**Department of Electrical Engineering**

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| **Faculty Member:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** | **Dated: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |
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| **Section:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** | **Semester: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |
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**EE-232 : Signals and Systems**

**Lab 8 : Discrete Time Fourier Series**

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|  |  | **PLO4 –CLO3** | | **PLO5-CLO3** | **PLO8-CLO4** | **PLO9-CLO4** |
| **Name** | **Reg. No** | **Viva / Quiz / Lab Performance** | **Analysis of data in Lab Report** | **Modern Tool Usage** | **Ethics and Safety** | **Individual and Team Work** |
|  |  | **5 Marks** | **5 Marks** | **5 Marks** | **5 Marks** | **5 Marks** |
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**Lab8: Fourier Series**

**Objectives**

The goal of this laboratory is to be able to calculate the fourier series of discrete time signals and plot the real part of the spectrum / Fourier series coefficients.

* Fourier Series Calculation of Discrete Time Signals
* Inverse Fourier Series Calculation given Fourier Series Coefficients

**Lab Instructions**

* This lab activity comprises of three parts: Pre-lab, Lab Exercises, and Post-Lab Viva session.
* The Pre-lab tasks should be completed before coming to the lab. The reports are to be submitted on LMS.
* The students should perform and demonstrate each lab task separately for step-wise evaluation
* Only those tasks that completed during the allocated lab time will be credited to the students. Students are however encouraged to practice on their own in spare time for enhancing their skills.

**Lab Report Instructions**

All questions should be answered precisely to get maximum credit. Lab report must ensure following items:

* Lab objectives
* MATLAB codes
* Results (graphs/tables) duly commented and discussed
* Conclusion

# Fourier Series of Continuous Time and Discrete Time Signals

## Pre-Lab

### Introduction

**DTFS**

For a DT signal with fundamental period , the DTFS synthesis and analysis equations are given by (1) and (2), respectively.

(1)

(2)

Remember that has period *,* so that the summation in (2)can be replaced with a sum over any consecutive values of *.* Similarly, is periodic in with period so that the summation in can be replaced with a sum over any consecutive values of .

## Lab Tasks

#### Fourier series of a Discrete Time (DT) Sinusoid

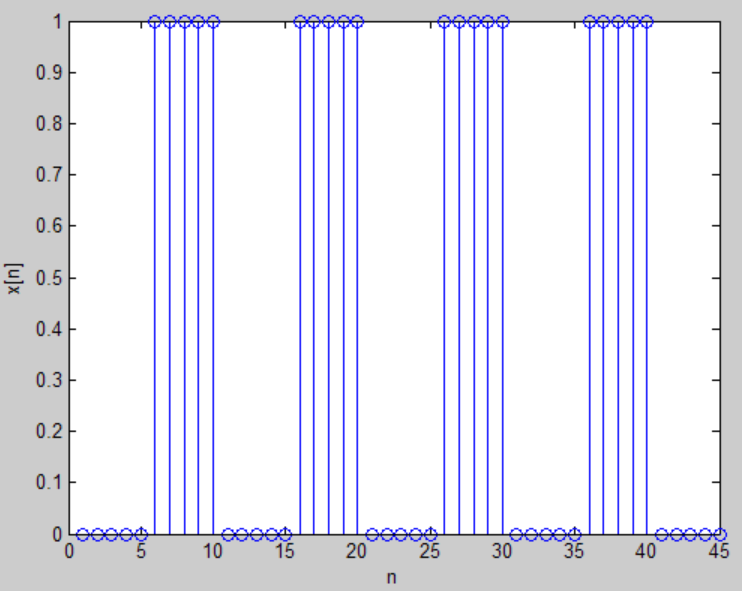
Write a function that will generate a single Discrete Time (DT) sinusoid . , Hz and sampling frequency Hz.

Detemine the period, , of this sinusoid? Determine the DT Fourier series coefficients and plot the magnitude and phase of the DT Fourier series coefficients.

* For calculating the DT Fourier series coefficients use (2).
* (2) will return the value of the th DTFS coefficient. For remaining coefficients, you may use a loop to iterate over values of . What will be the range of ?
* You have to make two plots of the coefficients against frequency axis instead of
  + One plot should be against frequency in radians. Other plot should be against frequency in Hz.
  + -th coefficient corresponds to frequency . Determine the range in radians of the distinct frequency components?
  + What is relation between frequency in Hz and frequency in radians?
* Also show the periodicity of the DTFS coefficients while plotting.
* Add the figures of both the time domain and frequency domain representation of the signals with appropriate axes, labels and titles.

#### Fourier Series of a DT Rectangular wave

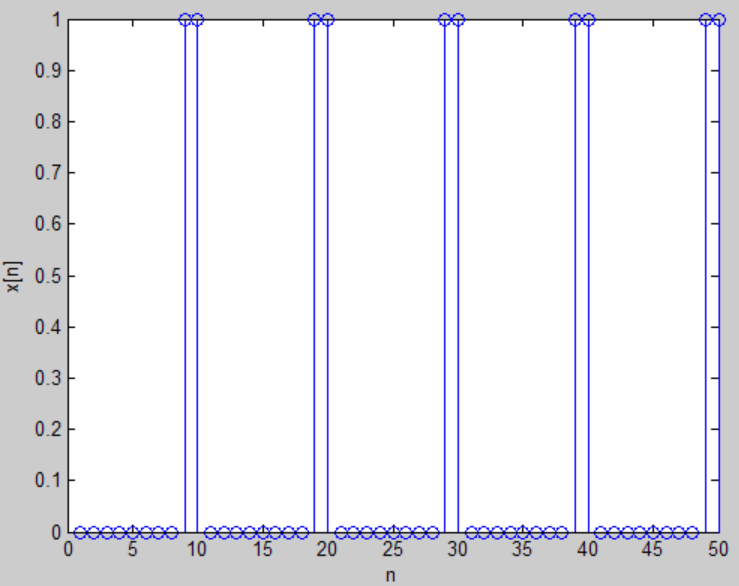
Assume a rectangular wave as shown below. Using a similar approach outlined in the previous task, obtain the DTFS representation of the rectangular wave. Plot the magnitude and phase of the fourier series coefficients with appropriate axes, labels and titles.



Detemine the period, , of this sinosoid? Determine the DT Fourier series coefficients and plot the magnitude and phase of the DT Fourier series coefficients.

* For calculating the DT Fourier series coefficients use (2).
* (2) will return the value of the th DTFS coefficient. For remaining coefficients, you may use a loop to iterate over values of . What will be the range of ?
* You have to make two plots of the coefficients against frequency axis instead of
  + One plot should be against frequency in radians. Other plot should be against frequency in Hz (Take Fs=8000. What will be effect of changing Fs?).
  + -th coefficient corresponds to frequency . Determine the range in radians of the distinct frequency components?
  + What is relation between frequency in Hz and frequency in radians?
* Also show the periodicity of the DTFS coefficients.
* Add the figures of both the time domain and frequency domain representation of the signals with appropriate axes, labels and titles.

Assume a rectangular wave as shown below. Using a similar approach outlined in the previous task, obtain the DTFS representation of the rectangular wave. Plot the magnitude and phase of the DT Fourier series coefficients with appropriate axes, labels and titles. What differences can you note from the frequency representation of previous waveform. What explanation can you provide for the difference observed?



### Lab task 2:

#### Inverse DT Fourier Series Calculation

For the signals in Tasks 1.2.1.1 and 1.2.1.2, reconstruct the signal using the obtained DTFS coefficients . The DT signal can be generated from the FS coefficients using (1).

(1)

Plot the reconstructed signal . Compare with original signal .