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Math 362 Fourier Analysis

October 3, 2017

Ch. 3.7 HW

Section 3.7

3.7.2

Consider the functions as defined on [0,1]. Let denote the symmetric extension of from [0,1] to [0,2], and let and denote the periodic extension of and for .

1. Use the MATLAB program LinearTimeFreq(a,b,n) with to plot the time domain and frequency graphs of
2. Use the MATLAB program LinearTimeFreqCII(a,b,n) with to plot the time domain and frequency graphs of
3. Determine whether and is continuous on
4. Describe the frequency spectrums of and . Are there similarities or differences? Be sure to include the order of convergence of the Fourier coefficients in your discussion.
5. List the values of the Fourier coefficients and for both and Are there similarities or differences? Are there any notable patterns?

a.)

|  |  |
| --- | --- |
| Input Commands | Output |
| >> LinearTimeFreq(2,3,8)  Coeff\_a0\_for\_f =  3.9990  Coeffs\_ak\_bk\_for\_f =  -0.0020 -0.6366  -0.0020 -0.3183  -0.0020 -0.2122  -0.0020 -0.1591  -0.0020 -0.1273  -0.0020 -0.1061  -0.0020 -0.0909  -0.0020 -0.0796 |  |

b.)

|  |  |
| --- | --- |
| Input Commands | Output |
| >> LinearTimeFreqCII(2,3,8)  Coeff\_af0\_for\_f =  3.9990  Coeffs\_ak\_bk\_for\_f =  -0.0020 -0.6366  -0.0020 -0.3183  -0.0020 -0.2122  -0.0020 -0.1591  -0.0020 -0.1273  -0.0020 -0.1061  -0.0020 -0.0909  -0.0020 -0.0796  Coeff\_a0\_for\_g =  3.9990  Coeffs\_ak\_bk\_for\_g =  -0.8106 0.0012  0 0  -0.0901 0.0004  0 0  -0.0324 0.0002  0 0  -0.0165 0.0002  0 0 |  |

c.)

For the expansion it is not continuous since at the endpoints the expansion will have to converge to an average of the endpoints on the graph. If this function were to be continuous the extension of it would fit in perfectly with the function itself to make it look like it continued with no discontinuities, but this is not the case for As for the expansion it is continuous due to the endpoints of the graph matching up with the beginning points. With these two pieces of information, we can say that is continuous on the interval and outside of it. The expansion is continuous in this interval, but not outside of it.

d.)

The frequency domain plot of in the previous graph portrays the frequency spectrum of . As for the frequency domain plot of it portrays the frequency spectrum of . This essentially means that the domain plots of both of the graphs are the frequencies of the respected functions. These plots are displaying the frequencies. Between the two separate plots of the frequencies, there are some similarities between the two. We can see that in both and that the dominant frequency is around 1. As for the remaining frequencies between the two it can be seen that the lower frequencies are close to one another for and There are some differences in these lower frequencies, but in the grand scheme they are pretty similar. As for the convergence rate of it has the Fourier Coefficients converge to zero on the order of since is discontinuous. As for the convergence rate of it converges to the rate of since is continuous but it’s derivatives are not.

e.)

The values of the Fourier coefficients and are valued as follows,

|  |  |  |
| --- | --- | --- |
|  |  |  |
|  | -0.0020  -0.0020  -0.0020  -0.0020  -0.0020  -0.0020  -0.0020  -0.0020 | -0.6366  -0.3183  -0.2122  -0.1591  -0.1273  -0.1061  -0.0909  -0.0796 |
|  | -0.8106  0  -0.0901  0  -0.0325  0  -0.0165  0 | 0.0012  0  0.0004  0  0.0002  0  0.0002  0 |

From the Fourier Coefficients we can conclude that there aren’t very many similarities between the two functions coefficients. But for patterns between the and for g we can see the even terms are 0. This is about the only pattern in the coefficients other than the being the same for . There are no other similarities or patterns.

3.7.11

Consider the functions as defined on [0,1]. Let denote the symmetric extension of from [0,1] to [0,2], and let and denote the periodic extension of and for .

1. Use the MATLAB program JumpTimeFreq(a,b,n) with to plot the time domain and frequency graphs of
2. Use the MATLAB program JumpTimeFreqCII(a,b,n) with to plot the time domain and frequency graphs of
3. Determine whether and is continuous on
4. Describe the frequency spectrums of and . Are there similarities or differences? Be sure to include the order of convergence of the Fourier coefficients in your discussion.
5. List the values of the Fourier coefficients and for both and Are there similarities or differences? Are there any notable patterns?

f.)

|  |  |
| --- | --- |
| Input Commands | Output |
| >> JumpTimeFreq(8,2,8)  Coeff\_a0\_for\_f =  5  Coeffs\_ak\_bk\_for\_f =  0.0117 3.8197  0 0  0.0117 1.2732  0 0  0.0117 0.7639  0 0  0.0117 0.5456  0 0 |  |

g.)

|  |  |
| --- | --- |
| Input Commands | Output |
| Coeff\_a0\_for\_g =  5  Coeffs\_ak\_bk\_for\_g =  3.8197 -0.0059  0 0  -1.2732 0.0059  0 0  0.7639 -0.0059  0 0  -0.5457 0.0059  0 0 |  |

h.)

The plot of isn’t continuous because the endpoints of this interval will not match up with the beginning points therefore making it discontinuous. If the periodic extension were to be plotted along with the interval above, we would see the limits of the left and right endpoints converging to the average of the two. This is the case for With that being said, the contrary is true for is continuous outside of the interval that is plotted above. This is obvious because if the periodic extension were to be added on to the interval that was already plotted above, the endpoints would match up with the points in the beginning and this would be continuous. This is the case with .

i.)

The frequency domain plot of is also the frequency spectrum of , therefore we can say that the frequency domain plot of is portraying the spectrum of . The same is true for As for we can say that the frequency domain plot of is also the frequency spectrum of , the frequency domain plot of is portraying the spectrum of . This is the same as the case with . So this is a similarity between the two that they both portray their respected frequency spectrums in their frequency domain plot. Since ’s periodic extension is discontinuous, it will have the Fourier Coefficients decay to zero at the rate of . Since ’s periodic extension is continuous, but it’s derivative is not, we will see the Fourier Coefficients decay to zero at the rate of . The biggest difference between the two is their decay rates.

j.)

The values of the Fourier Coefficients and are as follows,

|  |  |  |
| --- | --- | --- |
|  |  |  |
|  | 0.0117  0  0.0117  0  0.0117  0  0.0117  0 | 3.8197  0  1.2732  0  0.7639  0  0.5456  0 |
|  | 3.8197  0  -1.2732  0  0.7639  0  -0.5457  0 | -0.0059  0  0.0059  0  -0.0059  0  0.0059  0 |

From the Fourier Coefficients we don’t see much similarities between the two functions. These coefficients give way to indicating that is function is odd due to having the even numbered values all be zero amongst them. For the the coefficients are all the same for the ’s. Whereas for values of in , they are the same values for of . The only pattern that can be seen is from ’s coefficients alternating positive and negative.