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Math 362 Fourier Analysis

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Ch. 3.6 HW

Section 3.6

3.6.3

Use Corollary 3.6.1 to determine the order of convergence for the associated Fourier coefficients. Be sure to justify your answers using a time domain graph and brief discussion.

The function stated above will have Fourier Coefficients converge to zero on the order of since the periodic extension of this function is discontinuous. This can be seen with the following plot.

|  |  |
| --- | --- |
| Input Commands | Output Plot |
| >> boxtimefreqfcn(100) |  |

The discontinuity can be seen with the Gibbs phenomena on this plot.

3.6.5

Use Corollary 3.6.1 to determine the order of convergence for the associated Fourier coefficients. Be sure to justify your answers using a time domain graph and brief discussion.

The function stated above will have the Fourier Coefficients converge to zero on the order of The reason why for this convergence rate is due to the functions periodic extension being continuous but derivative of being discontinuous due to the point in the graph. With these two properties of the function we can conclude that it does indeed have the Fourier Coefficients converge to zero at the rate of . This can be seen in the following plot.

|  |  |
| --- | --- |
| Input Command | Output Command |
| >> boxtimefreqfcn(10) |  |

The discontinuity of the derivative of can be seen with the Gibbs phenomena on this plot.

3.6.20

For the functions on [0,1], use the Corollary 3.6.1 to determine the order of convergence for the associated Fourier coefficients.

From the following plot we can conclude that the Fourier Coefficients converge to zero on the order of . This is because the periodic extension of is discontinuous and the function at these points will converge to the left and right and limits thus making it not continuous. With these facts we can conclude that the coefficients will converge to zero on the order of

|  |  |
| --- | --- |
| Input Commands | Output Plot |
| >> boxtimefreqfcn(40) |  |

The Gibbs phenomena can illustrate why the periodic extension of this function is not continuous.

3.6.21

For the functions on [0,1], use the Corollary 3.6.1 to determine the order of convergence for the associated Fourier coefficients.

From the function above we can conclude that the periodic extension is continuous but the periodic extension is discontinuous due to the point in the graph. Therefore from this we can conclude that the function stated above will have the Fourier Coefficients converge to zero on the order of . We can see this prominently with the one period cycle of the function and its expansion in the following plot.

|  |  |
| --- | --- |
| Input Commands | Output Plot |
| >> boxtimefreqfcn(10) |  |

3.6.22

For the functions on [0,1], use the Corollary 3.6.1 to determine the order of convergence for the associated Fourier coefficients.

From the function above we can conclude that the Fourier Coefficients of the expansion will converge to the order of due to the periodic extension not being continuous. This can be seen due to the limits at these points of discontinuity converging to the average between the left and right-hand limits. This can be seen from just seeing one of the periodic cycles since the endpoint of the function on this interval is not the same as the starting point. This can be seen in the following plot.

|  |  |
| --- | --- |
| Input Commands | Output Plot |
| >> boxtimefreqfcn(10) |  |

The Gibbs Phenomena will explain the discontinuity of the periodic extension.

3.6.29

For the musical chords given, use the MATLAB program freqblurring(freq1,freq2,freq3,T) to do the following.

1. Plot the time and frequency domain graphs of for = . Show MATLAB commands used.
2. Does the frequency domain plot show frequency blurring?
3. Experiment with various time domain graphs of to estimate the period of , and then plot the time and frequency domain graphs of for . Does the frequency domain plot show frequency blurring?

a.)

|  |  |
| --- | --- |
| Input Commands | Output Plots |
| >> freqblurringchord(261.63,329.63,392,0.02) |  |

b.)

There is sufficient clustering in the frequency domain plot therefore there is frequency blurring in this function. This chord has frequency blurring due to clustering of nonzero values around the dominant frequencies.

c.)

|  |  |
| --- | --- |
| Input Commands | Output Plots |
| >> freqblurringchord(261.63,329.63,392,0.001) |  |

From the given plots of the commands in MATLAB, we can conclude that there is not frequency blurring with this period of (0.001). There is no frequency blurring due to there not being nonzero terms near the dominant frequencies of the frequency domain graph. From this experimental period that was put into MATLAB we can conclude the period of the function has to be (0.001), .

3.6.36

For the sound waves indicated, do the following.

1. Use the MATLAB commands audioread(‘filename.wav’) and SoundWaveTimeFreq(x,sr,TZL,TZR,FZL,FZR) to load the sound wave and plot the time and frequency domain graphs of . Show MATLAB commands used.
2. Does the frequency domain plot show frequency blurring? Briefly explain why there typically would or would not be frequency blurring in the frequency domain graph for the given sound wave.

The sound wave for speaking “Hello World”

a.)

|  |  |
| --- | --- |
| Input Commands | Output Plots |
| >> SoundWaveTimeFreq(x,sr,0.4,0.42,100,120) |  |

b.)

From the plots and especially the frequency domain plot we can conclude that there is frequency blurring for this sound wave. This is largely in part due to there being so many frequencies in this sound wave. With more frequencies, it’s just a higher possibility that there will be frequency blurring due to the possibility of other frequencies hanging around the dominant frequencies in the sound wave. Which is what can be found here in the plots above. If the sound wave were at a lower frequency, one could intuitively believe that there could a possibility of less frequency blurring due to less frequencies being present.