31606 Signals and Linear Systems in discrete time

Hands on 9
Group 1

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|||| How finite should it be?

i) Like a hot knive through a Butterworth We are asked to design a filter meeting the following requirements:

- Passband from 0.2 to 0.3
- Stopbands from 0 to 0.1 ad 0.4 to 1
- Rippels in passband no greater than 2dB
- Stopband attenuation min. 100dB

While the headline does imply that a butterworth filter could be used, this does not allow us to utilize that rippels in both the stop and passband are accepted.

We use the *Matlab* filter toolbox to design our filer:

```
% Construct an FDESIGN object and call its ELLIP method.
h  = fdesign.bandpass(Fstop1, Fpass1, Fpass2, Fstop2, Astop1, Apass, ...
                      Astop2);
Hd = design(h, 'ellip', 'MatchExactly', match);
```

Pole-Zero plot of the filter can be seen in fig. 1, frequency response (and specification boundaries) can be found in fig. 2 and impulse response in fig. 3

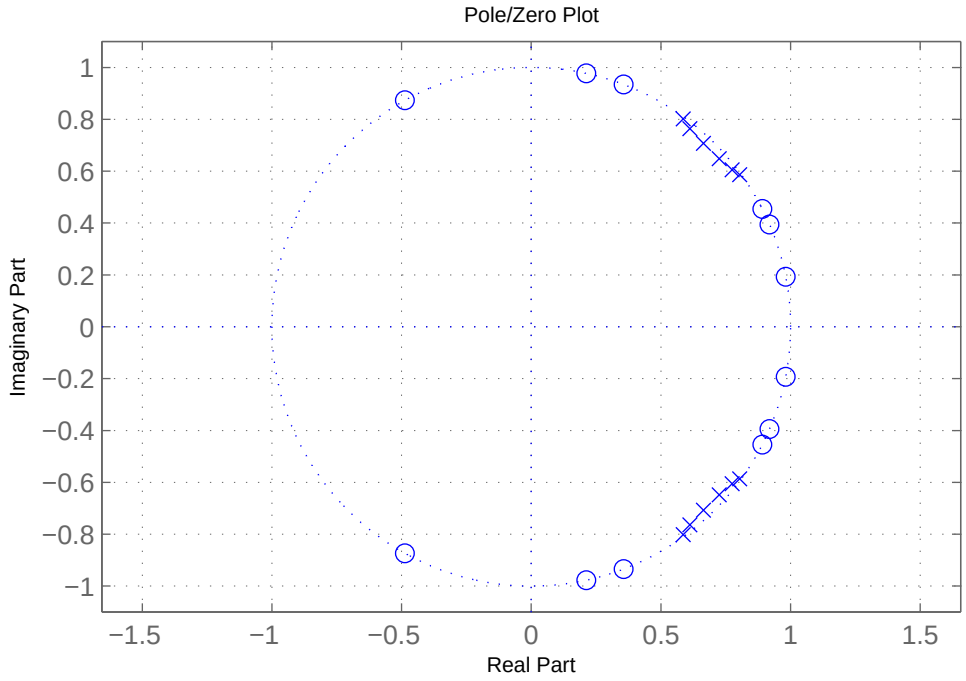

Figure 1: blablabla

We find that point i in the impulse response where the maximum amplitude is below a value of 10% of the maximum amplitude of the whole signal so that:

$$x[1 : \text{inf}] * 10\% > x[i : \text{inf}]$$

This is done with the *Matlab* code:

```
%make list of max of remaining response:
maxrest = uncut_ir;
for i = 1:length(maxrest)
    maxrest(i) = max( abs( uncut_ir(i:end) ) );
    if maxrest(i) < maxval*sig
        break; %stop here, i is now the index, where all samples [i:inf[ < max
    end
end
```

This gives an "effective" length of 134 samples. (Had we chosen a buttersworth filter instead this would have been 146 samples).

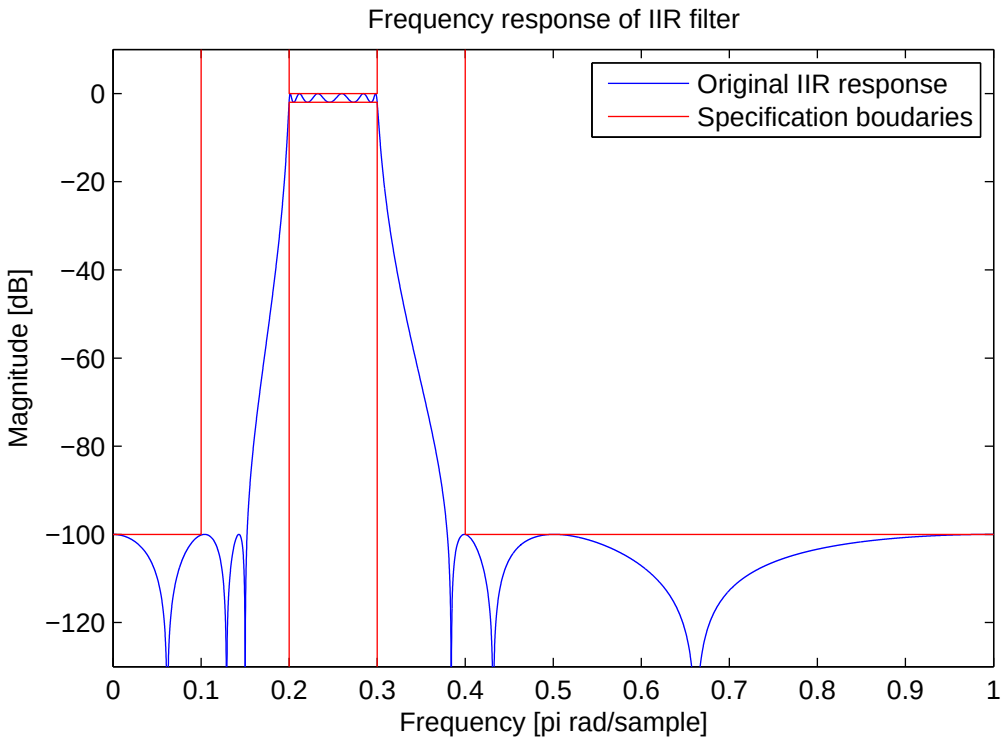

Figure 2: cornerfreq: 0.3004, 1.997

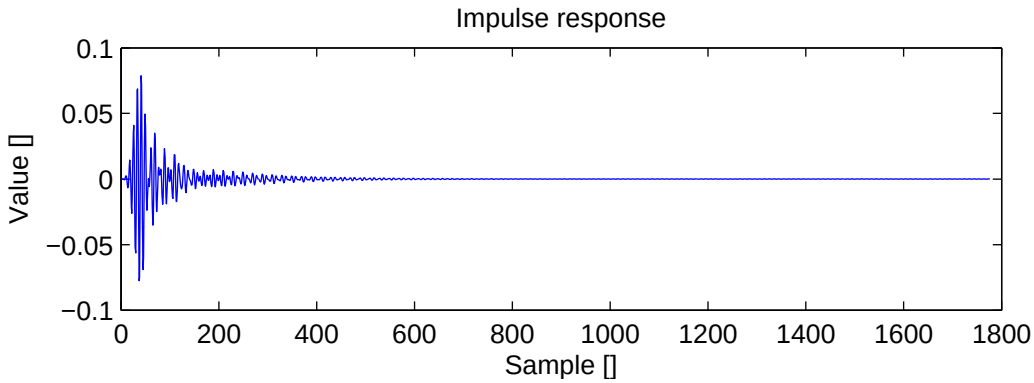

Figure 3: blablabla

We now use a rectangular window to cut the impulseresponse at 100%, 75%, 60%, 40% and 10% of the original. The frequency response of the filter with these impulseresponses as kernes are shown in fig. 4

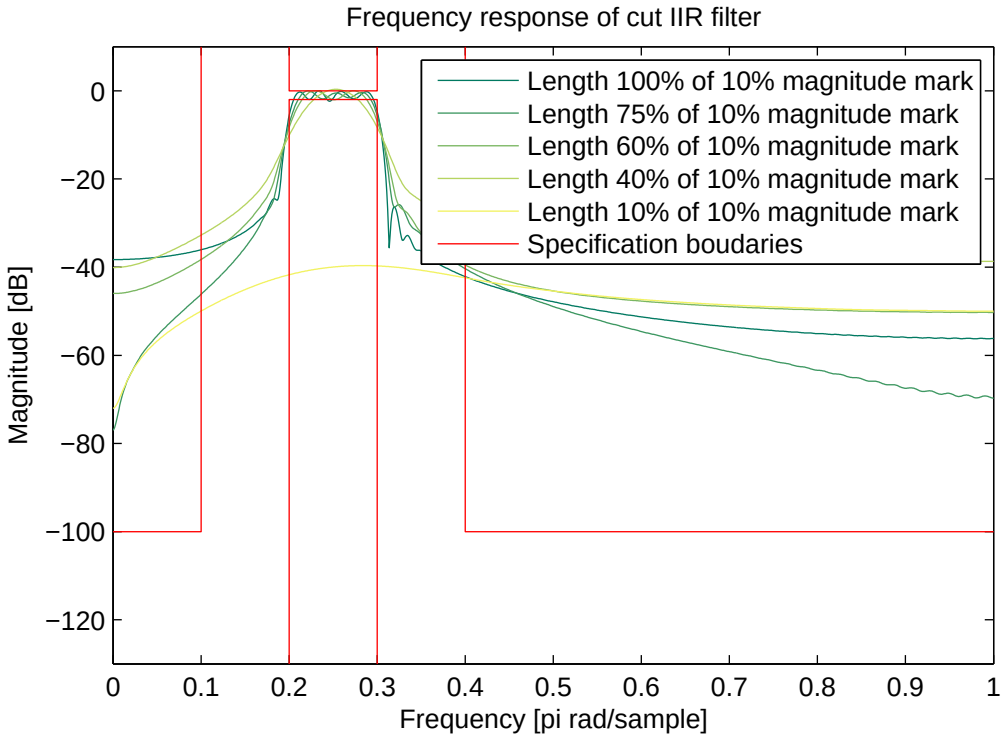

Figure 4: blablabla

It is quite clear that neither of the filters meet the requirements. As the impulse length is shortend there, surprisingly, is not that big of a difference in the filter, until somewhere between 40% and 10% of the length.

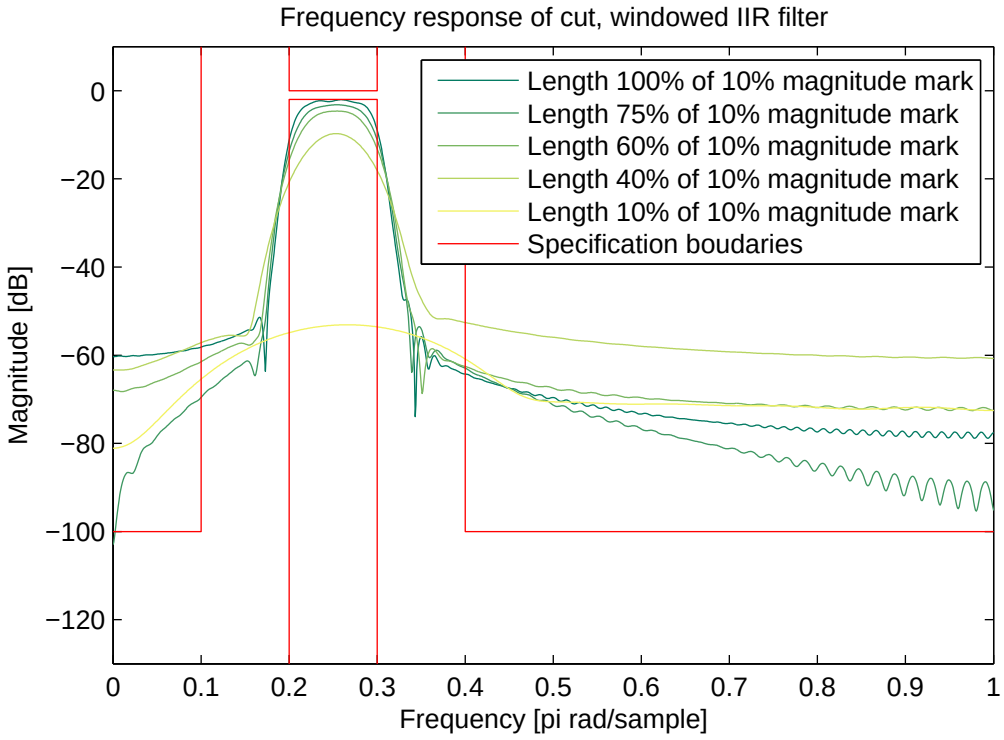

Figure 5: blablabla