Midterm - EECE 5356 – DSP
TuanKhai Nguyen

Problem 1:

```matlab
load("problem1data2023.mat")

p = 3; % 3rd order
N=length(x);

x_v = x((p+1):N);
xFirstCol = x(p:(N-1));
xFirstRow=x(p:(-1):1);
X=toeplitz(xFirstCol,xFirstRow);
ahls=pinv(X)*x_v
A=[1
    -ahls];
```

```
ahls = 3×1
    0.6115  a1
    0.3513  a2
   -0.4226  a3
```

Figure 1. Code and coefficients a1, a2, a3 of AR signal model.

Problem 3:

```matlab
load("problem3data2023.mat")
```

```matlab
P=2;
Q=2;
L = max(P,Q);
N = length(x);
yvec = y((L+1):N);
yFirstCol = y(L:(N-1));
yFirstRow = y(L:(-1):(L-P+1));
xFirstCol = x((L+1):N);
xFirstRow = x((L+1):(-1):(L-Q+1));
X=toeplitz(xFirstCol,xFirstRow);
Y=toeplitz(yFirstCol,yFirstRow);
D=[Y X];
theta = pinv(D)*yvec
a=theta(1:P)
b=theta((P+1):(P+Q+1))
```

```
theta = 5×1
   -0.0000
    0.2500
    3.0000
   -2.0000
    1.0000

a = 2×1
   -0.0000  a1
    0.2500  a2

b = 3×1
    3.0000  b0
   -2.0000  b1
    1.0000  b2
```

Figure 2. Code and coefficients of **a1, a2** of A(z), and **b0, b1, b2** of B(z)

Problem 2:

Since we have 4 peaks thus 4 complex sinusoids, or **2** <u>real</u> sinusoids. By zooming-in to the first 2 peaks, we get the analog frequencies of our 2 real sinusoids.
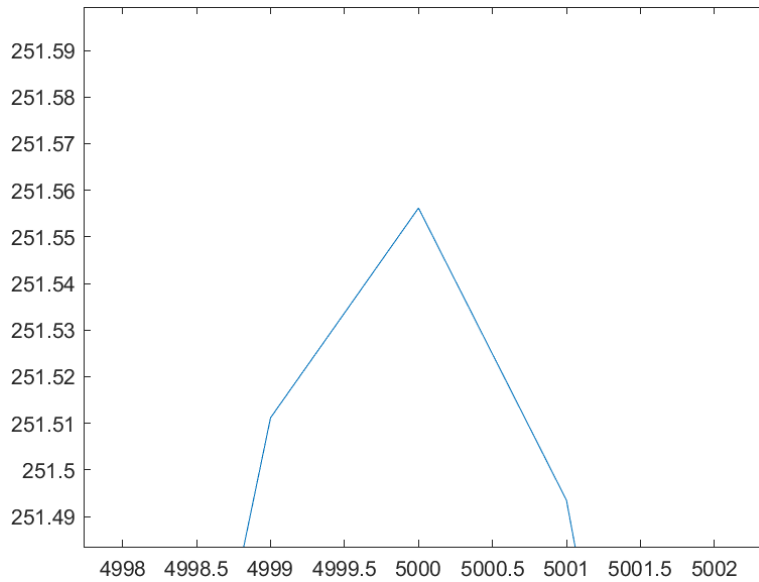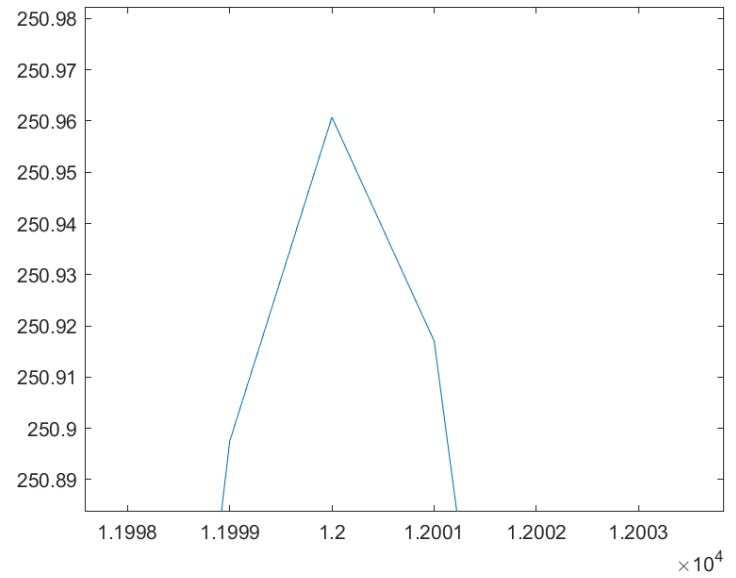

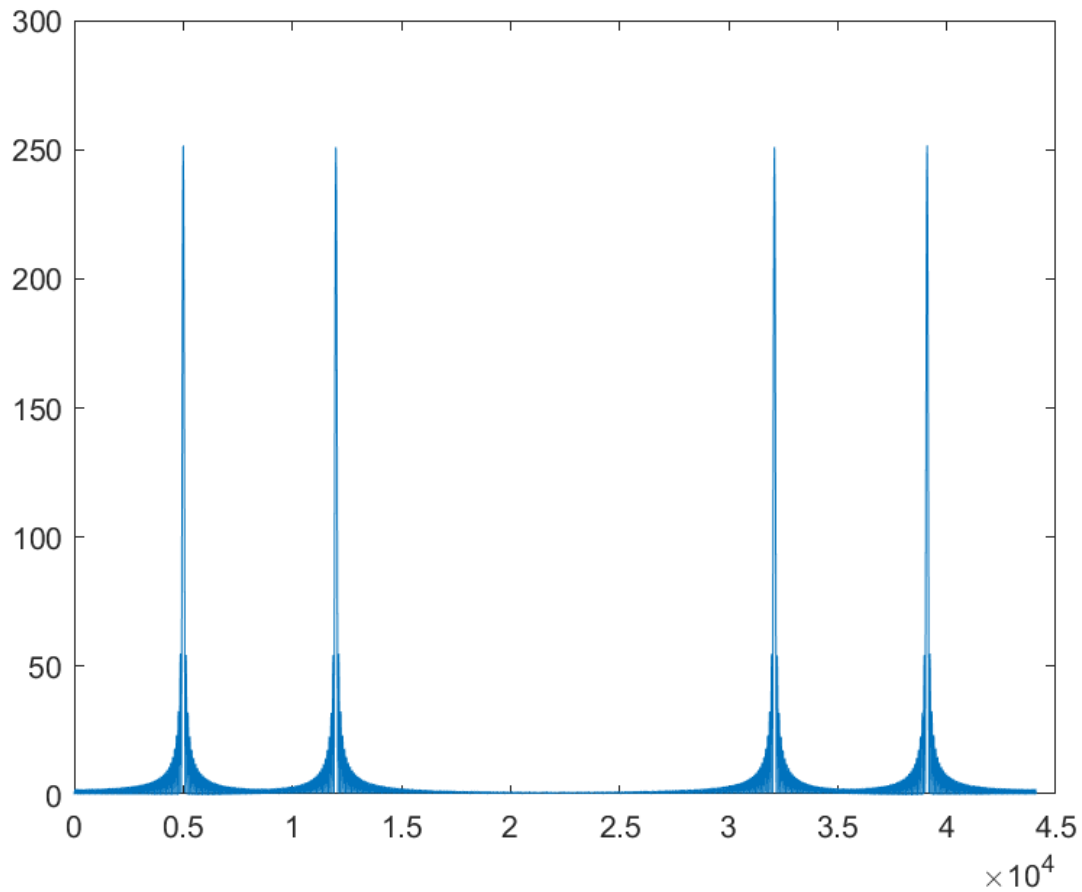Figure 3. First peak (5000 Hz)

Figure 4. Second peak (12000 Hz)

Figure 5. Magnitude of the FFT versus the analog frequency in Hz.

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Problem 4:

Lowpass filter specification:

Fpass = 8 kHz, Rpass = 0.5dB

Fstop = 15 kHz, Rstop = 50dB

Fs = 44100 Hz
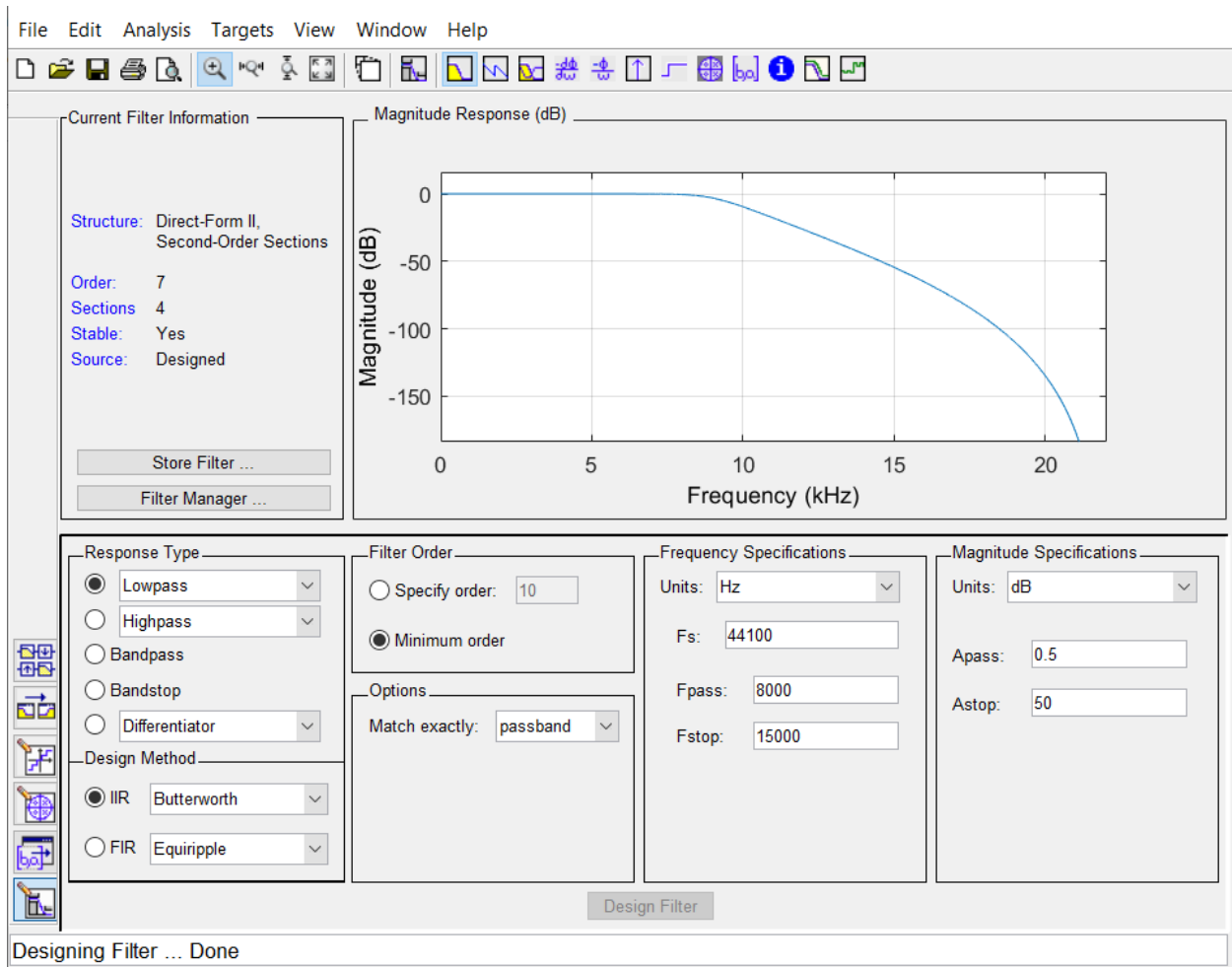
Figure 6. Butterworth filter. Order **7**.
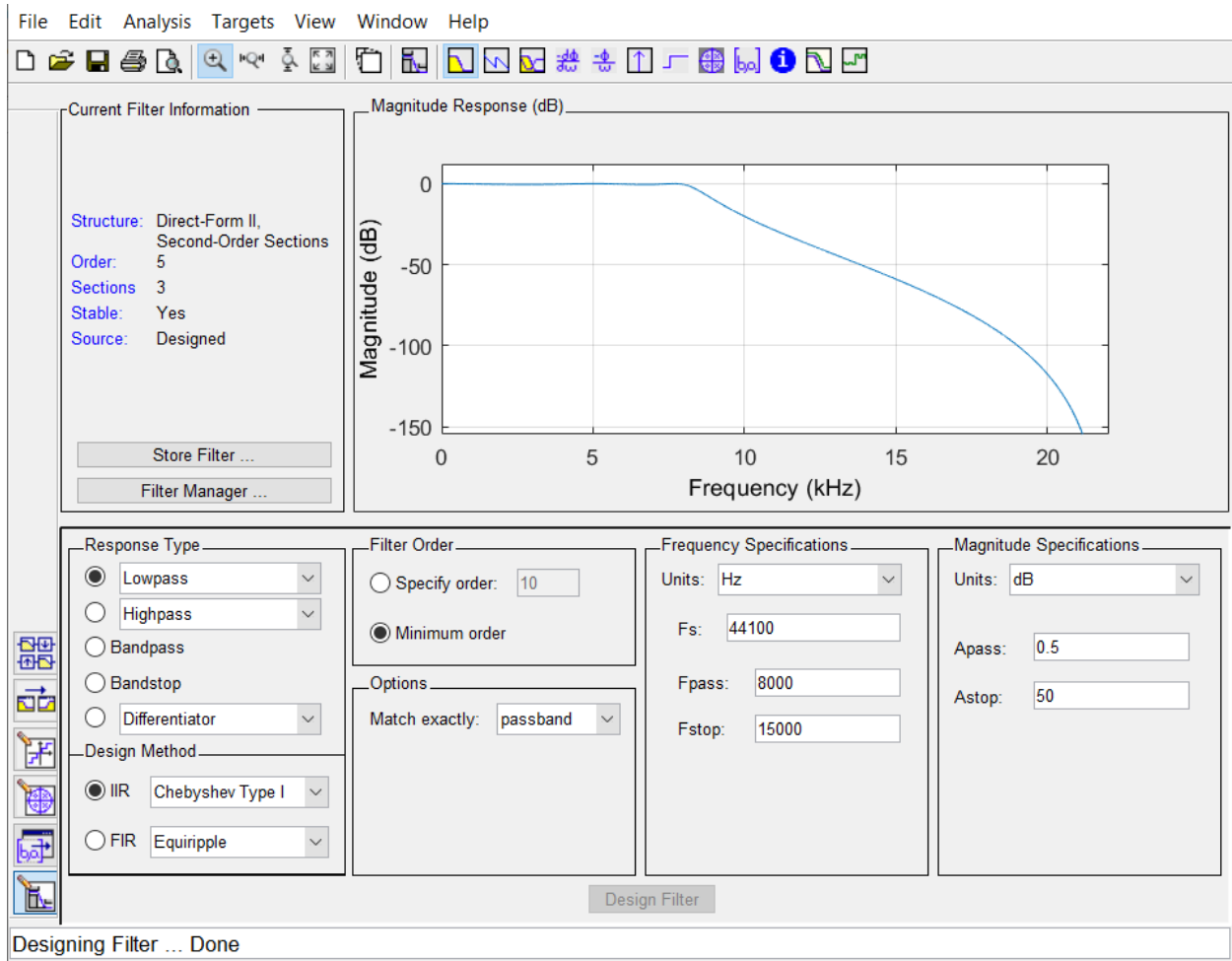
Figure 7. Chebyshev Type I filter. Order **5**.

File Edit Analysis Targets View Window Help

Current Filter Information

Structure: Direct-Form II,
Second-Order Sections

Order: 4
Sections 2
Stable: Yes
Source: Designed

Store Filter ...

Filter Manager ...

Magnitude Response (dB)

Response Type
- (•) Lowpass
- ( ) Highpass
- ( ) Bandpass
- ( ) Bandstop
- ( ) Differentiator

Design Method
- (•) IIR Elliptic
- ( ) FIR Equiripple

Filter Order
- ( ) Specify order: 10
- (•) Minimum order

Options
Match exactly: both

Frequency Specifications
Units: Hz
Fs: 44100
Fpass: 8000
Fstop: 15000

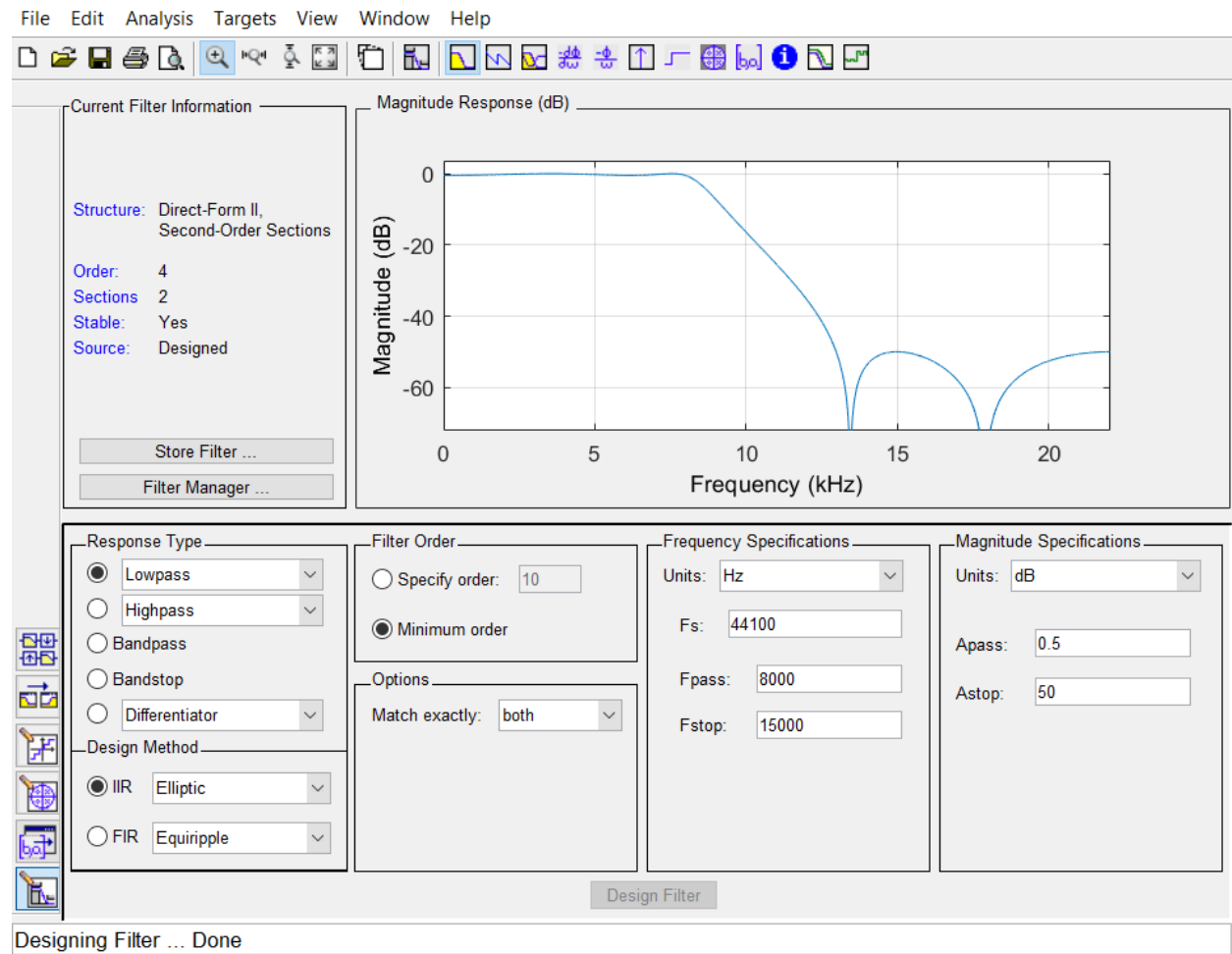### Magnitude Specifications
Units: dB
Apass: 0.5
Astop: 50

Design Filter

Designing Filter ... Done

Figure 8. Elliptic filter. Order **4.**