Faculty of Engineering & Technology
Electrical & Computer Engineering Department

ENEE2103

PreLab#04

Filters

Prepared by : Tareq Shannak

ID Number : 1181404

Instructor : Dr. Alhareth Zyoud

Teaching Assistant : Mahdi Salem

Section : 5

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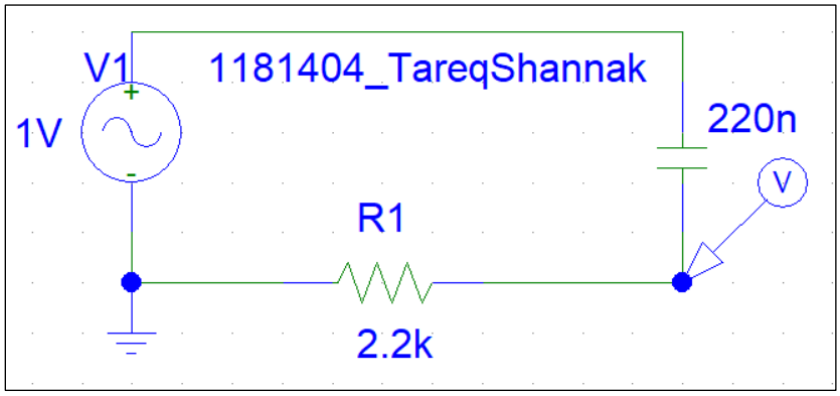
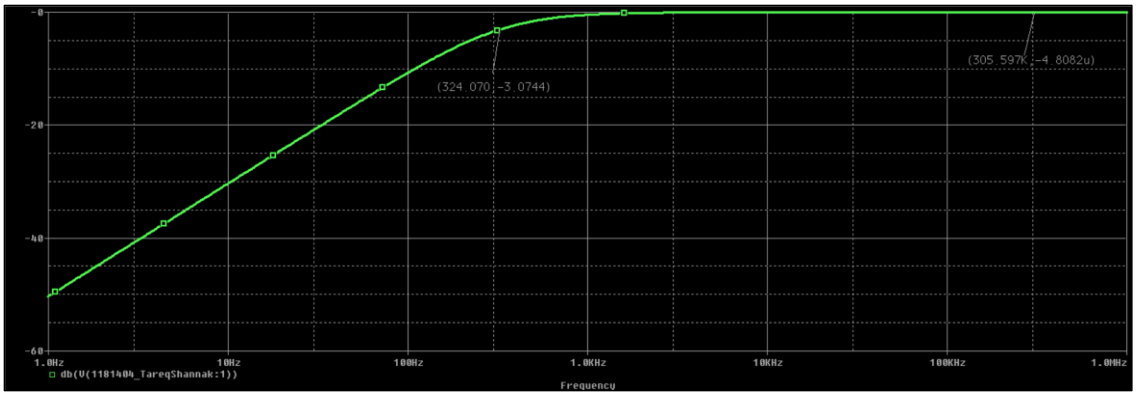
Passive Filters

First Order Circuits

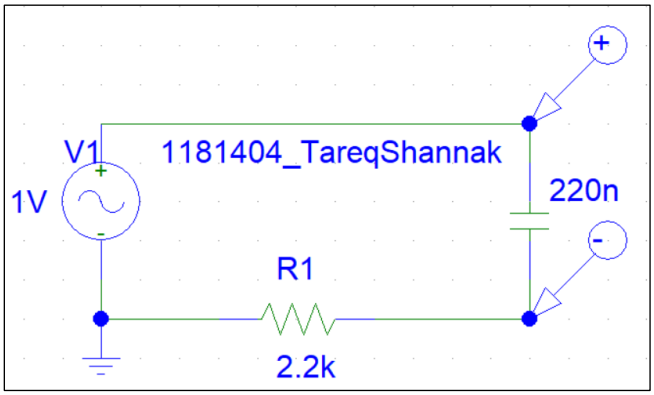


$$From\ Theory: f_c = \frac{1}{2\pi RC} = \frac{1}{2\pi(2.2k)(220n)} HZ \cong 328.833\ HZ$$

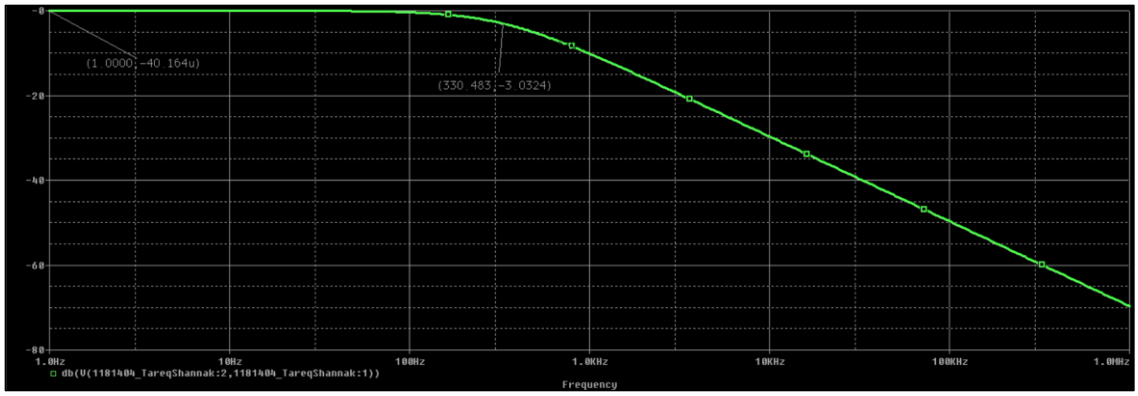
$$\left|\frac{V_{out}}{V_{in}}\right| = v_{out} = magnitude\ of\ v_c + v_l = magnitude\ of\ v_r \rightarrow v_{out} = 0\ db$$



$$From\ Graph: magnitude\ of\ v_r = -4.8082u\ db$$
$$When\ v = (-4.8082u - 3)db \approx -3db, f_c \cong 324.070HZ, High\ Pass\ Filter$$

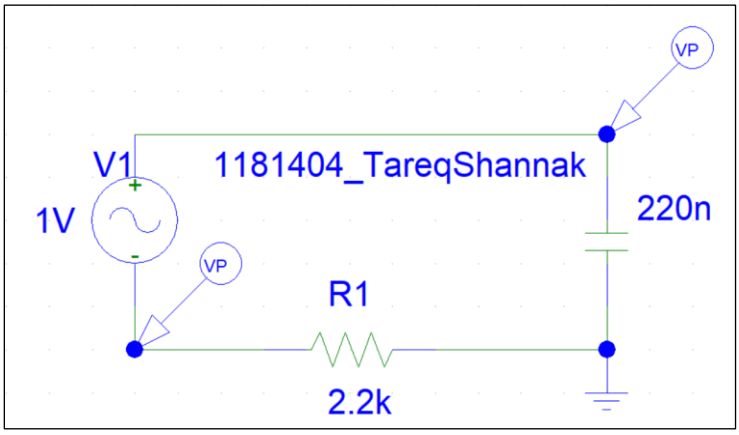


$$From\ Theory: f_c = \frac{1}{2\pi RC} = \frac{1}{2\pi(2.2k)(220n)} HZ \cong 328.833\ HZ$$

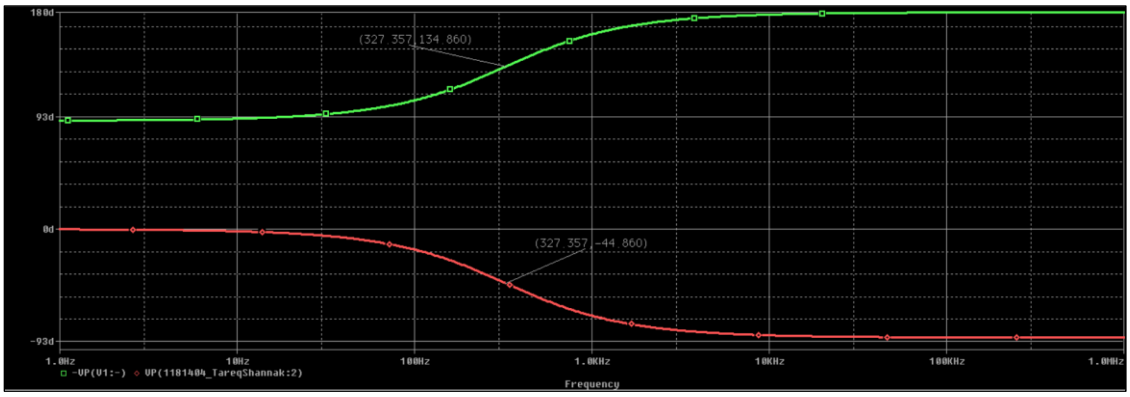


$From\ Graph: magnitude\ of\ v_c = -40.164u\ db$

$When\ v = (40.164u - 3)db \approx -3db, f_c \cong 330.483\ HZ, Low\ Pass\ Filter$



$\varphi_c = -\tan^{-1} 2\pi fRC = -\tan^{-1} 2\pi(328.833)(2200)(220n) = -\tan^{-1} 1 = -45\ degrees$

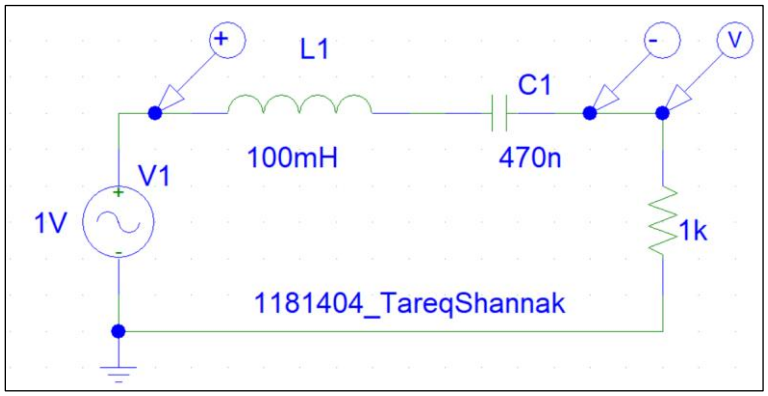


$From\ Graph: \varphi_{r\ when\ f=f_c}, \varphi = 135\ degrees = -45\ in\ \tan\varphi$

$\varphi_{c\ when\ f=f_c}, \varphi = -45\ degrees$

Second Order Circuits

Band Pass Filter

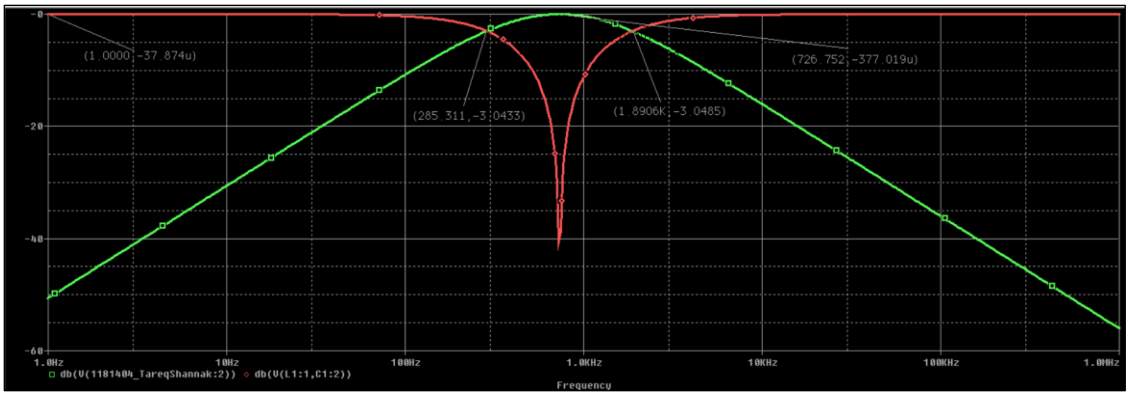


$$From\ Theory: f_c = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{(100m)(470n)}} HZ \cong 734.127\ HZ$$

$$f_{c1} = \frac{1}{2\pi}\left(\sqrt{(\frac{R}{2L})^2 + \frac{1}{LC}} - \frac{R}{2L}\right) = \frac{1}{2\pi}\left(\sqrt{(5000)^2 + \frac{1}{(0.1)(470n)}} - 5000\right) HZ \cong 286.907\ HZ$$

$$f_{c2} = \frac{1}{2\pi}\left(\sqrt{(\frac{R}{2L})^2 + \frac{1}{LC}} + \frac{R}{2L}\right) = \frac{1}{2\pi}\left(\sqrt{(5000)^2 + \frac{1}{(0.1)(470n)}} + 5000\right) HZ \cong 1878.457\ HZ$$

$$\left|\frac{V_{out}}{V_{in}}\right| = v_{out} = magnitude\ of\ v_c + v_l = magnitude\ of\ v_r \rightarrow v_{out} = 0db$$



$$From\ \textbf{Red}\ Graph: For\ v_c + v_l, magnitude = -37.874u\ db$$

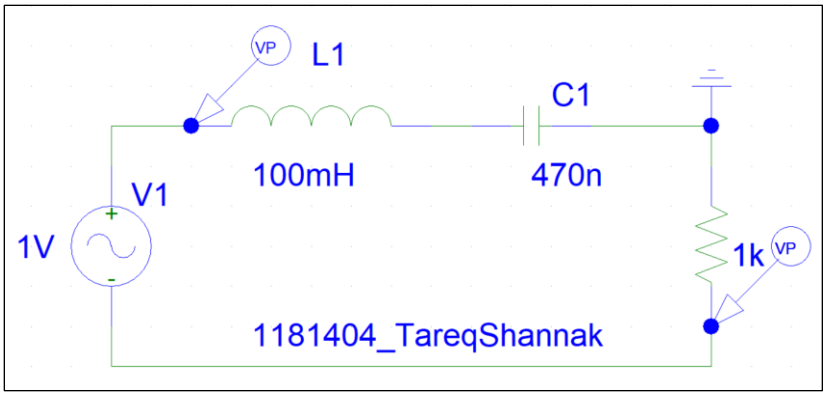
$$When\ v = (-37.874u - 3)db \approx -3db, f_c \cong 726.752\ HZ, f_{c1} \cong 285.311HZ, f_{c2} \cong 1890.6\ HZ$$

Band Pass Filter

$$From\ \textbf{Green}\ Graph: For\ v_r, magnitude = -377.019u\ db$$

$$When\ v = (-377.019u - 3)db \approx -3db, f_c \cong 726.752\ HZ, f_{c1} \cong 285.311HZ, f_{c2} \cong 1890.6\ HZ$$

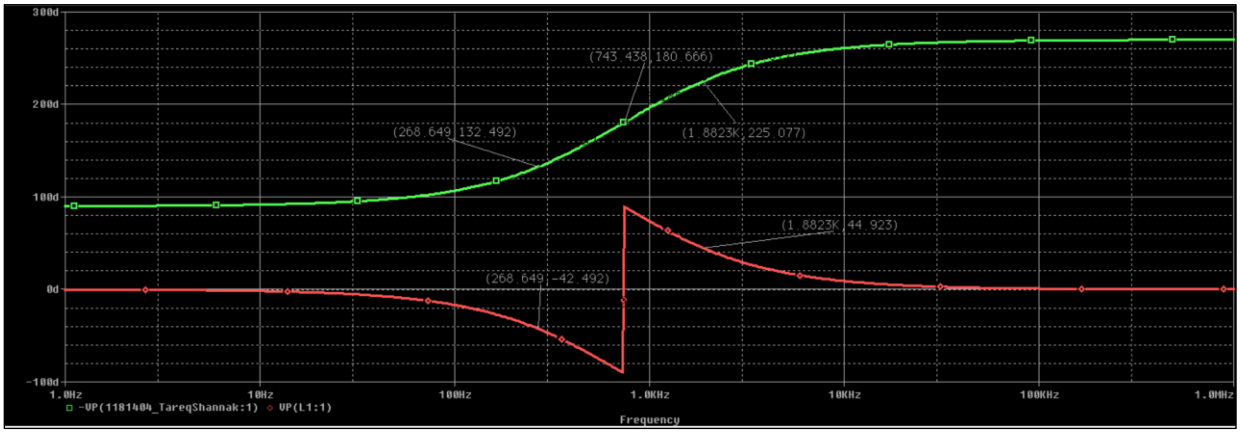
Band Reject Filter



$$\varphi_c = -\tan^{-1}\left(\frac{\frac{1}{LC} - (2\pi f_c)^2}{\frac{2\pi f_c R}{L}}\right) = -\tan^{-1}\left(\frac{\frac{1}{(0.1)(470n)} - (2\pi(734.127))^2}{\frac{2\pi(734.127)(1000)}{(0.1)}}\right) = 0\ degree$$

$$\varphi_{c1} = -\tan^{-1}\left(\frac{\frac{1}{LC} - (2\pi f_{c1})^2}{\frac{2\pi f_{c1} R}{L}}\right) = -\tan^{-1}\left(\frac{\frac{1}{(0.1)(470n)} - (2\pi(286.907))^2}{\frac{2\pi(286.907)(1000)}{(0.1)}}\right) = -45\ degrees$$

$$\varphi_{c2} = -\tan^{-1}\left(\frac{\frac{1}{LC} - (2\pi f_{c2})^2}{\frac{2\pi f_{c2} R}{L}}\right) = -\tan^{-1}\left(\frac{\frac{1}{(0.1)(470n)} - (2\pi(1878.457))^2}{\frac{2\pi(1878.457)(1000)}{(0.1)}}\right) = 45\ degrees$$



From Green Graph: $\varphi_{when\ f=f_c} = 180\ degrees = 0\ in\ \tan\varphi$,

$\varphi_{when\ f=f_{c1}} = 132\ degrees = -48\ in\ \tan\varphi$,

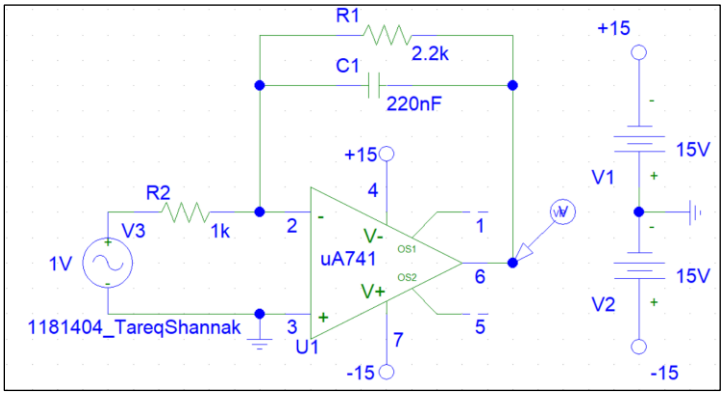
$\varphi_{when\ f=f_{c2}} = 225\ degrees = 45\ in\ \tan\varphi$

From Red Graph: $\varphi_{when\ f=f_c} = 0\ degree$,

$\varphi_{when\ f=f_{c1}} = -42.492\ degrees$, $\varphi_{when\ f=f_{c2}} = 44.932\ degrees$

Active Filters

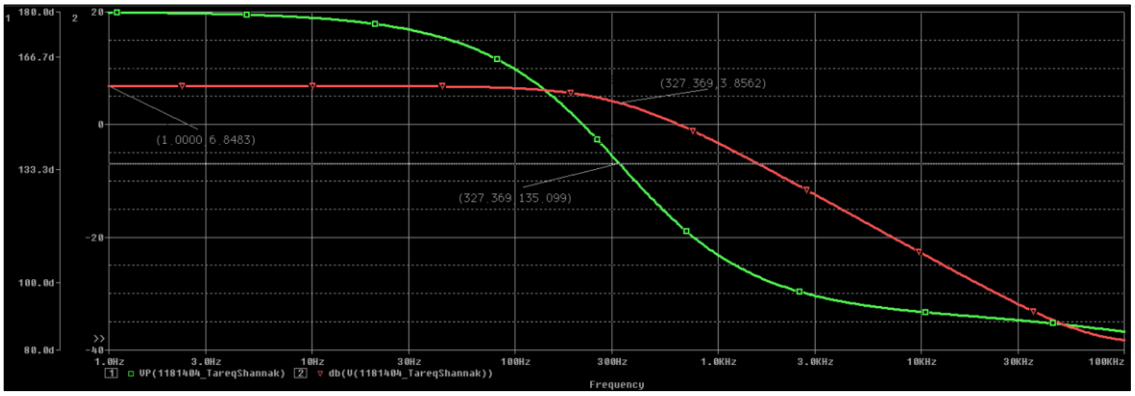
Simplified Inverting Amplifier Filter



$$From\ Theory: f_c = \frac{1}{2\pi R_1 C} = \frac{1}{2\pi(2.2k)(220n)} = 328.833\ HZ$$

$$v_o = \left|\frac{v_{out}}{v_{in}}\right| = \left|\frac{-\frac{R_1}{R_2}\ v_{in}}{v_{in}}\right| = \frac{R_1}{R_2} = \frac{2.2k}{1k} = 2.2v = 20\ \log 2.2\ db = 6.8485\ db$$

$$\varphi_c = -\tan^{-1} 2\pi fRC = -\tan^{-1} 2\pi(328.833)(2200)(220n) = -\tan^{-1} 1 = -45\ degrees$$



$$From\ Graph: For\ v_o, magnitude = 6.8483\ db$$

$$When\ v = (6.8483 - 3)db \approx 3.8483\ db, f_c \cong 327.369\ HZ, Low\ Pass\ Filter$$

$$\varphi_{when\ f=f_c} = 135.009\ degrees \approx 135\ degrees = -45\ in\ \tan\varphi$$