

School of Engineering and Applied Science (SEAS)  
Ahmedabad University

BTech(ICT) Semester VI: Digital Signal Processing

Laboratory Assignment-7

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**AIM ::** LAB7 helps to understand the concept of butterworth filter Using **impz** and **freqz** functions. In addition to this, I can use **buttord**, **butter** function for finding **n**, **cutoffFreq**, numerator and denominator coefficients and after that use of **freqz** function for plot magnitude and phase .

1. Solution Problem-1

(a) Matlab Script:

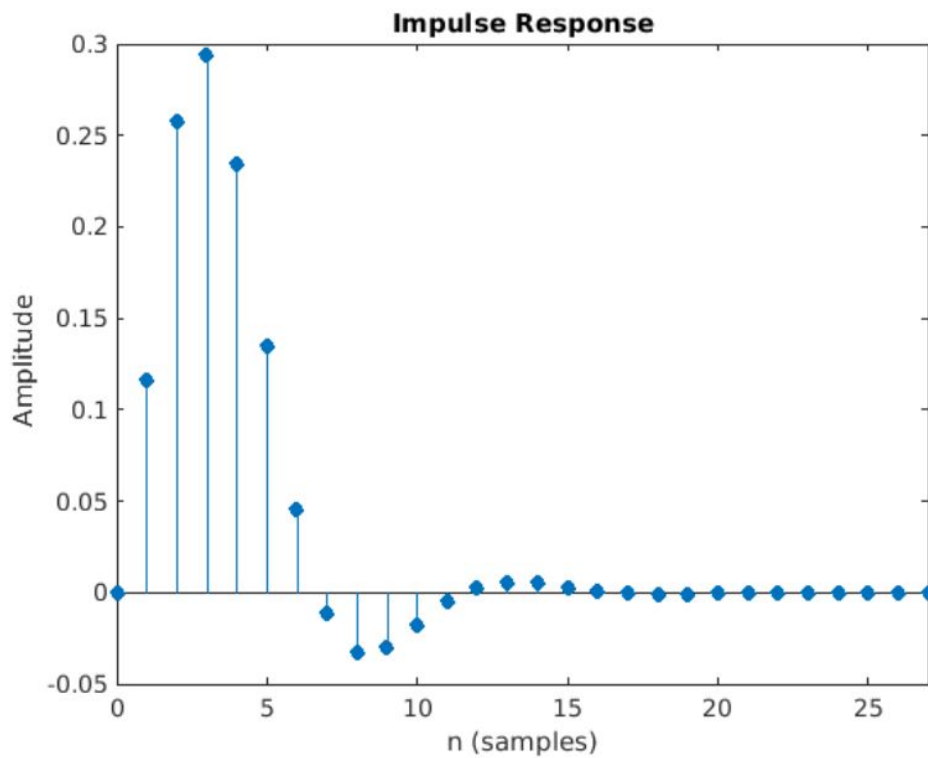
```
1 clc ;
2 close all ;
3 clear ;
4 %impz(b,a,n) with no output arguments plots the impulse response of the digital
  filter with numerator coefficients b and denominator coefficients a.
5 %b :: coefficients of numerator part as [...b4(Z^4) b3(Z^3) b1(Z^2) b1(Z^1) b0(Z
  ^0) b(-1)(Z^-1) b(-2)(Z^-2) b(-3)(Z^-3) ...]
6 %a :: coefficients of denominator part as [...b4(Z^4) b3(Z^3) b1(Z^2) b1(Z^1) b0(Z
  ^0) b(-1)(Z^-1) b(-2)(Z^-2) b(-3)(Z^-3) ...]
7 %n(optional):: number of samples for impz(b,a,n)
8 b=[0 0.116 0.0715];
9 a=[1 -1.6014 1.0211 -0.2321];
10 figure(1)
11 impz(b,a) %Plots Impulse Response of H(Z)
12
13 %freqz function : freqz(b,a,n,fs) without output argument, Display the magnitude
  and phase responses of the filter.
14 %b=numerator coefficients
15 %a=denominator coefficients
16 %(optional)n=Number of evaluation points, specified as a positive integer scalar
  no less than 2. When n is absent, it defaults to 512. For best results, set n
  to a value greater than the filter order.
17 %fs=sampling freq
18 fs=8000;
19 figure(2)
20 freqz(b,a,fs); %Plots magnitude and phase response
21 %n=1131; as it's optional i take my roll-number last four digit
22 %freqz(b,a,n,fs)
```

(b) Approach:

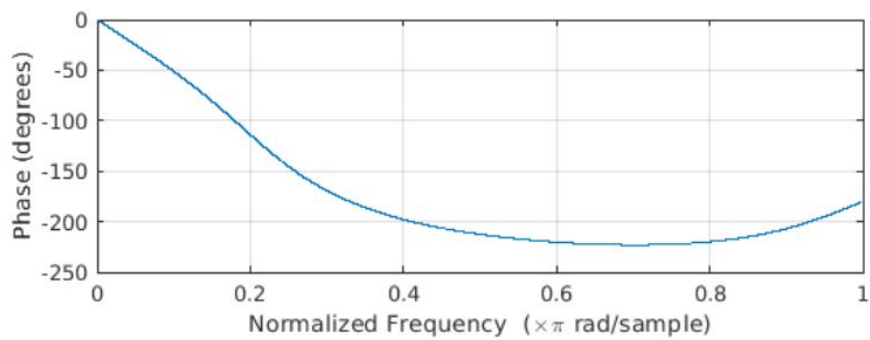
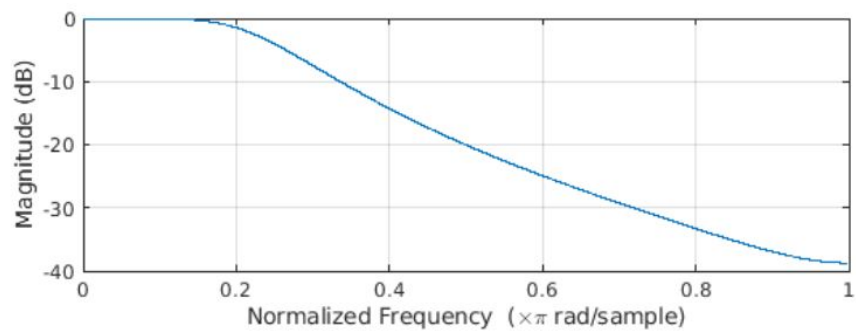
Direct taking  $H(Z)$  from calculation on paper which is given by sir,

$$H(Z) = \frac{0.116Z^{-1} + 0.0715Z^{-2}}{1 - 1.6014Z^{-1} + 1.0211Z^{-2} - 0.2321Z^{-3}}$$

Coefficients of numerator(b) would be [0; 0.116; 0.0715] and denominator(a) would be [1; -1.6014; 1.0211; -0.2321] assigning to b and a, respectively. After that passing b,a as argument to plot impulse response of Transfer function with the help of **impz(b,a)** function. Which plots Amplitude Vs. samples graph of  $H(Z)$ . **freqz(b,a,n,fs)** function, plots magnitude response and phase response of  $H(Z)$  with sampling frequency.



without giving 'n' value, It takes by default 512



with giving 'n' value as 1131 for impulse response

