EE670A

PYTHON ASSIGNMENT #0

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```python
"""
PYTHON Assignment #0
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"""
#Aim: Generate 1,00,00,000 iid instantiations of the Rayleigh fading channel. Plot Histograms of Magnitude and Phase as PDF from the data.
# Compare the plots with standard Rayleigh distribution (for magnitude) and Uniform distribution (for phase) curves.

import numpy as np
import numpy.random as nr
import matplotlib.pyplot as plt

nbins=1000
nSamples=10000000
#Real and Imaginary Parts of the noise channel model are iid Gaussian random variables with mean 0 and variance 1 each.
#Hence the resultant is Complex Gaussian distribution with mean=0 and variance=2.We also normalise it by dividing with the standard deviation.
h=(nr.normal(0,1,nSamples) + 1j*nr.normal(0,1,nSamples))/np.sqrt(2);
amp=np.abs(h)
phi=np.angle(h)

#Amplitude PDF
plt.figure(1)
plt.hist(amp,nbins,density=True) #Density=true; plot as PDF
plt.suptitle("Amplitude PDF",fontsize=18)
plt.xlabel("a", fontsize=16)
plt.ylabel("$f_A$(a)", fontsize=16)

#Phase PDF
plt.figure(2)
plt.hist(phi,nbins,density=True)
plt.suptitle("Phase PDF",fontsize=18)
plt.xlabel("$\phi$",fontsize=16)
plt.ylabel("$f_\phi(\phi)$",fontsize=16)


#Assumptions: PDFs of amplitude and phase of the above data follows Rayleigh and Uniform distributions respectively.
#To verify:

#Rayleigh PDF
x=np.linspace(0,5,nbins)
a=np.zeros(nbins)
for i in range(nbins):
    a[i]=(2*x[i]*(np.exp(-x[i]**2)))
plt.figure(3)
plt.plot(x,a,color="red",linewidth=2)
plt.suptitle('Rayleigh PDF with SD .707',fontsize=18)
plt.xlabel("a",fontsize=16)
plt.ylabel("$f_A$(a)",fontsize=16)

#Uniform PDF
y=np.linspace(-5,5,nbins)
p=np.zeros(nbins)
for i in range(nbins):
    if (-np.pi<y[i] and y[i]<np.pi):
        p[i]=1/(2*np.pi)
plt.figure(4)
plt.plot(y,p,color="red",linewidth=2)
plt.suptitle('Uniform PDF from -pi/2 to +pi/2',fontsize=18)
plt.xlabel("$\phi$",fontsize=16)
plt.ylabel("$f_\phi(\phi$)",fontsize=16)

#Now superimposing Amplitude PDF and Rayleigh PDF
plt.figure(5)
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```python
plt.hist(amp,nbins,density=True)
plt.plot(x,a,color="red",linewidth=2)
plt.suptitle('Channel Amplitude PDF superimposed with Rayleigh PDF',fontsize=16)
plt.xlabel("a",fontsize=16)
plt.ylabel("$f_A$(a)",fontsize=16)

#Now superimposing Phase PDF and Uniform PDF
plt.figure(6)
plt.hist(phi,nbins,density=True)
plt.plot(y,p,color="red",linewidth=2)
plt.suptitle('Channel Phase PDF superimposed with Uniform PDF',fontsize=18)
plt.xlabel("$\phi$",fontsize=16)
plt.ylabel("$f_\phi(\phi$)",fontsize=16)


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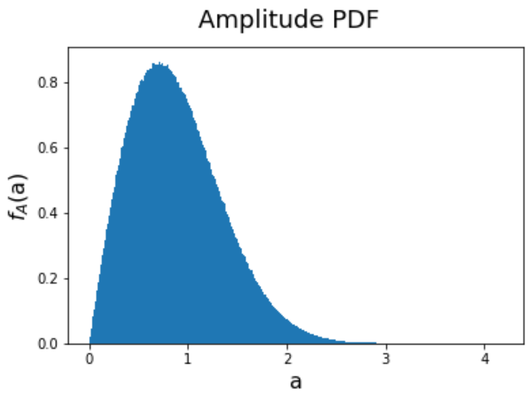
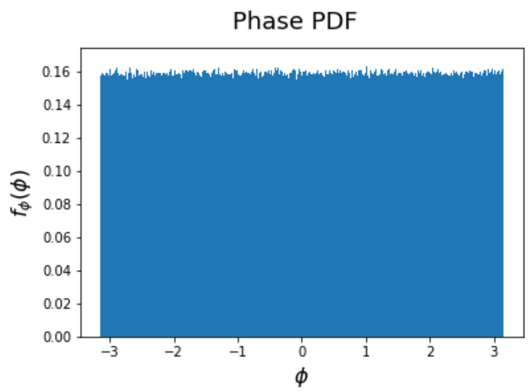
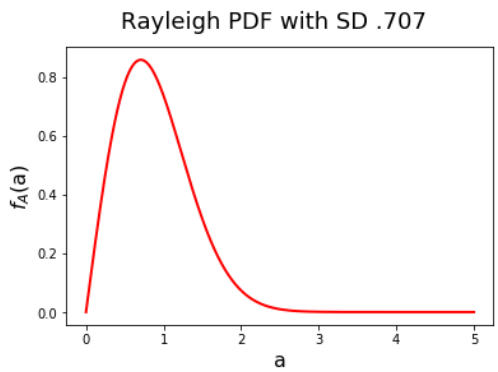
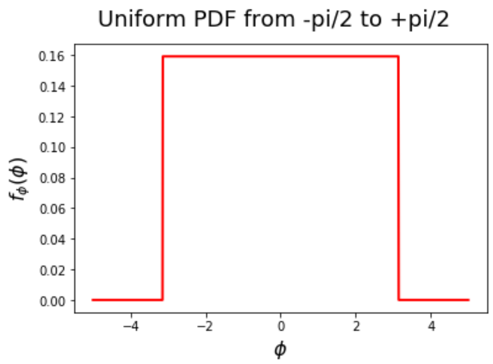
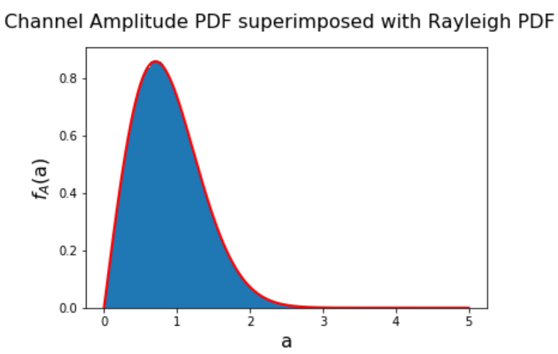
<u>Output:</u>

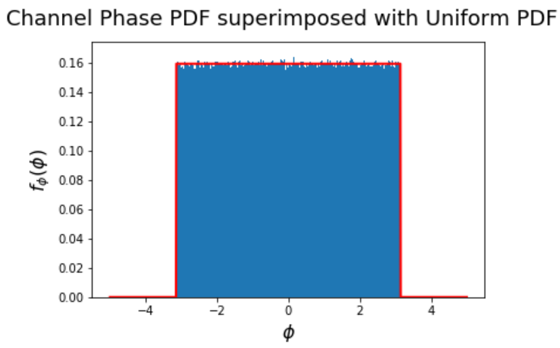












Observation:

The PDFs of amplitude and phase of the above generated complex baseband channel coefficient ‘h’ follows Rayleigh and Uniform distributions respectively. This is verified by superimposing them with the PDFs described in the class lectures.
The complex baseband channel coefficient ‘h’ is a Gaussian random variable with real and imaginary parts as zero mean, independent and identically distributed gaussian random variables. It is seen that the magnitude PDF follows Rayleigh distribution with variance 0.5 and the phase is uniformly distributed in the interval [-π,+π]