taking square root of both sides

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

$$1 = \omega_c RC$$

Divide both sides by RC

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