Massachusetts Institute of Technology
Department of Electrical Engineering and Computer Science

6.341: Discrete-Time Signal Processing

Fall 2005

Problem Set 9

Spectral Analysis with the DFT

Issued: Tuesday, November 15, 2005. **Due:** Tuesday, November 22, 2005.

Reading: Chapter 10, Sections 10.0, 10.1, 10.2, 10.6, 10.7.

Problem 9.1

OSB Problem 10.12

Problem 9.2

OSB Problem 10.14

Problem 9.3

OSB Problem 10.24

Problem 9.4

OSB Problem 10.31

Problem 9.5

OSB Problem 10.44

Problem 9.6

OSB Problem 10.37

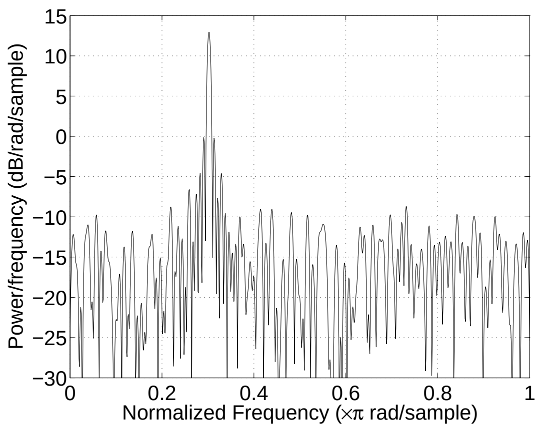
Problem 9.7

In both parts of this problem, you are asked to match spectral estimates with the spectral estimation technique used. The two parts are independent of each other. **In every plot, the standard "connecting of dots" is used to give a continuous curve from a finite number of data points.**

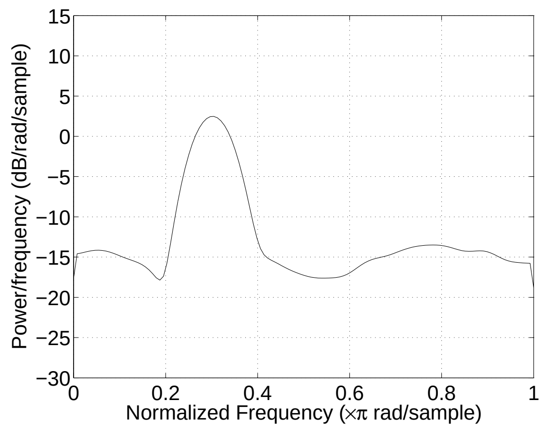
(a) Consider a signal that is known to be the sum of a single sinusoidal component and a white noise sequence. Four periodogram-style spectral estimates were computed:

	Data record length	DFT length	Averaging	Description
1.	256	256	none	periodogram from 256 samples
2.	256	2048	none	periodogram from 256 samples zero-padded to length 2048
3.	256	32	8 segments	averaged periodogram from 8 segments of length 32
4.	2048	256	8 segments	averaged periodogram from 8 segments of length 256

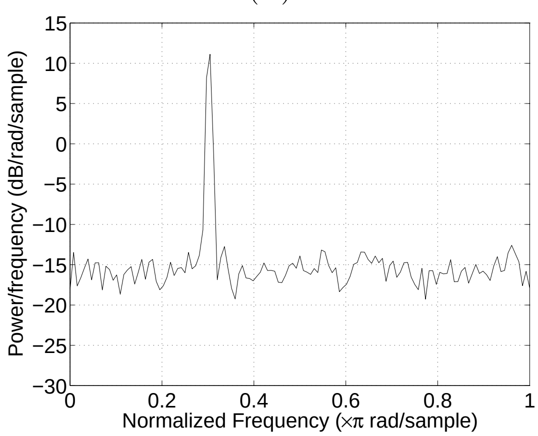
The estimates obtained are shown below. The plots are for frequencies $\omega \in [0, \pi]$ and the vertical axes are in logarithmic (dB) units. (The form of the plots and axis labels should be familiar because they conform to the MATLAB defaults.)



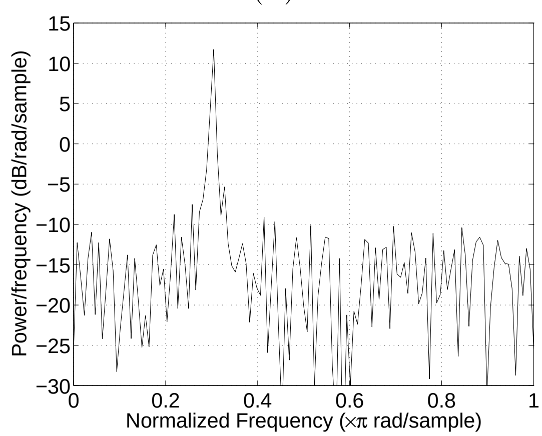
(A)



(B)



(C)



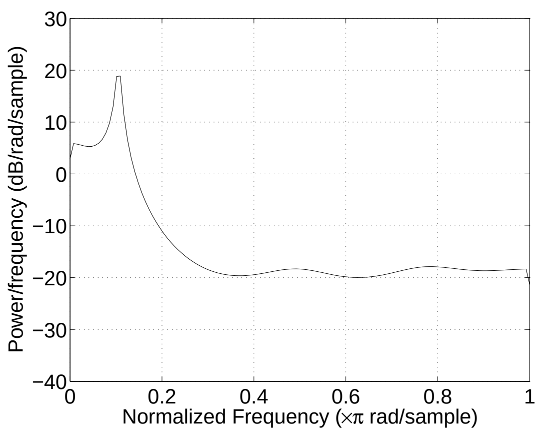
(D)

Match the techniques to the estimates, noting that each technique is used exactly once.

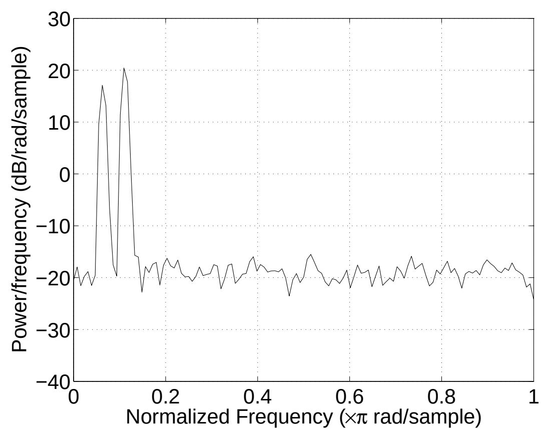
(b) A signal is known to be the sum of two sinusoidal components and a white noise sequence. The same data record of length 1024 was used to compute each of the four spectral estimates:

1. Periodogram
2. Welch's method (averaged modified periodogram with Hamming window and eight segments overlapping by 50%)
3. All-pole model of order 8
4. All-pole model of order 16

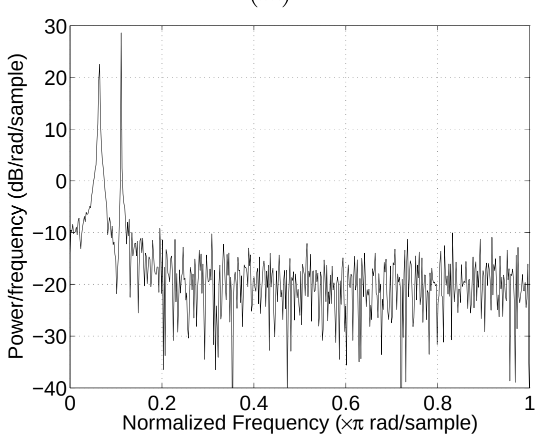
The estimates obtained are shown below. The plots are for frequencies $\omega \in [0, \pi]$ and the vertical axes are in logarithmic (dB) units. (The form of the plots and axis labels should be familiar because they conform to the MATLAB defaults.)



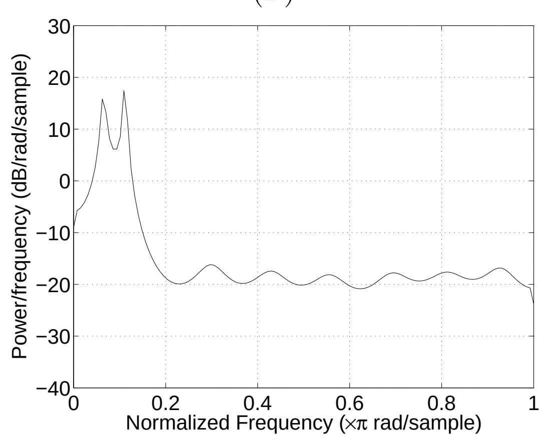
(A)



(B)



(C)



(D)

Match the techniques to the estimates, noting that each technique is used exactly once.