

# 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](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)

$Y_f = \text{fft}(y, N_{\text{fft}});$

k =

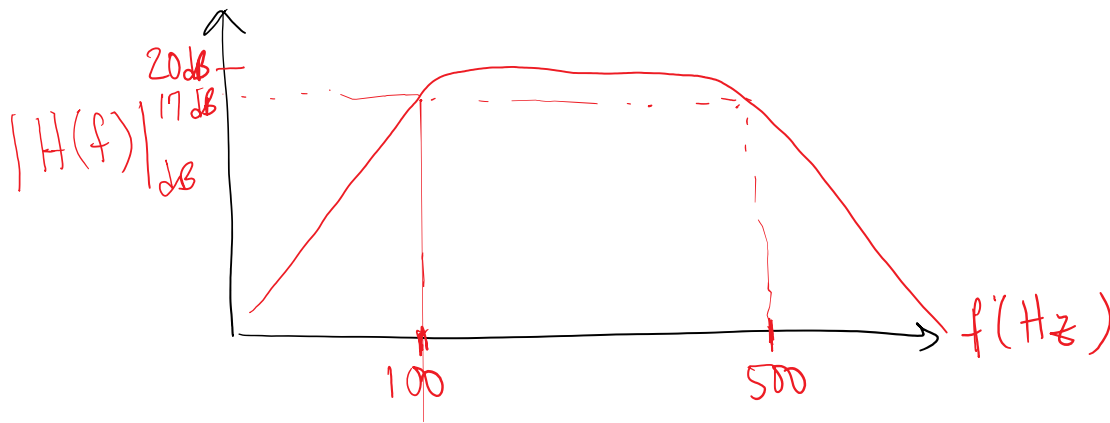
$[Y_{\text{max}}, k] = \text{max}(\text{abs}(Y_f));$

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display(k)

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

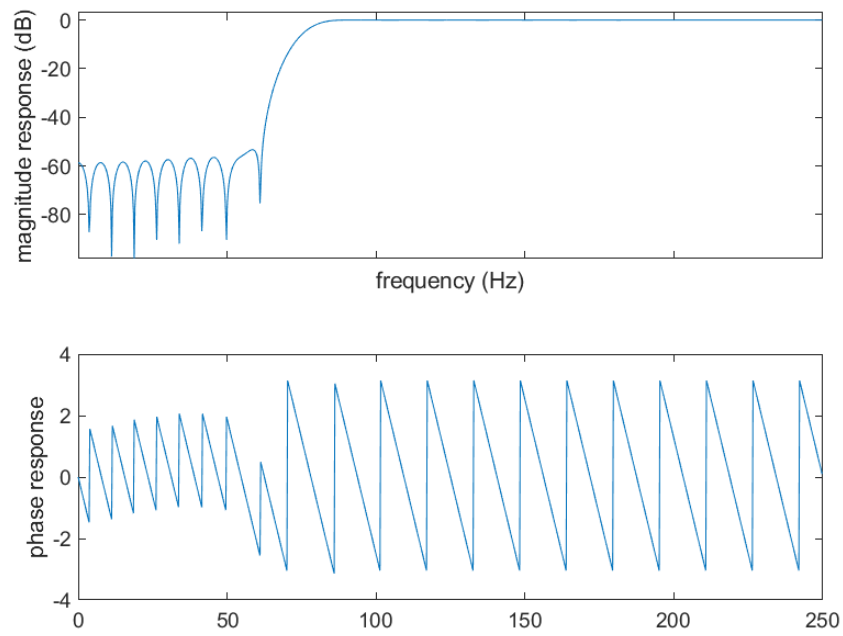
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- 4<sup>th</sup> order  
-  $f_s = 2000 Hz$

## 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(_____, _____, _____);
```

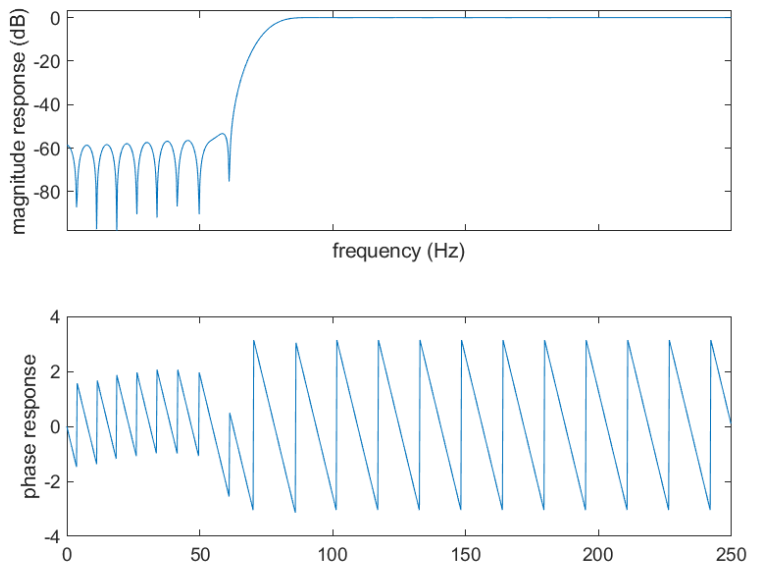
```
Nfft = 2^10;  
H = freqz(_____, _____, Nfft);
```

```
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) _____

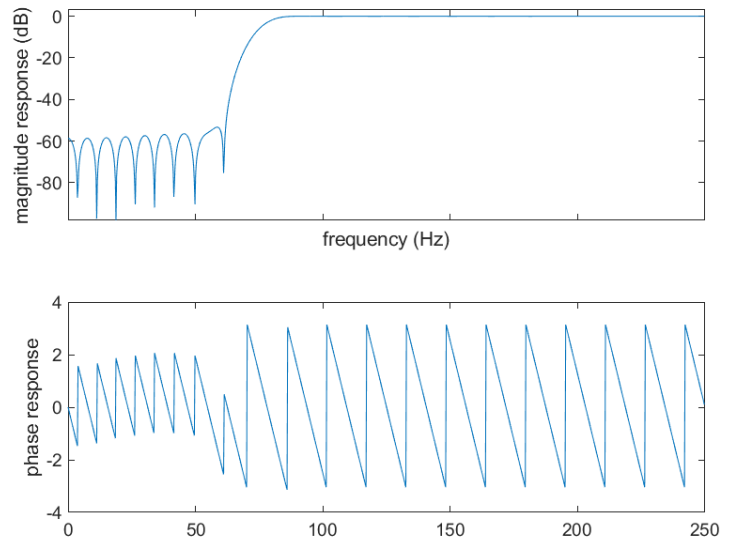
B = fir1(_B)_____, _C)_____, _D)_____

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

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

subplot(2,1,2);

plot(f, _I) _____);
```



$$H(z) = \frac{b_0 + b_1 z^{-1} + \dots}{a_0 + a_1 z^{-1} + \dots}$$

$\frac{1}{1}$

$B = [b_0, b_1, \dots]$   
 $A = [a_0, a_1, \dots]$

for FIR @  $A = 1$

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
```

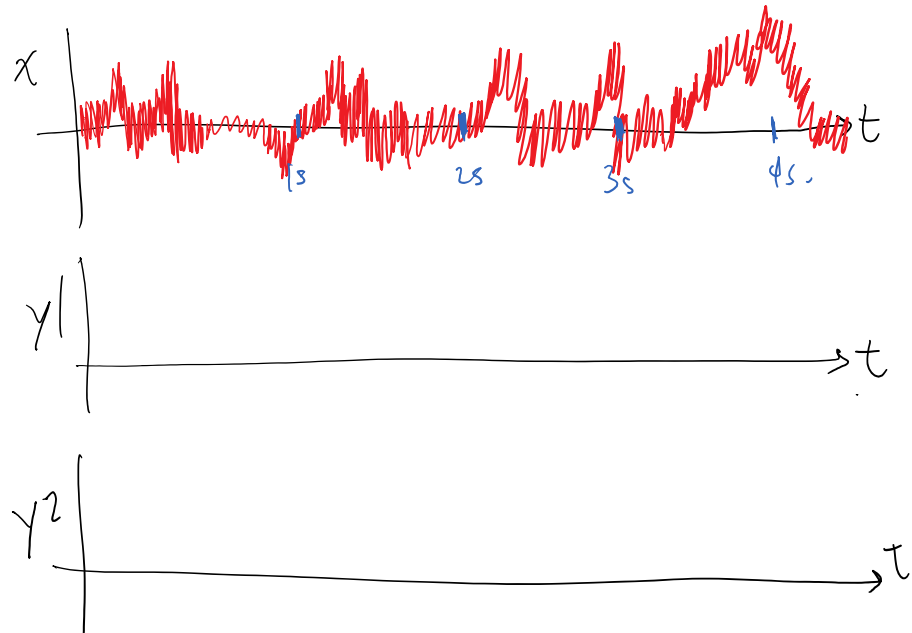
```
Lwin = round(0.5*fs);
```

```
w = ones(1, Lwin)/Lwin;
```

```
y2 = conv(xrect, w, 'same');
```

```
Subplot(2,1,2);
```

```
Plot(t, y2)
```



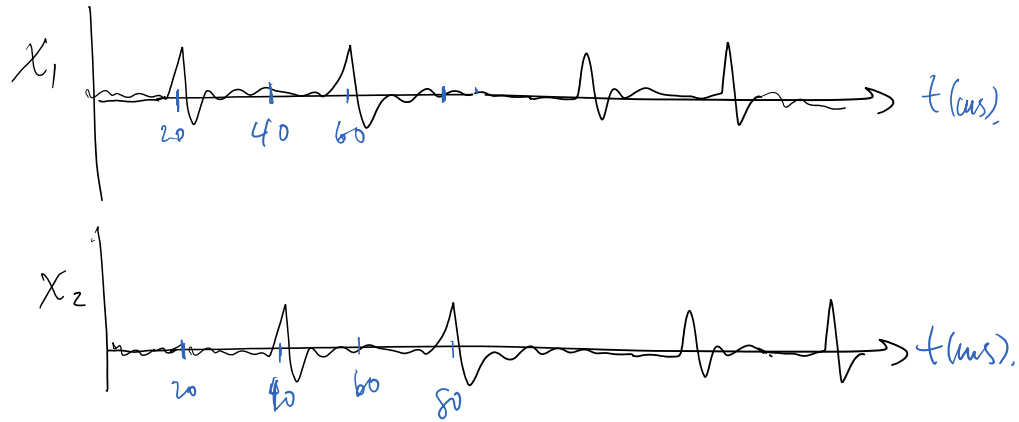
## Determine the output of the code

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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', noverlap);

f = D) _____;

t = E) _____;

%% How can you view the STFT?
F) _____(t, f, abs(X_stft))
```