

EE 20N: Fall 2003

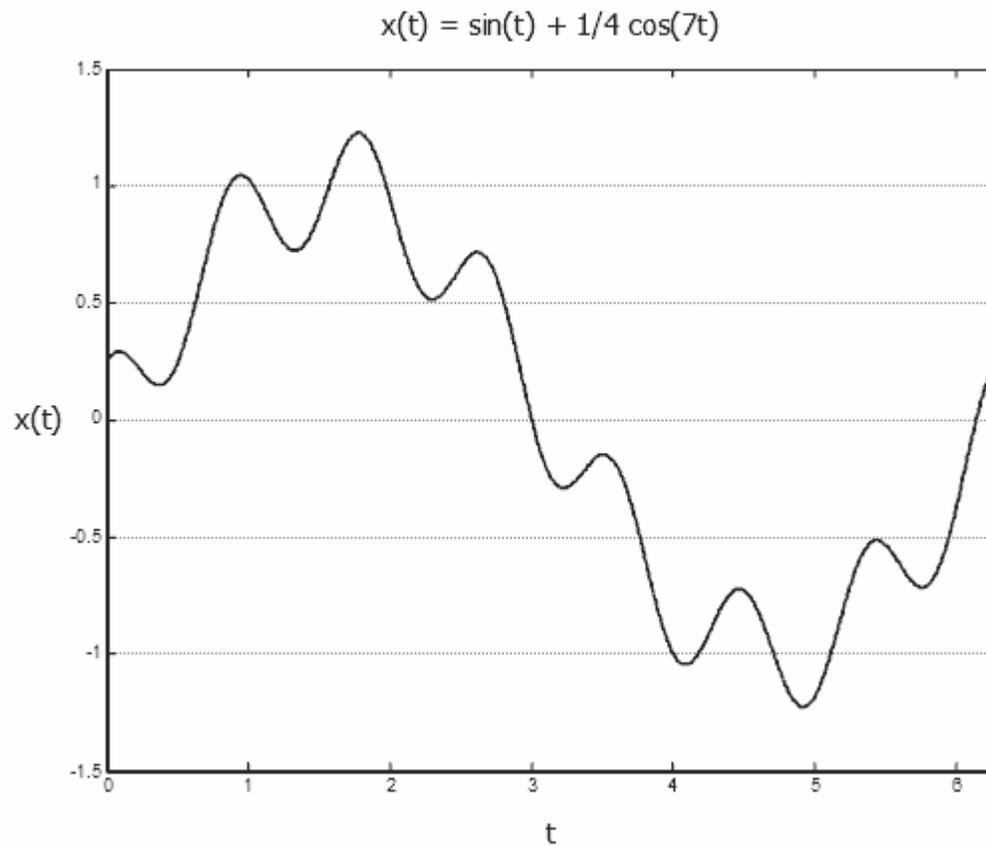
Midterm 2

Professor Sheila Ross

Problem 1:

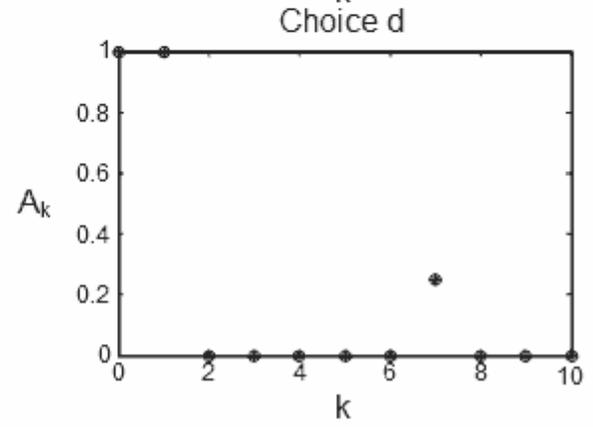
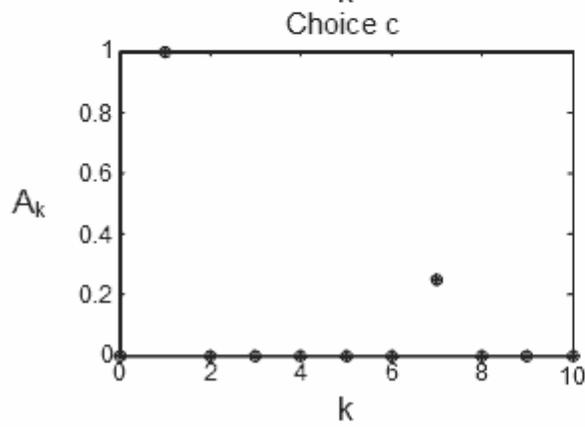
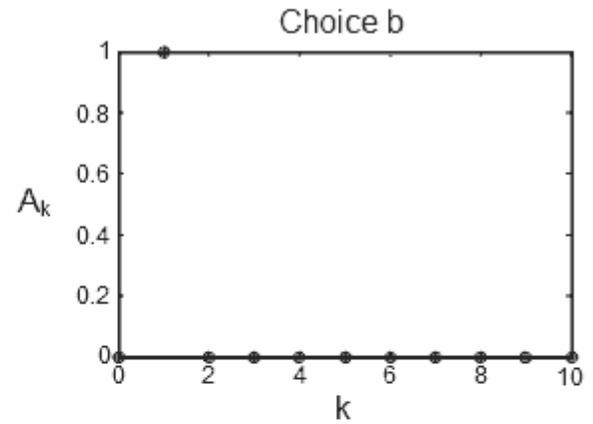
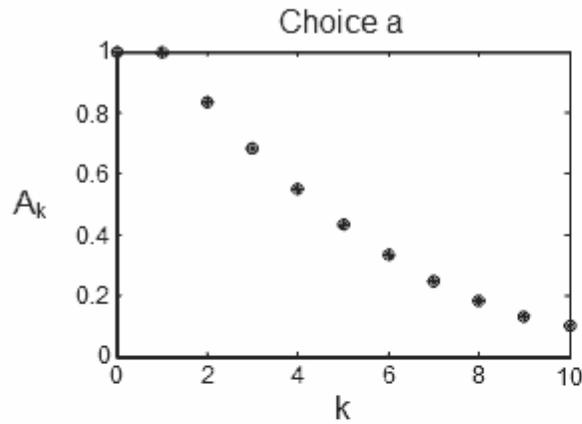
Consider the following signal: $x(t) = \sin(t) + \frac{1}{4}\cos(7t)$ for all t in *Reals*

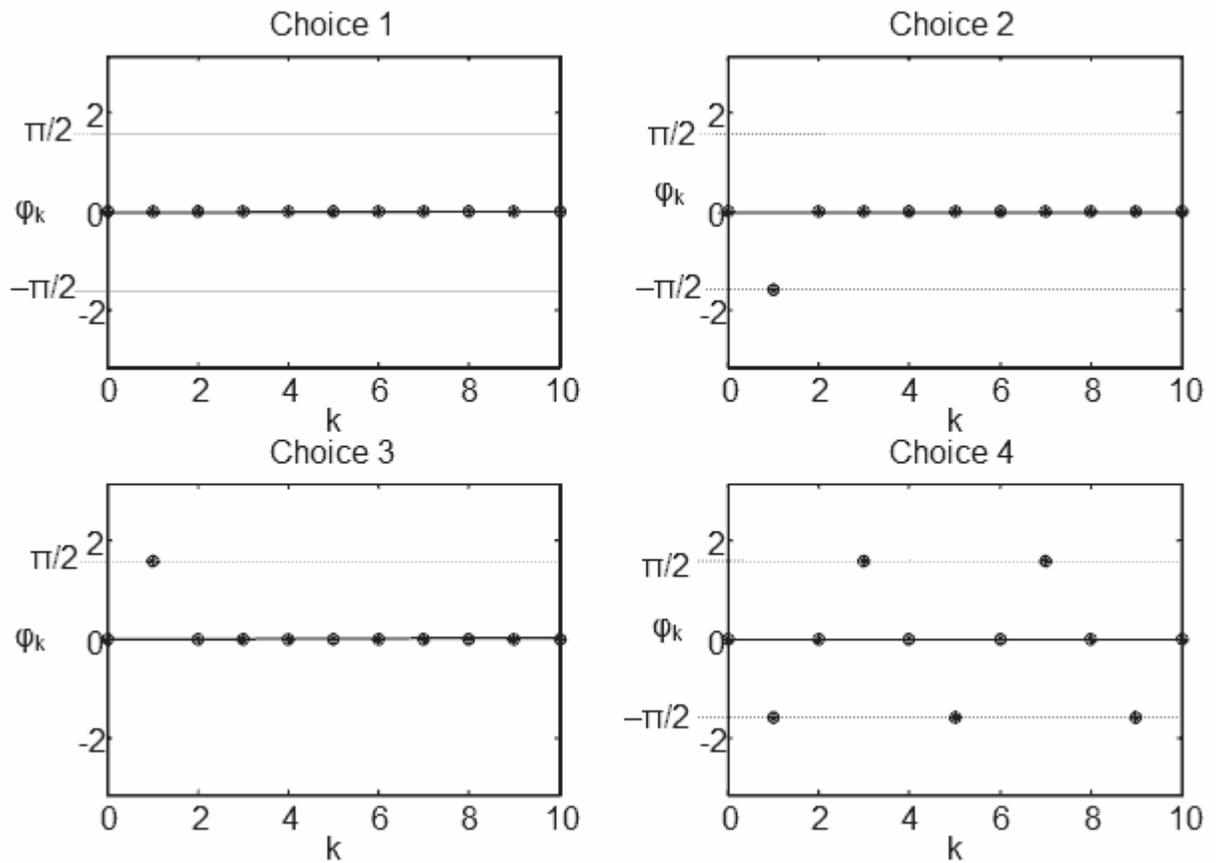
This signal is shown below.



a) What is the fundamental frequency ω_0 for this signal?

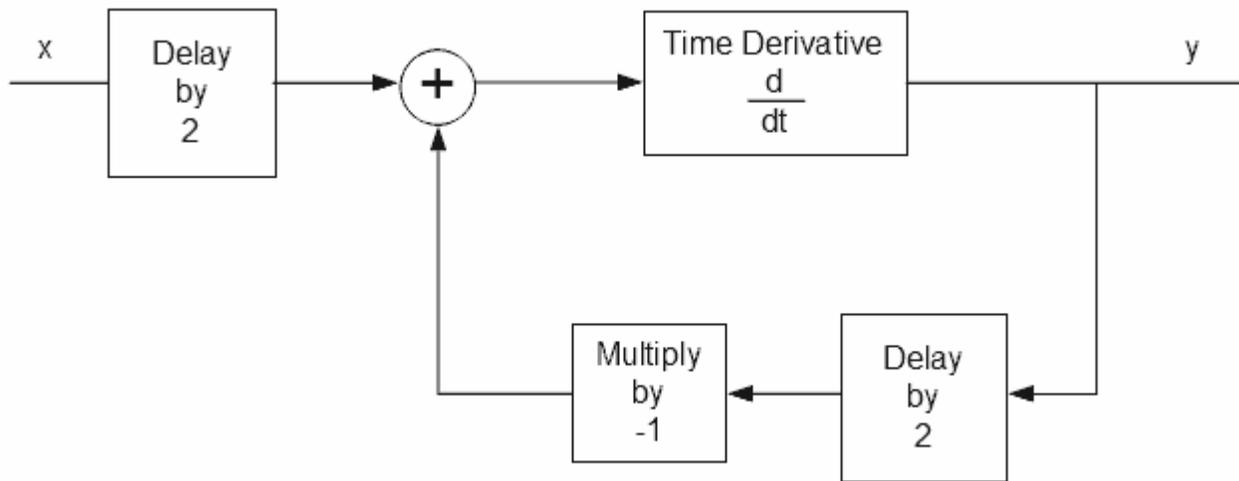
b) Of the graphs of A_k and φ_k shown, only one pair of graphs (one A_k graph and its corresponding φ_k graph) shows the correct trigonometric Fourier series for this signal. Which is the correct graph for A_k ? Which is the corresponding correct graph for φ_k ?





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

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

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

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

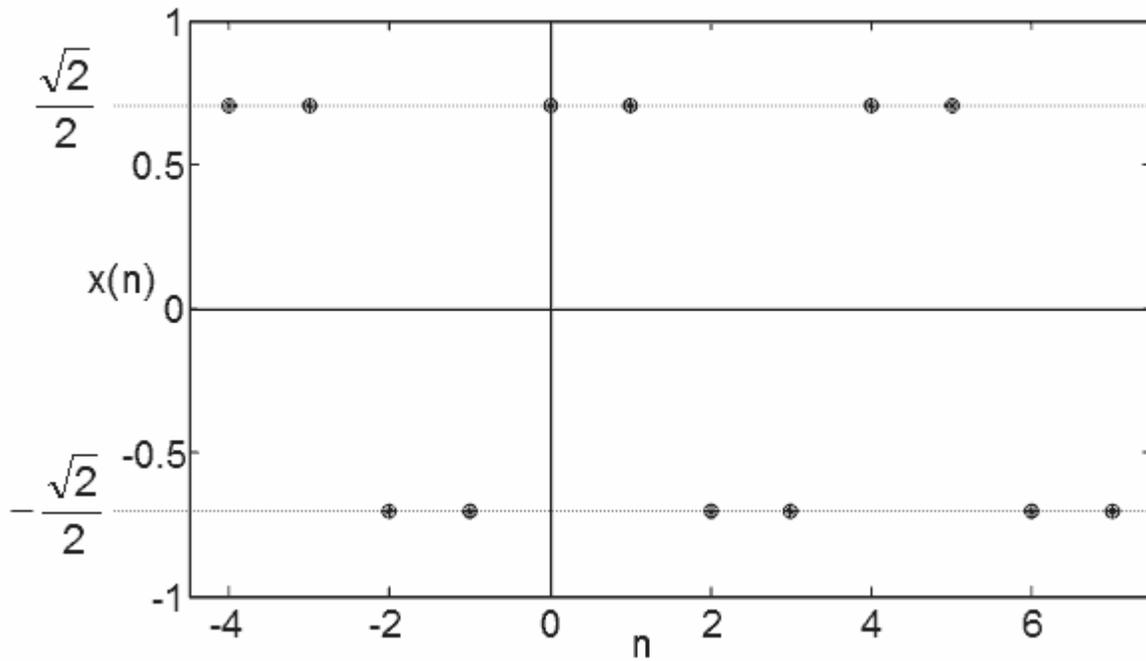
and the continuous-time input

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

- What is the period of the input x ?
- 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:

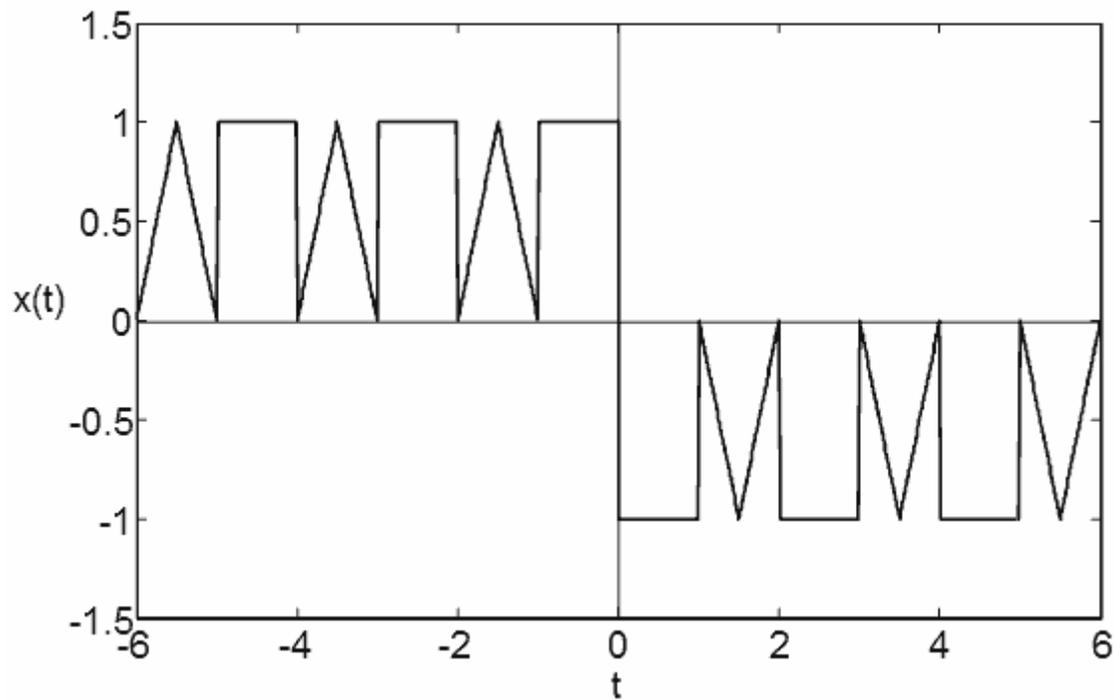


Find *both* the trigonometric and complex exponential Fourier coefficients for this signal.

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

Problem 8:

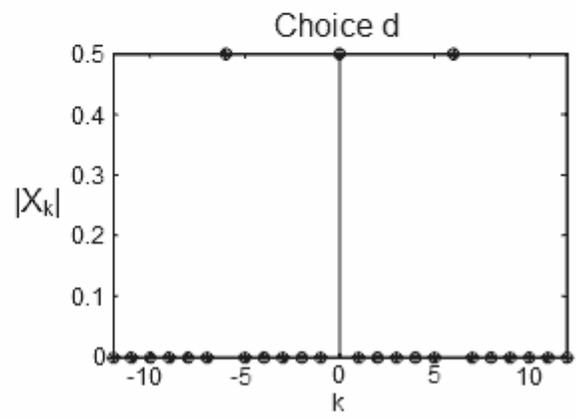
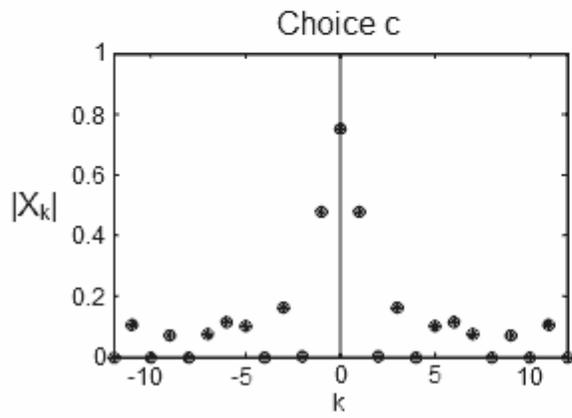
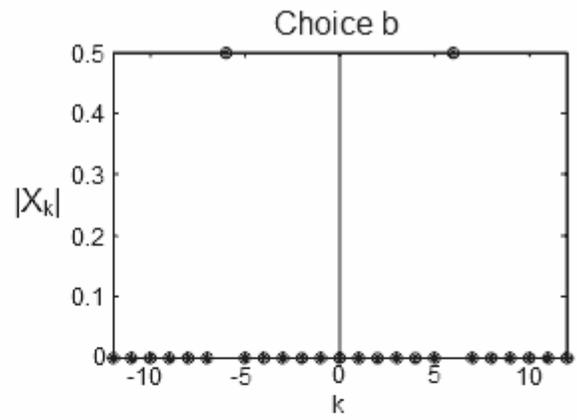
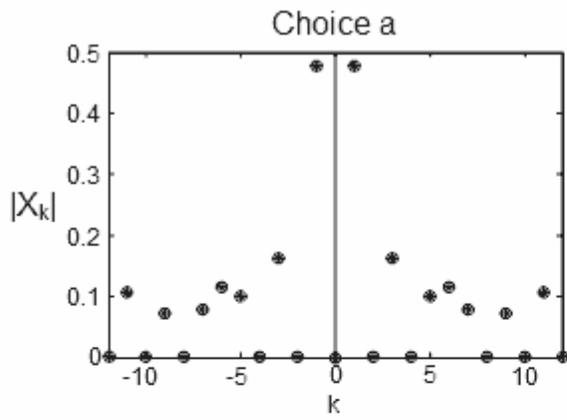
Consider the continuous-time "mystery signal" illustrated below for one period:

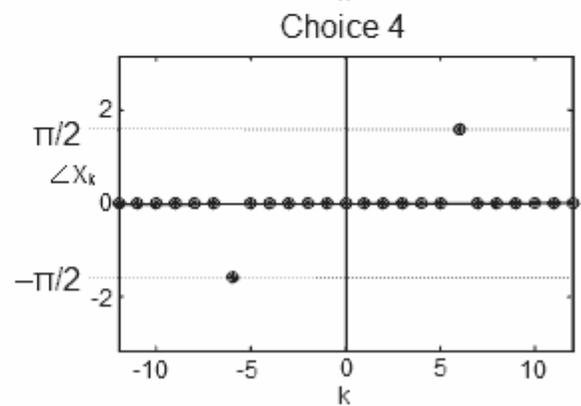
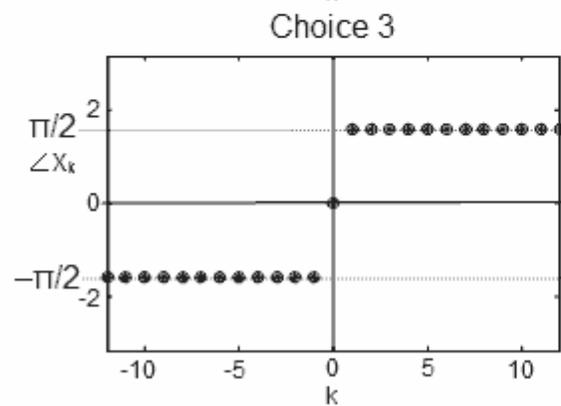
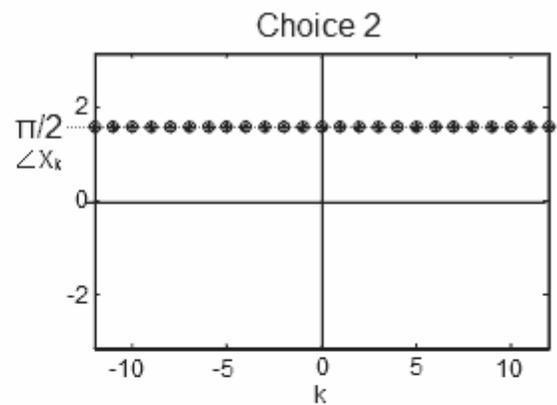
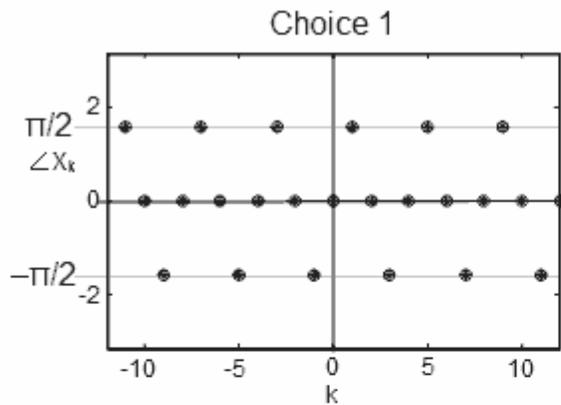


a) What is the fundamental frequency ω_0 for this signal?

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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