

# EE 20N: Fall 2003

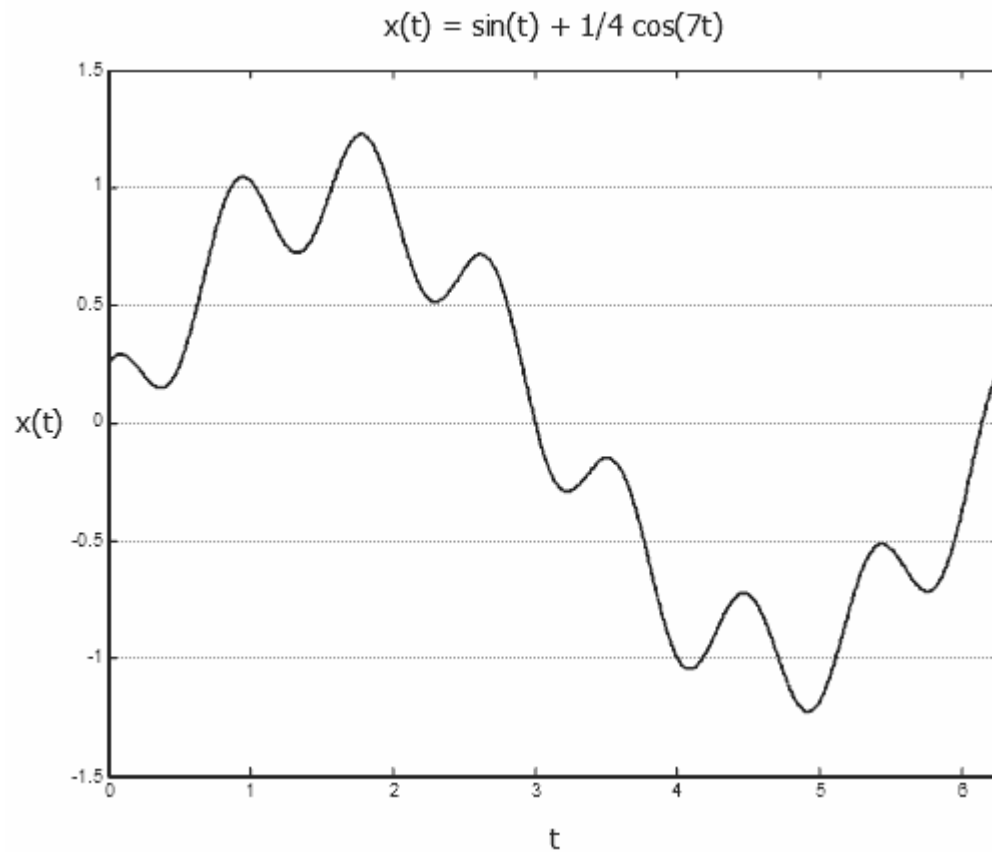
## Midterm 2

Professor Sheila Ross

### Problem 1:

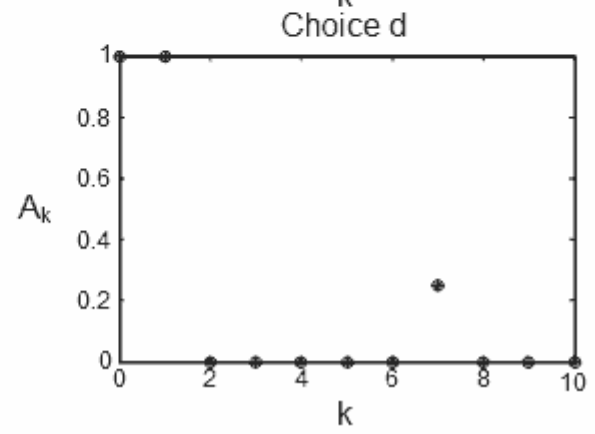
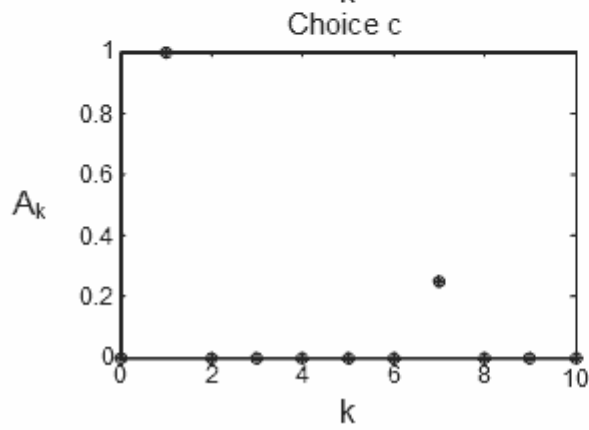
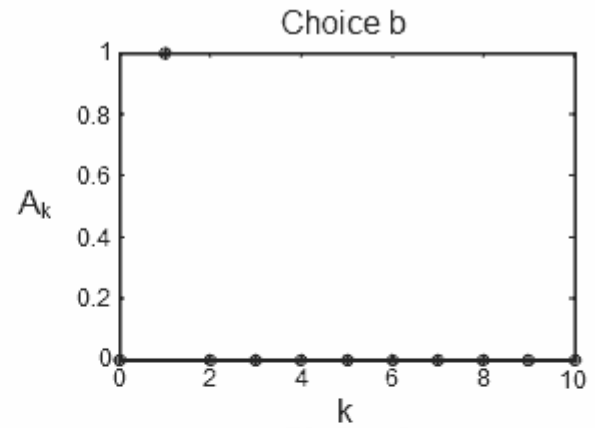
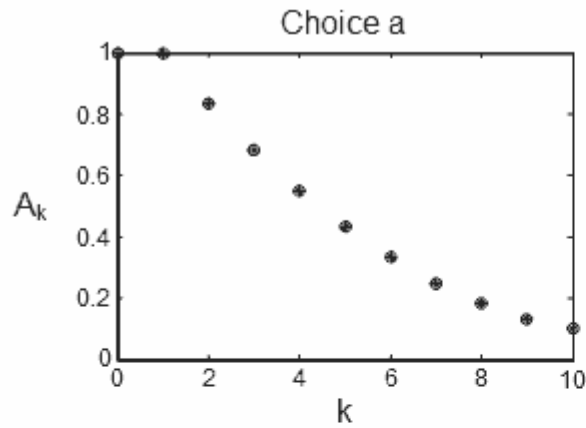
Consider the following signal:  $x(t) = \sin(t) + \frac{1}{4}\cos(7t)$  for all  $t$  in *Reals*

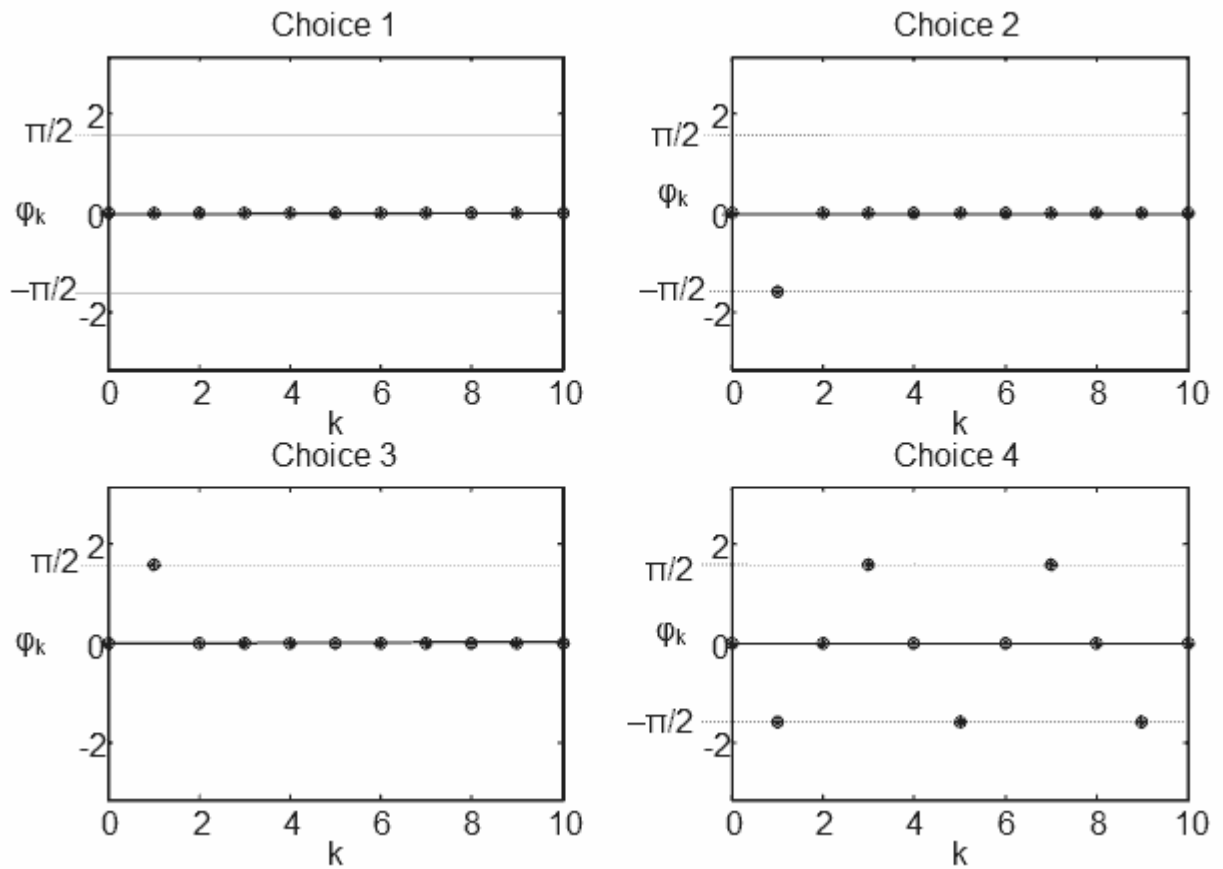
This signal is shown below.



a) What is the fundamental frequency  $\omega_0$  for this signal?

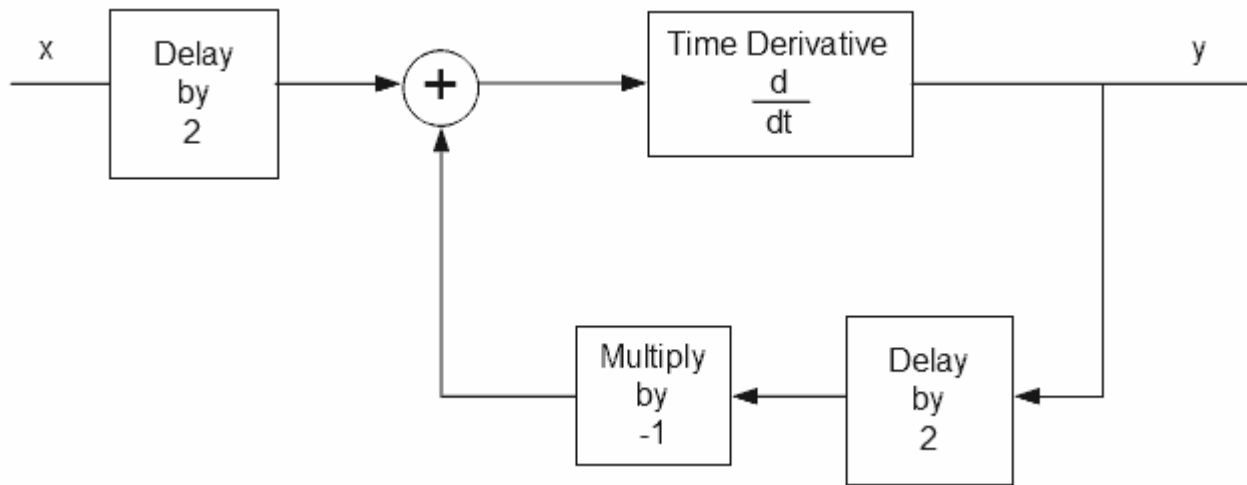
b) Of the graphs of  $A_k$  and  $\varphi_k$  shown, only one pair of graphs (one  $A_k$  graph and its corresponding  $\varphi_k$  graph) shows the correct trigonometric Fourier series for this signal. Which is the correct graph for  $A_k$ ? Which is the corresponding correct graph for  $\varphi_k$ ?





**Problem 2:**

Consider the continuous-time system with input  $x$  and output  $y$  defined by the diagram below.



Find the frequency response  $H(\omega)$  for this system.

### Problem 3:

Consider the continuous-time LTI system described by the impulse response

$$h(t) = \delta(t) + 2\delta(t - 2) + 3\delta(t + 3)$$

- a) Is this a FIR system or an IIR system? *Justify your answer.*
- b) Is this system causal? *Justify your answer.*
- c) For a general input  $x$ , give a *simple* expression for the output  $y$ . *Justify your answer.*

### Problem 4:

Indicate whether the following continuous-time systems are linear, time-invariant, and/or causal. You are *not required* to show your reasoning.

a)  $S(x)(t) = e^{i2\pi t}x(t)$

- Linear?
- Time-invariant?
- Causal?

b)  $S(x)(t) = x(-t - 2)$

- Linear?
- Time-invariant?
- Causal?

c)  $S(x)(t) = x(t - 2)^2$

- Linear?
- Time-invariant?
- Causal?

### Problem 5:

Consider the discrete-time system given by

$$y(n) + 2y(n - 2) = x(n)$$

- a) Find the frequency response  $H(\omega)$  for this system.
- b) Provide matrices  $A$ ,  $B$ ,  $C$  and  $D$  and a state  $s(n)$  leading to the equivalent description

$$s(n + 1) = As(n) + Bx(n)$$

$$y(n) = Cs(n) + Dx(n)$$

Find the impulse response  $h(n)$  for this system.

Hint: Is this system causal? What does that tell you about  $h(n)$ ?

### Problem 6:

Consider the continuous-time system with magnitude response and phase response given by

$$|H(\omega)| = 10 \text{ for } \omega \in [-\pi/2, \pi/2], 0 \text{ otherwise}$$

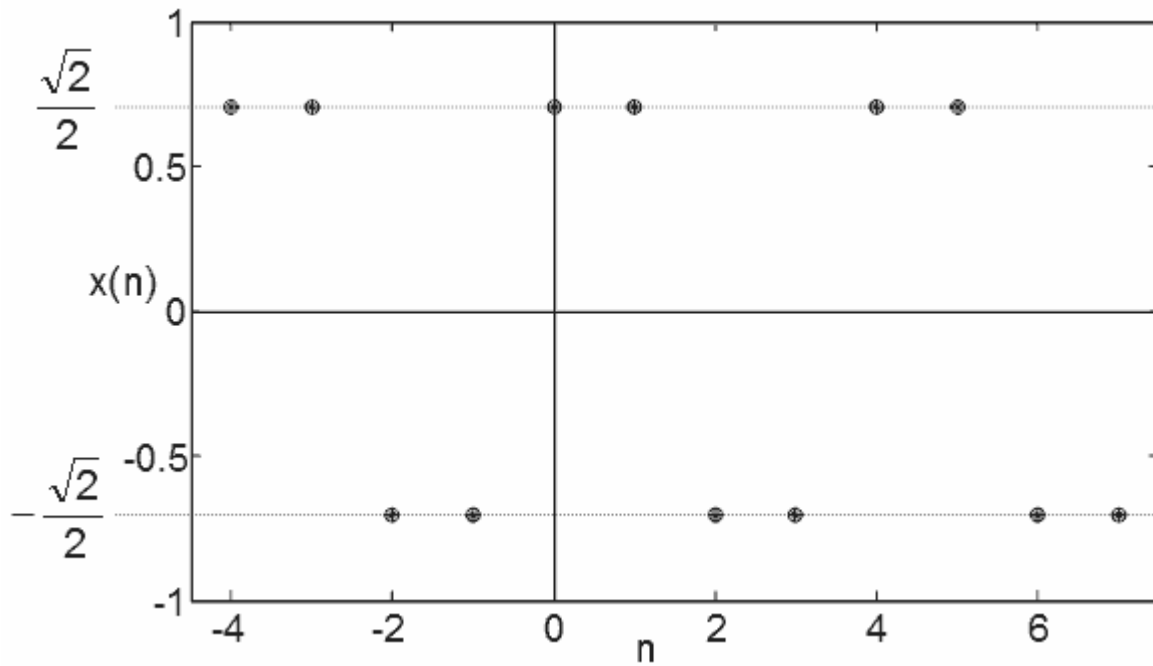
and the continuous-time input

$$x(t) = 4 + 3\sin(\pi t/3) - 2\cos(\pi t/2) - \sin(\pi t)$$

- a) What is the period of the input  $x$ ?
- b) What is the output  $y$  corresponding to the input  $x$ ? Express your answer *without using imaginary numbers*.

**Problem 7:**

Consider the discrete-time signal  $x$  depicted below over three periods:

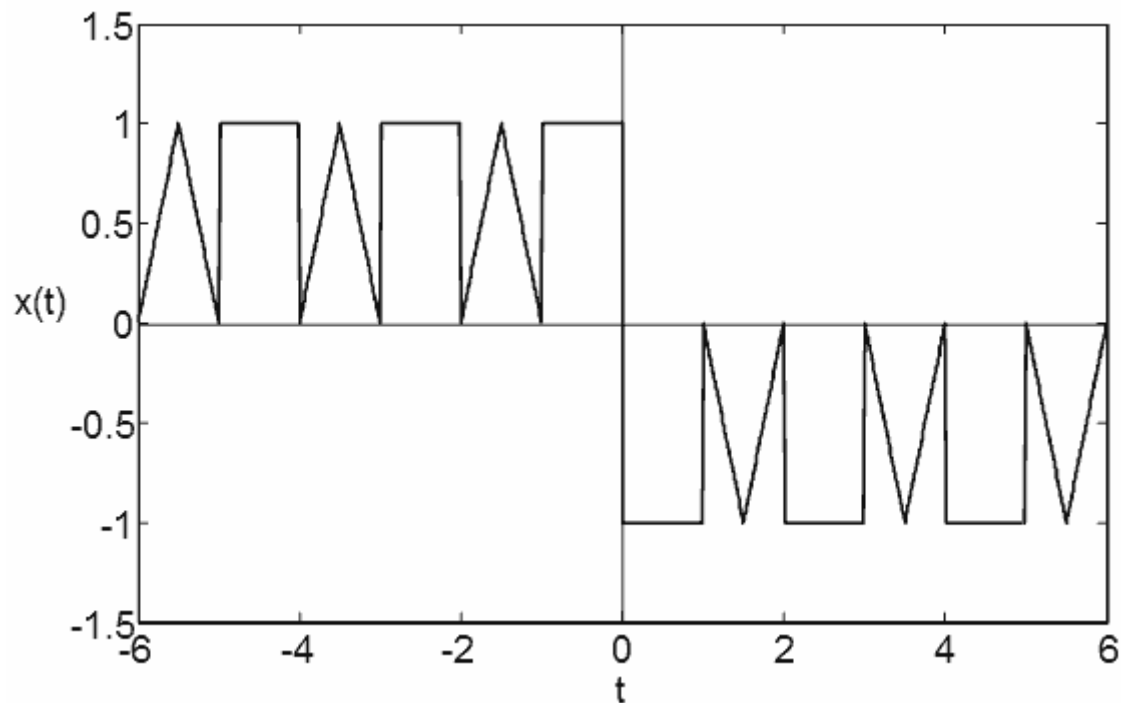


Find *both* the trigonometric and complex exponential Fourier coefficients for this signal.

The *simpler* your final answer is, the *more credit* you will receive.

### Problem 8:

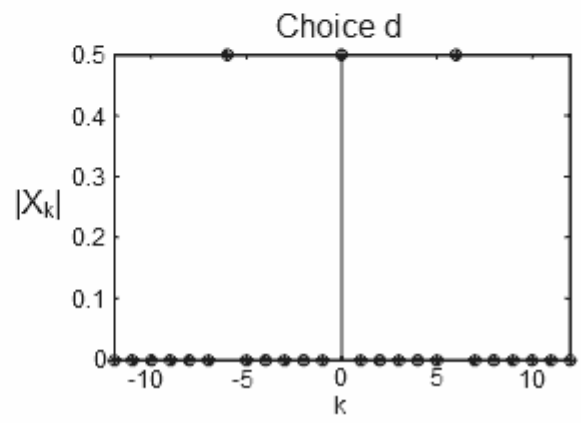
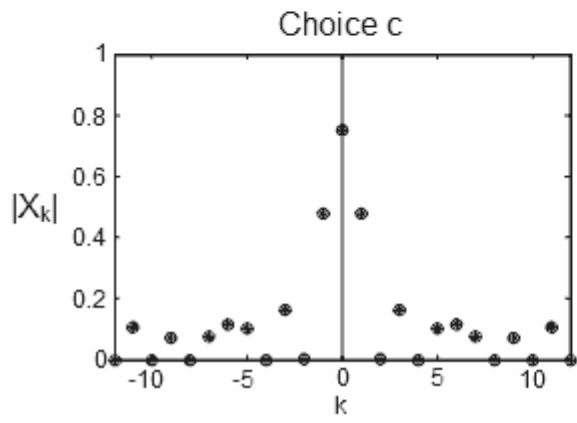
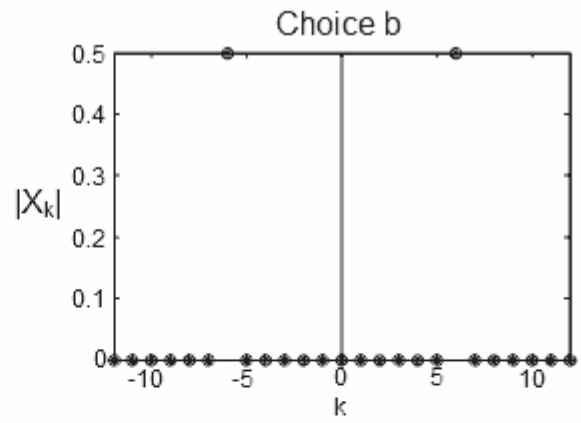
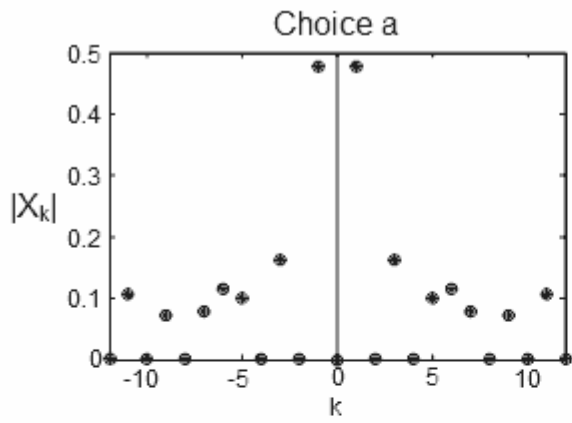
Consider the continuous-time "mystery signal" illustrated below for one period:



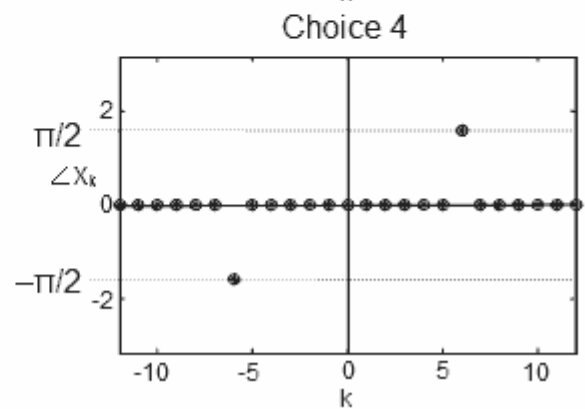
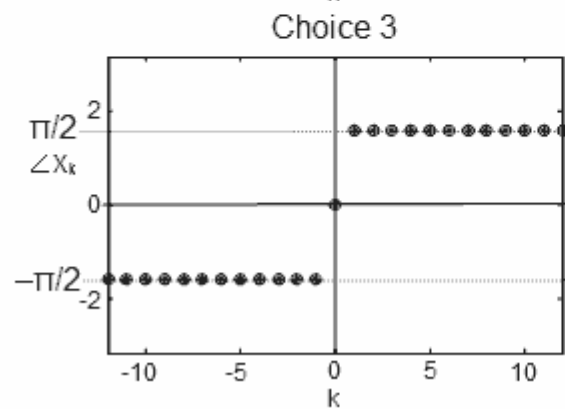
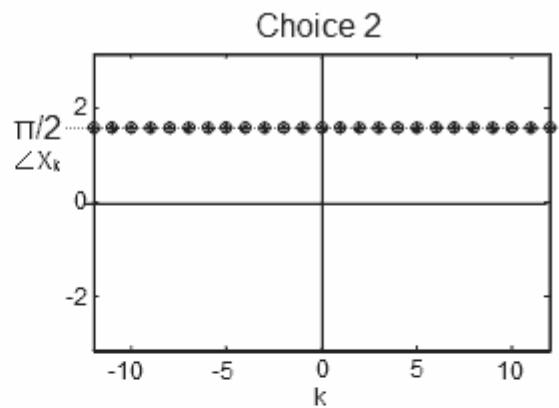
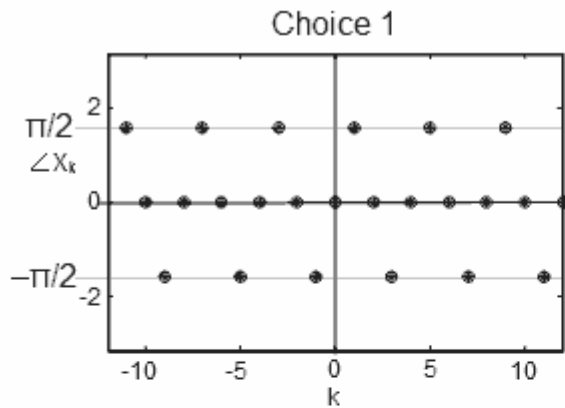
a) What is the fundamental frequency  $\omega_0$  for this signal?

b) Of the graphs of  $|X_k|$  and  $\angle X_k$  on the next page, only one pair of graphs (one  $|X_k|$  graph and its corresponding  $\angle X_k$  graph) shows the correct complex exponential Fourier series for this signal.

Which is the correct graph for  $|X_k|$ ? Which is the corresponding correct graph for  $\angle X_k$ ? *Justify your answer.*








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