

Exam 2 topics

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- Fourier transforms, frequency spectra
 - fft
 - pwelch
 - windowing
 - segmenting
- STFT, spectrogram
- Frequency response, general filter characteristics
 - z-transforms - relation to difference equation, impulse response, transfer function
 - freqz
 - frequency vector
- FIR
 - fir1
 - moving average
- IIR
 - butter
- Cross-correlation

From <https://calstatela.instructure.com/courses/70086/discussion_topics/874850>

What is Nfft?

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Suppose a speech signal $y(t)$ is sampled at 44kHz.

MATLAB output:

Let's say there is a peak frequency at 2750Hz.

>> display(k)

$Yf = fft(y, Nfft);$

k =

$[Ymax, k] = max(abs(Yf));$

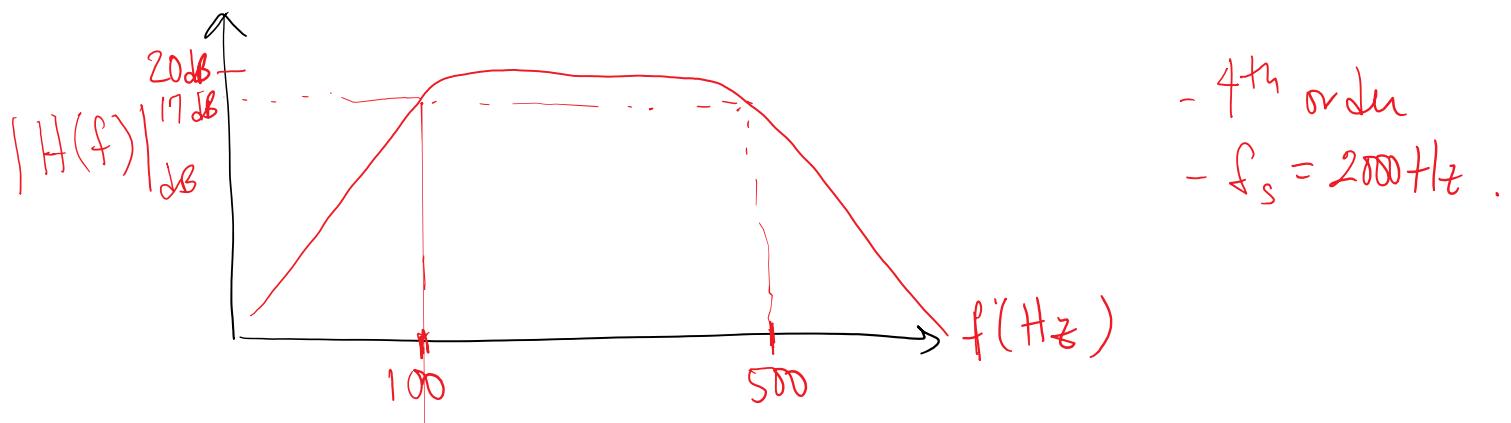
128

display(k)

Write code to create an IIR filter with the following frequency response

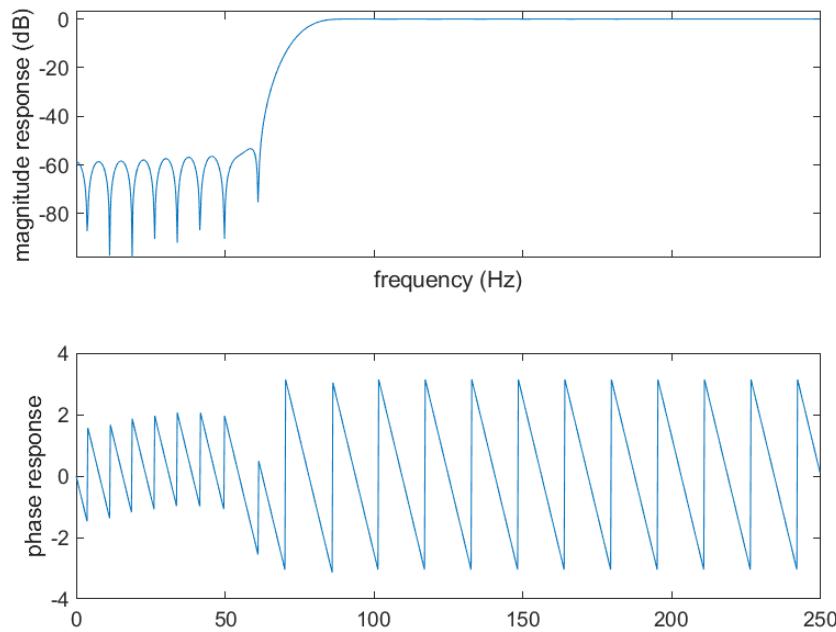
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A) What type of filter is this?

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B) What is the cutoff frequency in Hz?

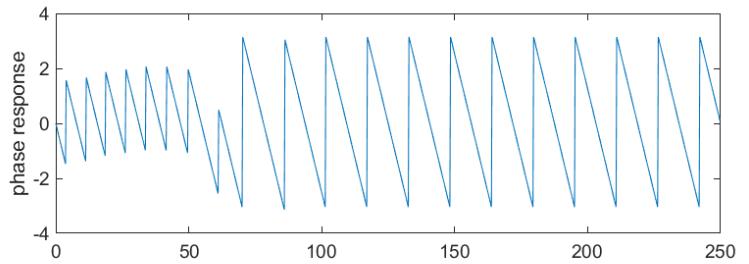
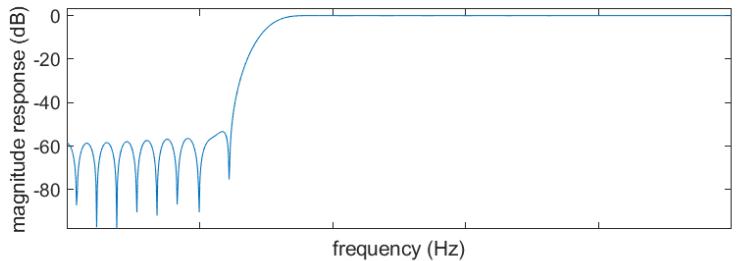
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```
fs = 500;  
Wn = 0.3;
```

```
B = fir1(_____, _____, _____);
```

```
Nfft = 2^10;  
H = freqz(_____, _____, Nfft);
```

```
f = _____;  
figure;  
subplot(2,1,1);  
plot(f, 20*log10(_____));  
  
subplot(2,1,2);  
  
plot(f, _____);
```



Complete the following code in order to plot the frequency response of an FIR filter

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```
fs = 500;
Wn = 0.3;
```

_A) _____

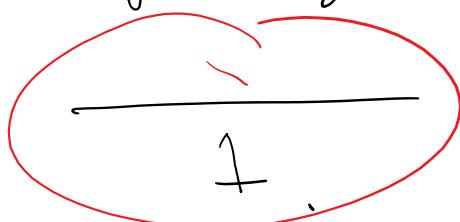
B = fir1(_B) _____, _C) _____, _D) _____

```
Nfft = 2^10; B
H = freqz( E) A, Nfft);
```

```
f = _G) _____;
figure;
subplot(2,1,1);
plot(f, 20*log10(_H))));

subplot(2,1,2);
plot(f, _I) _____);
```

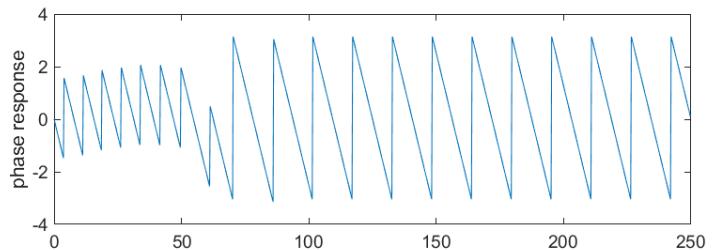
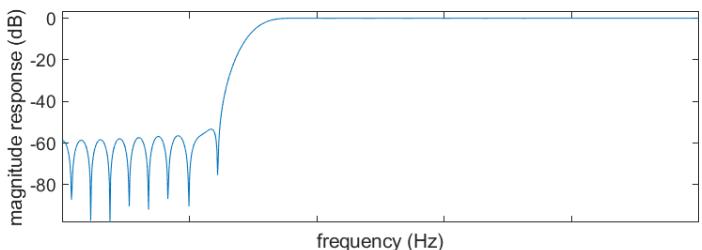
$$H(z) = \frac{b_0 + b_1 z^{-1} + \dots}{1 + a_1 z^{-1} + \dots}$$



$$B = [b_0, b_1, \dots]$$

$$A = [a_0, a_1, \dots]$$

for FIR $\oplus A = 1$



Fill in the blank, then answer the question below

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% x is collected from a blood glucose sensor. We are interested in the trends in the sensor signal.

```
fs = 5000;
```

```
xrect = abs(x);
```

```
Lwin = round(0.1*fs);
```

```
w = A) _____ (1, Lwin) / _B) _____;
```

```
y = conv(xrect, w, 'same');
```

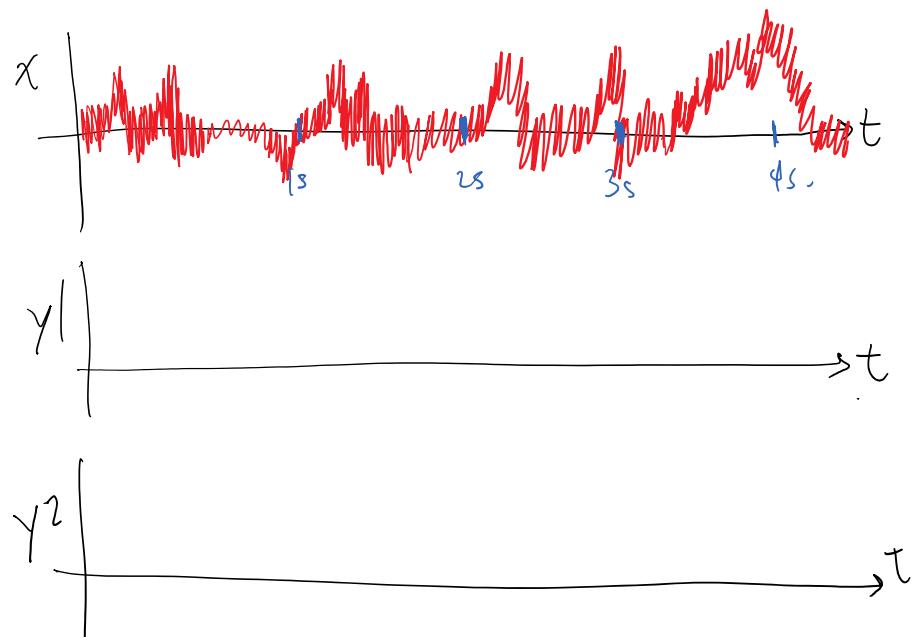
What kind of filter are we processing applying to x? A
_____ C) _____ filter

Also, what type of signal do we call 'y'? It is the
_____ D) _____ of the glucose sensor signal.

What would the output look like for the given x shown below?

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```
fs = 5000;  
  
xrect = abs(x);  
  
Lwin = round(0.1*fs);  
w = ones(1, Lwin)/Lwin;  
y1 = conv(xrect, w, 'same');  
  
subplot(2,1,1);  
plot(t, y1); % assume t was  
already loaded in with x  
  
Lwin = round(0.5*fs);  
w = ones(1, Lwin)/Lwin;  
y2 = conv(xrect, w, 'same');  
  
Subplot(2,1,2);  
Plot(t, y2)
```



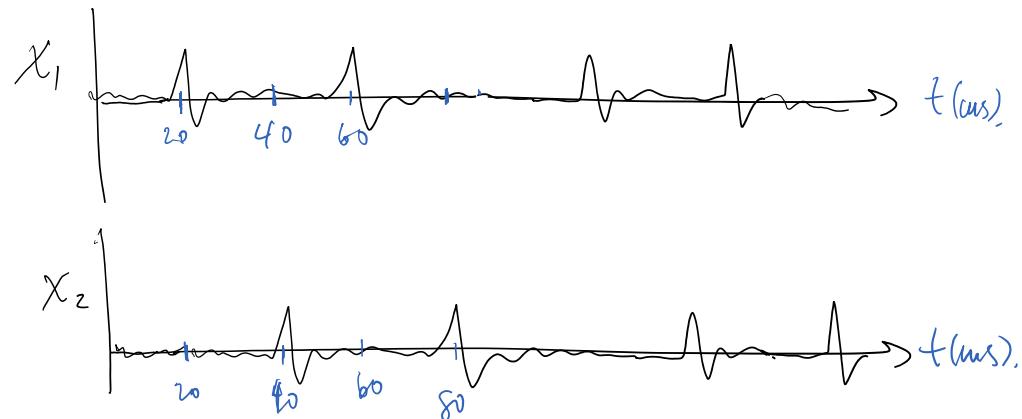
Determine the output of the code

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```
fs = 1000;
```

```
[R12, lags] = xcorr(x1, x2);
```

```
plot(lags, R12);
```



Write the difference equation that describes the system defined by the given transfer function

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$$H(z) = \frac{4 - 3z^{-1} + 7z^{-2}}{1 + 4z^{-1} - 3z^{-2} + 5z^{-3}}$$

Fill in the code to find the STFT of an EEG signal x, using 2-second Bartlett windows and 75% overlap

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```
Twin = 2;  
Lwin = A)_____;  
  
w = bartlett( B)_____);  
  
No = round( C)_____);  
Nfft = 2^13;  
  
X_stft = stft(x, 'Window', win, 'FFTLength', Nfft, 'OverlapLength', nooverlap);  
  
f = D)_____;  
  
t = E)_____;  
  
%% How can you view the STFT?  
F) _____(t, f, abs(X_stft))
```