Philip Nevins

10/21/2022

ECE 315 Signals and Systems

HW#2 Problem 3

Note: Some of the problems are plotted with 3 periods and some with 1. They vary to give a good graph visually.  
  
**PART A (Aperiodic)**

Chart, histogram

Description automatically generated

# -\*- coding: utf-8 -\*-

"""

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HW#2, Problem 3a

"""

import numpy as np

import matplotlib.pyplot as plt

#Period

N0 = ((326\*np.pi) / 9)

#Number of periods to plot, starting from n = 0

**numPeriods = 3**

lastn = numPeriods\*N0

#Time

n = np.arange(0, lastn + 1)

#Phase Shift

oneVec = np.ones(np.size(n))

#Signal

x = 2.0\*np.sin(((9.0)/163.0)\*n - (0.75\*np.pi)\*oneVec)

fig, ax = plt.subplots(1, figsize=(15,6))

ax.stem(n, x)

ax.set\_xlim([0, lastn])

ax.set\_ylim([-2.25, 2.25])

#Plot Settings

ax.set\_xlabel("Time $n$", fontsize='large')

ax.set\_ylabel("Signal Function $x[n]$", fontsize='large')

ax.set\_title("Signal $x[n]$ v Time $n$", fontsize='x-large')

**PART B (periodic and average power)**

Chart, histogram

Description automatically generated

**The average power of x[n] is 2.00 (furlongs^2 / fortnight).**

# -\*- coding: utf-8 -\*-

"""

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HW#2, Problem 3b

"""

import numpy as np

import matplotlib.pyplot as plt

#Period

N0 = 326/3

#Number of periods to plot, starting from n = 0

**numPeriods = 3**

lastn = numPeriods\*N0

#Time

n = np.arange(0, lastn + 1)

#Phase Shift

oneVec = np.ones(np.size(n))

#Signal

x = 2.0\*np.cos(((3.0\*np.pi)/163.0)\*n - (np.pi/4)\*oneVec)

fig, ax = plt.subplots(1, figsize=(15,6))

ax.stem(n, x)

ax.set\_xlim([0, lastn])

ax.set\_ylim([-2.25, 2.25])

#Plot Settings

ax.set\_xlabel("Time $n$", fontsize='large')

ax.set\_ylabel("Signal Function $x[n]$", fontsize='large')

ax.set\_title("Signal $x[n]$ v Time $n$", fontsize='x-large')

avgPower = np.dot(np.abs(x)[0:108],np.abs(x)[0:108])/108;

print("The average power of x[n] is {0} (furlongs^2 / fortnight).".format(avgPower))

**PART C (aperiodic, imaginary)**

A picture containing histogram

Description automatically generated

Histogram

Description automatically generated  
  
Chart, histogram

Description automatically generated

# -\*- coding: utf-8 -\*-

"""

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HW#2, Problem 3c

"""

import numpy as np

import matplotlib.pyplot as plt

#Period

N0 = 253

#Number of periods to plot, starting from n = 0

**numPeriods = 1**

lastn = numPeriods\*N0

#Time

n = np.arange(0, lastn + 1)

#Phase Shift

oneVec = np.ones(np.size(n))

#Signal

x = 3.0\*np.exp((((2j\*np.pi)/253.0) - (np.pi/48)\*oneVec)\*n)

fig, ax = plt.subplots(1, figsize=(15,6))

ax.stem(n, x)

ax.set\_xlim([0, lastn])

ax.set\_ylim([0, 3.25])

#Plot Settings

ax.set\_xlabel("Time $n$", fontsize='large')

ax.set\_ylabel("Signal Function $x[n]$", fontsize='large')

ax.set\_title("Signal $x[n]$ v Time $n$", fontsize='x-large')  
  
# -\*- coding: utf-8 -\*-

"""

@author: phil nevins

"""

#x = 3.0\*np.exp((((2j\*np.pi)/253.0) - (np.pi/48)\*oneVec)\*n)

import numpy as np

import matplotlib.pyplot as plt

lastn = 75

n = np.arange(0, lastn + 1) # time vector

oneVec = np.ones(np.size(n)) # vector of ones for phase shift

phase = (((2\*n\*np.pi)/253.0)\*oneVec)

mag = np.exp(-n\*np.pi/48)

xre = 3.0\*mag\*np.cos(phase) # real part of x[n]

xim = 3.0\*mag\*np.sin(phase) # imag part of x[n]

fig, ax = plt.subplots(1, figsize=(15,6))

ax.stem(n, xre)

ax.set\_xlim([0, lastn])

ax.set\_ylim([0, 3.25])

ax.set\_title("Real Part of the aperiodic Signal x[n]")

ax.set\_xlabel("Time n")

ax.set\_ylabel("Re{x[n]}")

fig, ax = plt.subplots(1, figsize=(15,6))

ax.stem(n, xim)

ax.set\_xlim([0, lastn])

ax.set\_ylim([0, 0.5])

ax.set\_title("Imaginary Part of the aperiodic Signal x[n]")

ax.set\_xlabel("Time n")

ax.set\_ylabel("Im{x[n]}")

**PART D (periodic, imaginary and average power)**

Chart, histogram

Description automatically generated

**The average power of x[n] is 9.00 (furlongs^2 / fortnight).**

Chart, histogram

Description automatically generated

Chart, histogram

Description automatically generated

# -\*- coding: utf-8 -\*-

"""

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ECE 315 Signals & Systems

HW#2, Problem 3d

"""

import numpy as np

import matplotlib.pyplot as plt

#Period

N0 = (287/4)

#Number of periods to plot, starting from n = 0

**numPeriods = 1**

lastn = numPeriods\*N0

#Time

n = np.arange(0, lastn + 1)

#Phase Shift

oneVec = np.ones(np.size(n))

#Signal

x = 3.0\*np.exp(((8j\*np.pi\*n) / 287) - (3j\*np.pi/2)\*oneVec)

fig, ax = plt.subplots(1, figsize=(15,6))

ax.stem(n, x)

ax.set\_xlim([0, lastn])

ax.set\_ylim([-10, 10])

#Plot Settings

ax.set\_xlabel("Time $n$", fontsize='large')

ax.set\_ylabel("Signal Function $x[n]$", fontsize='large')

ax.set\_title("Signal $x[n]$ v Time $n$", fontsize='x-large')

avgPower = np.dot(np.abs(x)[0:72],np.abs(x)[0:72])/72

print("The average power of x[n] is {0} (furlongs^2 / fortnight).".format(avgPower))

# -\*- coding: utf-8 -\*-

"""

@author: phil nevins

"""

#x = 3.0\*np.exp(((8j\*np.pi\*n) / 287) - (3j\*np.pi/2)\*oneVec)

import numpy as np

import matplotlib.pyplot as plt

lastn = 287/4

n = np.arange(0, lastn + 1) # time vector

oneVec = np.ones(np.size(n)) # vector of ones for phase shift

phase = (((8\*np.pi\*n) / 287) - (3\*np.pi/2)\*oneVec)

mag = 3

xre = mag\*np.cos(phase) # real part of x[n]

xim = mag\*np.sin(phase) # imag part of x[n]

fig, ax = plt.subplots(1, figsize=(15,6))

ax.stem(n, xre)

ax.set\_xlim([0, lastn])

ax.set\_ylim([-3.25, 3.25])

ax.set\_title("Real Part of the periodic Signal x[n]")

ax.set\_xlabel("Time n")

ax.set\_ylabel("Re{x[n]}")

fig, ax = plt.subplots(1, figsize=(15,6))

ax.stem(n, xim)

ax.set\_xlim([0, lastn])

ax.set\_ylim([-3.25, 3.25])

ax.set\_title("Imaginary Part of the periodic Signal x[n]")

ax.set\_xlabel("Time n")

ax.set\_ylabel("Im{x[n]}")

**PART E (aperiodic and imaginary)**Chart, histogram

Description automatically generated

Chart, histogram

Description automatically generated

Chart, histogram

Description automatically generated

# -\*- coding: utf-8 -\*-

"""

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ECE 315 Signals & Systems

HW#2, Problem 3e

"""

import numpy as np

import matplotlib.pyplot as plt

#Period

N0 = (192\*np.pi/5)

#Number of periods to plot, starting from n = 0

**numPeriods = 1**

lastn = numPeriods\*N0

#Time

n = np.arange(0, lastn + 1)

#Phase Shift

oneVec = np.ones(np.size(n))

#Signal

x = 3.0\*np.exp(((-5j\*n) / 96) - (1j\*np.pi/3)\*oneVec)

fig, ax = plt.subplots(1, figsize=(15,6))

ax.stem(n, x)

ax.set\_xlim([0, lastn])

ax.set\_ylim([-3, 3])

#Plot Settings

ax.set\_xlabel("Time $n$", fontsize='large')

ax.set\_ylabel("Signal Function $x[n]$", fontsize='large')

ax.set\_title("Signal $x[n]$ v Time $n$", fontsize='x-large')

# -\*- coding: utf-8 -\*-

"""

@author: pnevi

"""

#x = 3.0\*np.exp(((-5j\*n) / 96) - (1j\*np.pi/3)\*oneVec)

import numpy as np

import matplotlib.pyplot as plt

lastn = 192\*np.pi/5

n = np.arange(0, lastn + 1) # time vector

oneVec = np.ones(np.size(n)) # vector of ones for phase shift

phase = ((-5\*n) / 96) - (np.pi/3)\*oneVec

mag = 3.0

xre = mag\*np.cos(phase) # real part of x[n]

xim = mag\*np.sin(phase) # imag part of x[n]

fig, ax = plt.subplots(1, figsize=(15,6))

ax.stem(n, xre)

ax.set\_xlim([0, lastn])

ax.set\_ylim([-3.25, 3.25])

ax.set\_title("Real Part of the aperiodic Signal x[n]")

ax.set\_xlabel("Time n")

ax.set\_ylabel("Re{x[n]}")

fig, ax = plt.subplots(1, figsize=(15,6))

ax.stem(n, xim)

ax.set\_xlim([0, lastn])

ax.set\_ylim([-3.25, 3.25])

ax.set\_title("Imaginary Part of the aperiodic Signal x[n]")

ax.set\_xlabel("Time n")

ax.set\_ylabel("Im{x[n]}")