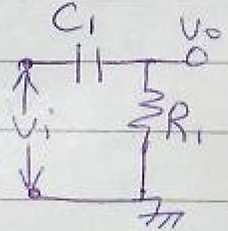
CHAPTER 2
Freqy Response

2.1 Low freqy Response



$$V_o(S) = \frac{R_1}{R_1 + 1/SC_1} V_i(S)$$

$$\therefore V_o(S) = \frac{S}{S + 1/R_1C_1} \cdot V_i(S)$$

$$\therefore A_L(S) = \frac{S}{S + 1/R_1C_1} = T.F \quad \text{where } S = j\omega = j2\pi f$$

* This function has zero when $S = 0$

* This function has pole when $S = -1/R_1C_1$

* For Real freqy $S = j\omega = j2\pi f$

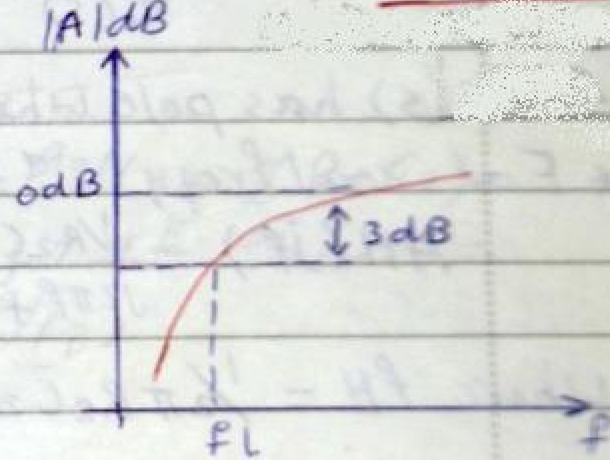
$$\therefore A_L(jf) = \frac{j2\pi f}{j2\pi f + 1/R_1C_1} = \frac{1}{1 - j(f_L/f)}$$

*Where: $f_L = 1/2\pi R_1 C_1 \Rightarrow$ lower 3dB freqy.

$$\therefore |A_L(jf)| = \frac{1}{\sqrt{1+(f_L/f)^2}}, \quad \theta = \tan^{-1}(f_L/f)$$

* $f = f_L \rightarrow |A_L| = 1/\sqrt{2} = 0.707 \rightarrow$ mid band region

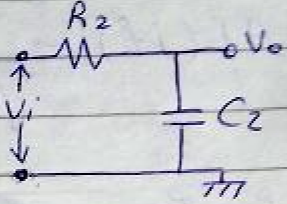
So f_L is a freqy at which the gain has fallen to 0.707 times the mid band value A_o.



In (dB) $\rightarrow 20 \log 1/\sqrt{2} = 3$dB, so f_L is the lower 3dB freqy.

2.2 High freqy Response

$$V_o(S) = \frac{1/SC_2}{1/SC_2 + R_2} \cdot V_i(S)$$



$$V_o(S) = \frac{1/R_2C_2}{S + 1/R_2C_2} \cdot V_i(S)$$

$$\therefore AH(S) = \frac{V_o(S)}{V_i(S)} = \frac{1/R_2C_2}{S + 1/R_2C_2} = T.F$$

* $AH(S)$ has pole when $S = -1/R_2C_2$ — لا يوجد zero يوجد كالبط

* For real freqy $S = j\omega = j2\pi f$

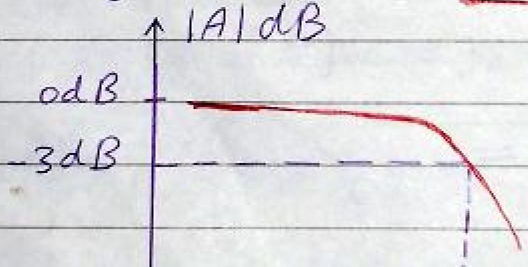
$$\therefore AH(jf) = \frac{1/R_2C_2}{j2\pi f + 1/R_2C_2} = \frac{1}{1 + jf/f_H}$$

Where $f_H = 1/2\pi R_2C_2 \Rightarrow$ upper 3dB freqy

$$|AH(jf)| = \frac{1}{\sqrt{1 + (f/f_H)^2}}, \quad \theta_H = \tan^{-1}(f/f_H)$$

Also At $f = f_H$ the gain reduced to $1/\sqrt{2}$ its mid band then f_H is called upper 3dB freqy.

* The freqy dependence c/s on high and low freqy range is called (**Bode plot**)



2.3 Bode plot

* The freqy Response is indicated by two curves:

① The magnitude of T.F.

② The phase Angle of T.F.

These two curves maybe be approximated by piece wise linear regions

2.3.1 Single pole T.F.

Consider $A(S) = A_o/(1+ S R_2 C_2)$

for real freqy $S = j 2\pi f$ then

$A(jf) = A_o/(1 + j f/f_p)$

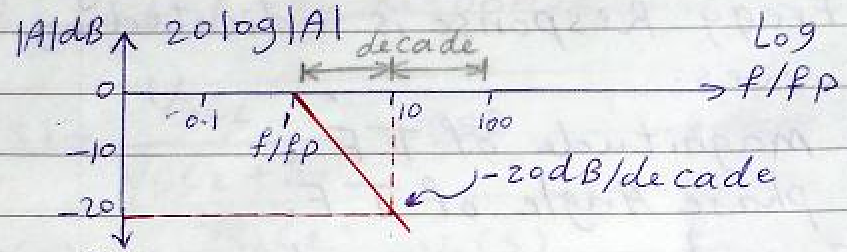
Where $f_p = 1/2\pi R_2 C_2$

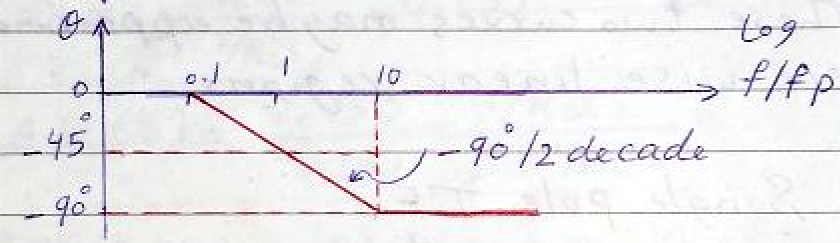
$$|A| = \frac{|A_o|}{\sqrt{1+(f/f_p)^2}} \quad , \theta = -\tan^{-1} f/f_p$$

$$|A|dB = \underbrace{20\log|A_o|}_{0} - 20\log\sqrt{1+(f/f_p)^2}$$

* for $f < f_p \rightarrow$ The c/s is horizontal line
* for $f > f_p \rightarrow$ The c/s is stright line of slope -20dB per decade
* for $f << f_p \rightarrow$ then $\theta \rightarrow 0°$ OR at $f = 0.1 f_p$ $\rightarrow \theta = 0°$
* for $f >> f_p \rightarrow$ then $\theta \rightarrow -90°$ OR at $f = 10 f_p$

* For $f = f_p \longrightarrow \theta = -45^\circ$.





For phase Angle when $0.1 f_p < f < 10 f_p$ we plot a straight line of slop of $-90^\circ/2$ decade

3.2: Single Zero T.F.

Consider $A(s) = A_0(1 + sK)$ then

$A(jf) = A_0(1 + j\, f/f_z)$, $f_z = 1/2\pi K$

$\therefore |A|dB = 20\log|A_0| + 20\log\sqrt{1 + (f/f_z)^2}$

$\theta = \tan^{-1} f/f_z$

K = constant