**No Collaboration for any part.**

**Exercise 1.**

1.

Zeros are located at and while poles are located at and . As the zeros lie on the unit circle. Meanwhile since and , the poles lie slightly outside of the unit circle. Therefore, because the poles lie outside the unit circle, the system is stable. Finally, based on the definition of we can determine that firstly and if then so , so this filter is not real.

2.

A screen shot of a computer program

Description automatically generated

A diagram of a curve

Description automatically generated

3.

A computer screen with numbers and symbols

Description automatically generated

The FWHM is 11.4/year, to increase the sharpness, and thereby decrease the FWHM, the epsilon value should be increased.

**Exercise 2.**

1.

By expanding out the equation, it can be determined that:

, , , , .

Calculating the exact values, we get:

, , , , ,

2.

A computer screen shot of a black screen with colorful text

Description automatically generated

3.

A graph of a number of objects

Description automatically generated with medium confidence

Reducing the FWHM value is done by increasing the epsilon value. Doing so would result in the impulse response shifting upwards as the terms would all increase in value when .

4.

A computer screen shot of text

Description automatically generated

A graph with numbers and a line

Description automatically generated with medium confidence

**Exercise 3.**

1.

A screen shot of a computer program

Description automatically generated

A graph of a graph showing the average of the global methane average

Description automatically generated

A graph of a graph showing the average of the year

Description automatically generated with medium confidence

2.

A computer screen shot of text

Description automatically generated

A graph with a blue line

Description automatically generated

3.

A screen shot of a computer program

Description automatically generated

A graph of an orange and blue line

Description automatically generatedA graph of a graph with a line

Description automatically generated with medium confidence

A screen shot of text

Description automatically generatedA graph of a graph showing the average of the average of the year

Description automatically generated with medium confidence

4.

A screen shot of a computer

Description automatically generated

A graph of a graph showing the average of a number of years

Description automatically generated with medium confidence

The FFT filtering method seems to be the best balance of retaining data and filtering out the annual effects. The notch filter seems to be a very strong filter that almost matches the trend exactly, which may be useful in some cases but could lose some information.

5.A screen shot of a computer program

Description automatically generated

A graph with green lines and numbers

Description automatically generated

It appears that the trend seems to dominate the data and prevent the filtering or FFT process from meaningfully impacting the difference.