Lab-10

10.1

b) None of the obtained filters are linear phase.

c) We can observe that different filters have different parameters to characterize them. Hence, based on requirement we can chose one of these filters. In a general sense, we usually go with butterworth or equiripple.

f) We know that, cut off for the filters is designed in the way that it lets f_1 to pass through and attenuates frequency f_2, here we can see that $f_1 = 500Hz$, $f_2 = 3kHz$ & $f_c = 2kHz$ as $f_1 < f_c < f_2$ holds. Hence output only depends upon $\sin 2\pi f_1 t$ & independent of $\sin 2\pi f_2 t$.

10.2a) Given that, $H(z) = b_0\,(1 - e^{j\omega_0} z^{-1})(1 - e^{-j\omega_0} z^{-1})$

$$\Rightarrow H(z) = b_0 (1 - z^{-1}(e^{j\omega_0} + e^{-j\omega_0}) + z^{-2})$$

We know that, $\omega_0 = \frac{\pi}{4}$ & $H(1) = 1$.

$$\Rightarrow H(1) = b_0 (1 - (2\cos\omega_0) z^{-1} + z^{-2})$$

$$\Rightarrow b_0 (2 - 2\cos\omega_0) = 1$$

$$\Rightarrow b_0 = \frac{1}{2(1-\cos\omega_0)}$$

$$\Rightarrow b_0 = \frac{2+\sqrt{2}}{6} = 1.7071$$

b) Given that $H(z) = \dfrac{b_0(1-e^{j\omega_0}z^{-1})(1-e^{-j\omega_0}z^{-1})}{(1-r_0 e^{j\omega_0}z^{-1})(1-r_0 e^{-j\omega_0}z^{-1})}$ & r_0 ...

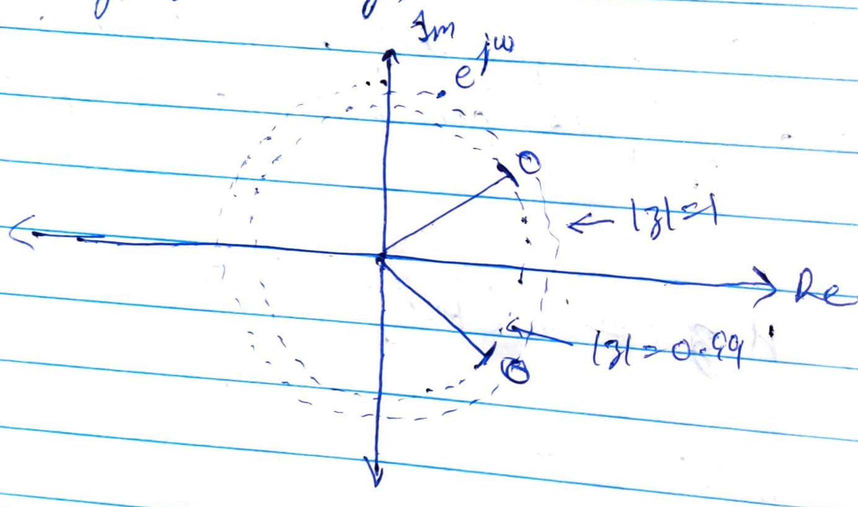
$\Rightarrow$ Given that $H(1)=1$, $\omega_0 = \frac{\pi}{4}$ & $r_0 = 0.99$

$\Rightarrow H(1) = \dfrac{b_0\,(1-2\cos\omega_0+1)}{1-2r_0\cos\omega_0+r_0^2}$

$\Rightarrow b_0 = \dfrac{1+r_0^2-2r_0\cos\omega_0}{2(1-\cos\omega_0)}$

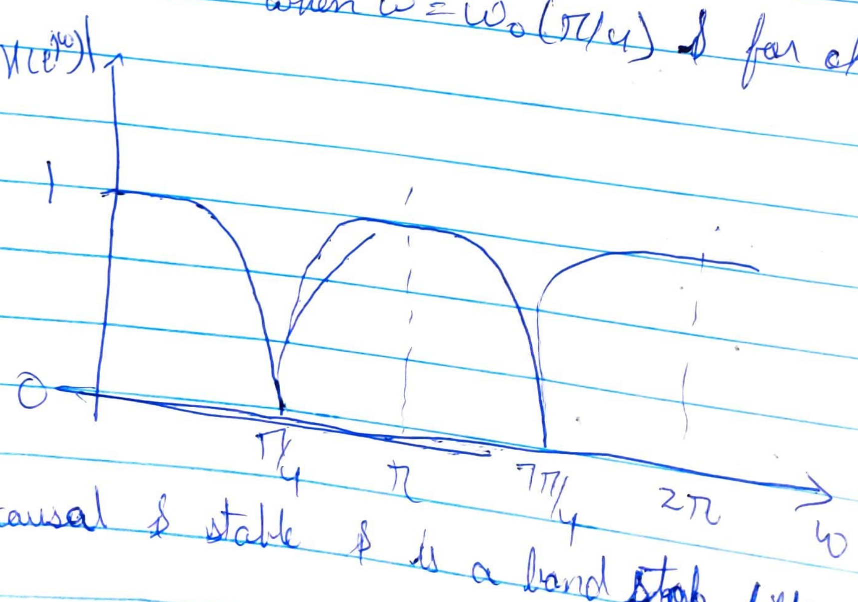
$\Rightarrow b_0 = 0.9170$

By visualizing geometrically,



$\Rightarrow H(e^{j\omega}) = 0$ when $\omega = \omega_0\,(\pi/4)$ & for other values it ≈ 1

$\Rightarrow$



It is causal & stable & is a band ~~stop~~ filter that attenuates freq $\pi/4$

c) On reducing r, the phase plot becomes non linear i.e. it moves away from ideal behaviour.
On changing r_0 from 0.99 to 0.5, the ideal nature of filter is lost.

e) For the given sound, given samples are 73113 & sampling rate is 8192 Hz.
$\Rightarrow$ duration of signal is 8.9249 seconds.
When we add the sinusoid with freq 1024 Hz, a sharp beep distortion is obtained.

Now, $F = \frac{f_c}{f_s} \Rightarrow \frac{1024}{8192} = \frac{1}{8}$ Hz

$\Rightarrow \omega_F = 2\pi F = \frac{\pi}{4}$

This is equal to cut off freq. for above notch filter, hence the distortion is removed.