EXPERIMENT 9 – FIR FILTER DESIGN:

CODE:

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

"""

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"""

import matplotlib.pyplot as plt

import numpy as np

from scipy.signal import freqz

wc=(np.pi/3)

M=11

a=(M-1)/2

b=(wc/np.pi)

hd\_n=[]

n = np.arange(M)

hd\_n = np.sin(wc \* (n - a)) / (np.pi \* (n - a))

hd\_n[M // 2] = b

def rectangular\_window(M):

n = np.arange(M)

n[0]=1

return n/n

def hamming\_window(M):

n = np.arange(M)

return 0.54 - 0.46 \* np.cos(2 \* np.pi \* n / (M - 1))

def hanning\_window(M):

n = np.arange(M)

return 0.5 - 0.5 \* np.cos(2 \* np.pi \* n / (M - 1))

hn\_r= hd\_n \* rectangular\_window(M)

print("Rectangular window coefficients:",hn\_r)

plt.figure(2)

plt.subplot(3,1,1)

wr,Hr=freqz(hn\_r)

plt.plot(wr\*57.29, 20\*np.log10(abs(Hr)))

plt.grid(True)

plt.title('Frequency Response of Linear Phase Low-pass FIR Filter - Rectangular window')

plt.xlabel('Frequency (degrees)')

plt.ylabel('Magnitude (dB)')

hn\_m = hd\_n \* hamming\_window(M)

print("\n Hamming window coefficients:",hn\_m)

wm,Hm=freqz(hn\_m)

plt.subplot(3,1,2)

plt.grid(True)

plt.plot(wm\*57.29,20 \* np.log10(abs(Hm)))

plt.title('Frequency Response of Linear Phase Low-pass FIR Filter - Hamming window')

plt.xlabel('Frequency (degrees)')

plt.ylabel('Magnitude (dB)')

hn\_n = hd\_n \* hanning\_window(M)

print("\n Hanning window coefficients:",hn\_n)

wn,Hn=freqz(hn\_n)

plt.subplot(3,1,3)

plt.grid(True)

plt.plot(wn\*57.29,20 \* np.log10(abs(Hn)))

plt.title('Frequency Response of Linear Phase Low-pass FIR Filter - Hanning window')

plt.xlabel('Frequency (degrees)')

plt.ylabel('Magnitude (dB)')

plt.figure(1)

plt.subplot(311)

plt.stem(hn\_r)

plt.title('window Coefficients - Rectangular window')

plt.xlabel('n')

plt.ylabel('Amplitude')

plt.subplot(312)

plt.stem(hn\_m)

plt.title('window Coefficients - Hamming window')

plt.xlabel('n')

plt.ylabel('Amplitude')

plt.subplot(313)

plt.stem(hn\_n)

plt.title('window Coefficients - Hanning window')

plt.xlabel('n')

plt.ylabel('Amplitude')

plt.figure(3)

plt.subplot(3,1,1)

plt.grid(True)

plt.plot(wr\*57.29,np.angle(Hr))

plt.title('Phase Response of Low-pass FIR Filter - Rectangular window')

plt.xlabel('Frequency (degrees)')

plt.ylabel('Phase')

plt.subplot(3,1,2)

plt.grid(True)

plt.plot(wm\*57.29,np.angle(Hm))

plt.title('Phase Response of Low-pass FIR Filter - Hamming window')

plt.xlabel('Frequency (degrees)')

plt.ylabel('Phase')

plt.subplot(3,1,3)

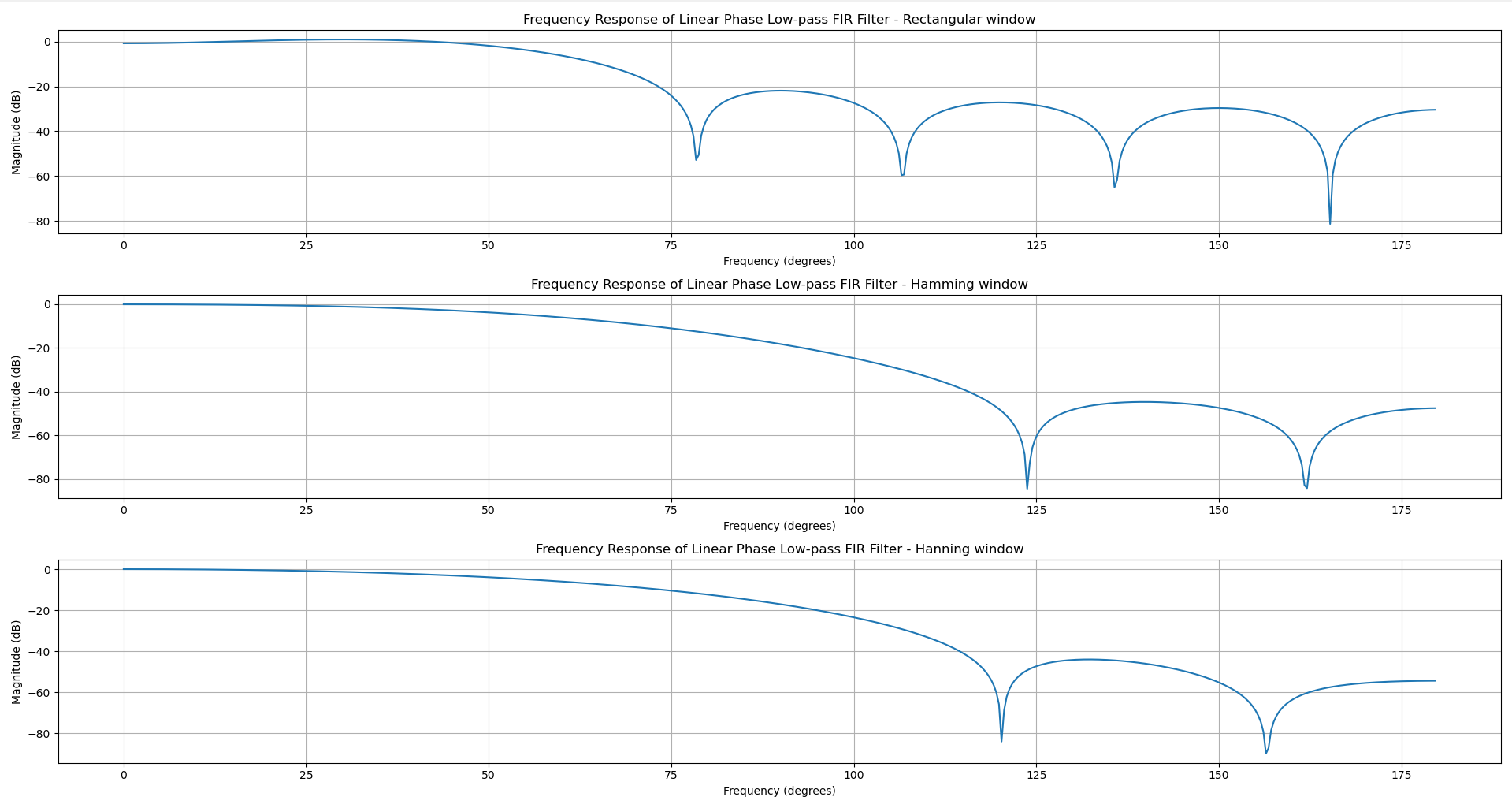
plt.grid(True)

plt.plot(wn\*57.29,np.angle(Hn))

plt.title('Phase Response of Low-pass FIR Filter - Hanning window')

plt.xlabel('Frequency (degrees)')

plt.ylabel('Phase')

OUTPUT:

