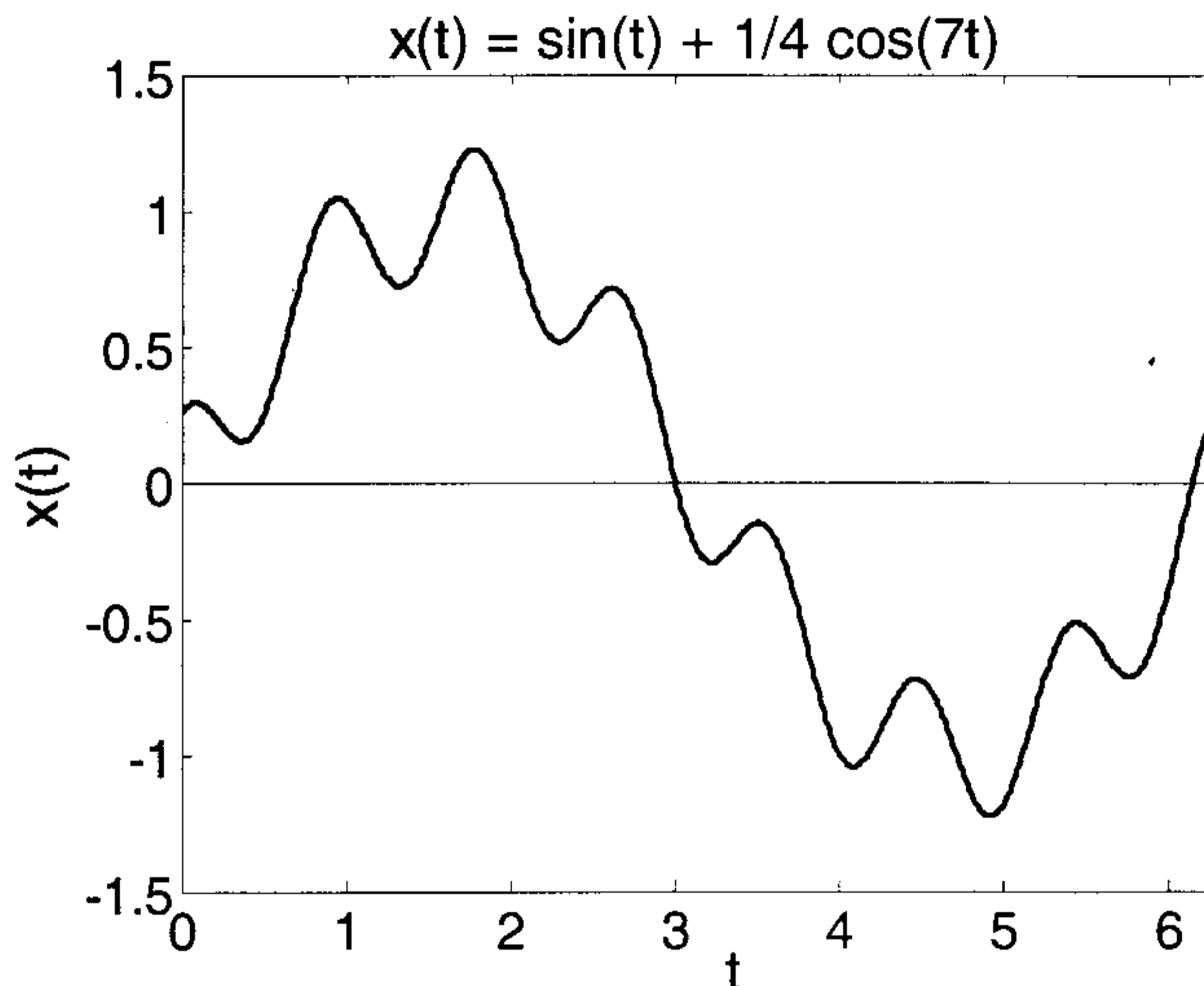


Name: _____

Problem 1: 9 Points Possible

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?

3 points, 1 point for $\omega_0 = \frac{2\pi}{P}$.

- b) Of the graphs of A_k and ϕ_k on the next page, 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 ?

Write your choices here. Justify your answer.

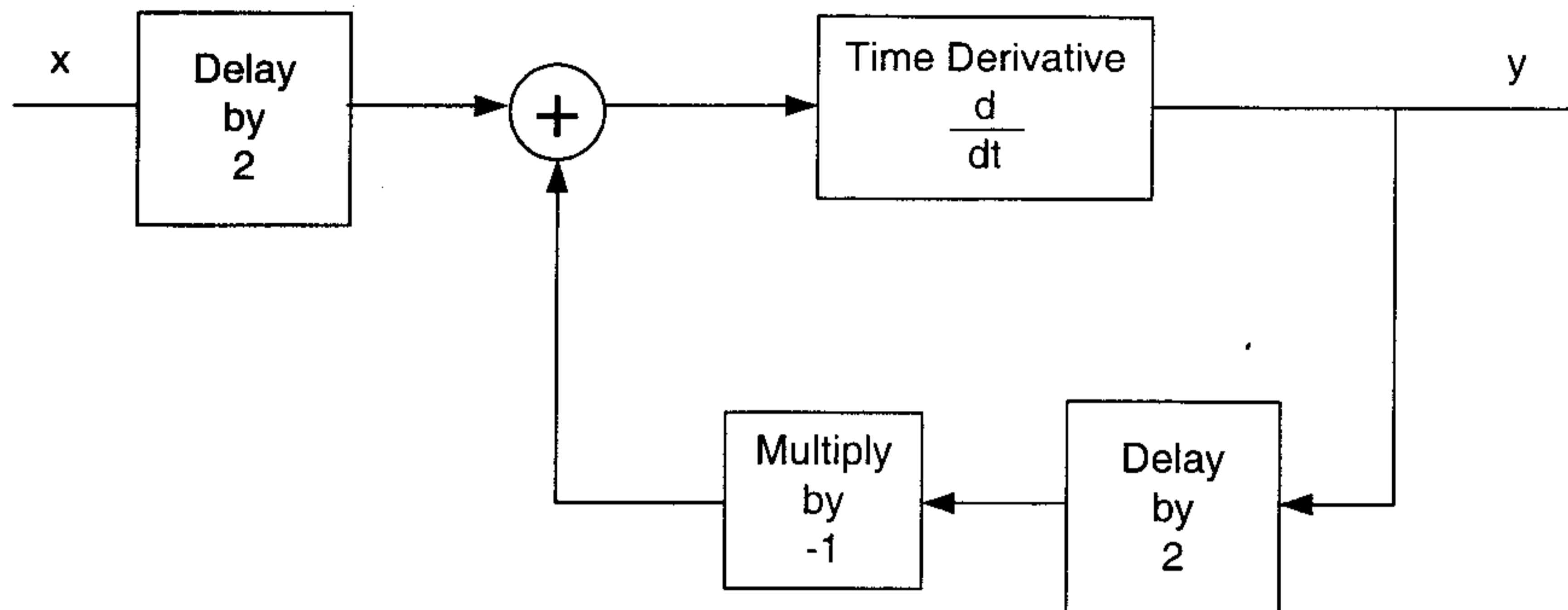
3 points each choice.

1 point if some justification given but answer wrong or giving choice 3 instead of 2.

2 points if correct but no/badly incorrect justification.

Name: _____

Problem 2: 12 Points Possible

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. Clearly indicate your final answer.

2 points for each individual $H(\omega)$

3 points for correct feedback simplification

3 points for correct cascade simplification

all or nothing
for each
part, except
only -1
for math or
sign errors

Name: _____

Problem 3: 12 Points Possible

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.

3 points 1 point if justification is wrong

b) Is this system causal? Justify your answer.

3 points 1 point if justification is wrong

c) For a general input x , give a simple expression for the output y . Justify your answer.

6 points

* Full credit if justification mentions sifting property

* 3 points if δ changed to x with no

* 3 points if convolution not worked out justification

Name: _____

Problem 4: 12 Points Possible

Indicate whether the following continuous-time systems are linear, time invariant, and/or causal by writing yes or no in the spaces provided. You are not required to show your reasoning.

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

Linear? _____

Time-invariant? _____

Causal? _____

1 point each, all or nothing.

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

Linear? _____

Time-invariant? _____

Causal? _____

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

Linear? _____

Time-invariant? _____

Causal? _____

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

Linear? _____

Time-invariant? _____

Causal? _____

Name: _____

Problem 5: 18 Points Possible

Consider the discrete-time system given by

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

- a) Find the frequency response $H(\omega)$ for this system. Write your final answer here.

5 points

- b) Provide matrices A, B, C, and D and a state $s(n)$ leading to the equivalent description

$$s(n+1) = A s(n) + B x(n)$$

$$y(n) = C s(n) + D x(n)$$

Write your final answer here.

8 points

* 2 points for good try
 * 5 points if A + B wrong

- c) Find the impulse response $h(n)$ for this system. Write your final answer here.
 Hint: Is this system causal? What does that tell you about $h(n)$?

5 points

* 2 points if not in closed form

* 2-2.5 points if not omitted ($n \leq 0$)

* 3.5 points if is wrong

cases
 , etc)
 computation

Name: _____

Problem 6: 12 Points Possible

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

$$|H(\omega)| = \begin{cases} 10 & \text{for } \omega \in [-\pi/2, \pi/2] \\ 0 & \text{otherwise} \end{cases} \quad \angle H(\omega) = \begin{cases} \omega & \text{for } \omega \in [-\pi/2, \pi/2] \\ 0 & \text{otherwise} \end{cases}$$

and the continuous-time input

$$x(t) = 4 + 3\sin\left(\frac{\pi}{3}t\right) - 2\cos\left(\frac{\pi}{2}t\right) - \sin(\pi t)$$

- a) What is the period of the input x ?

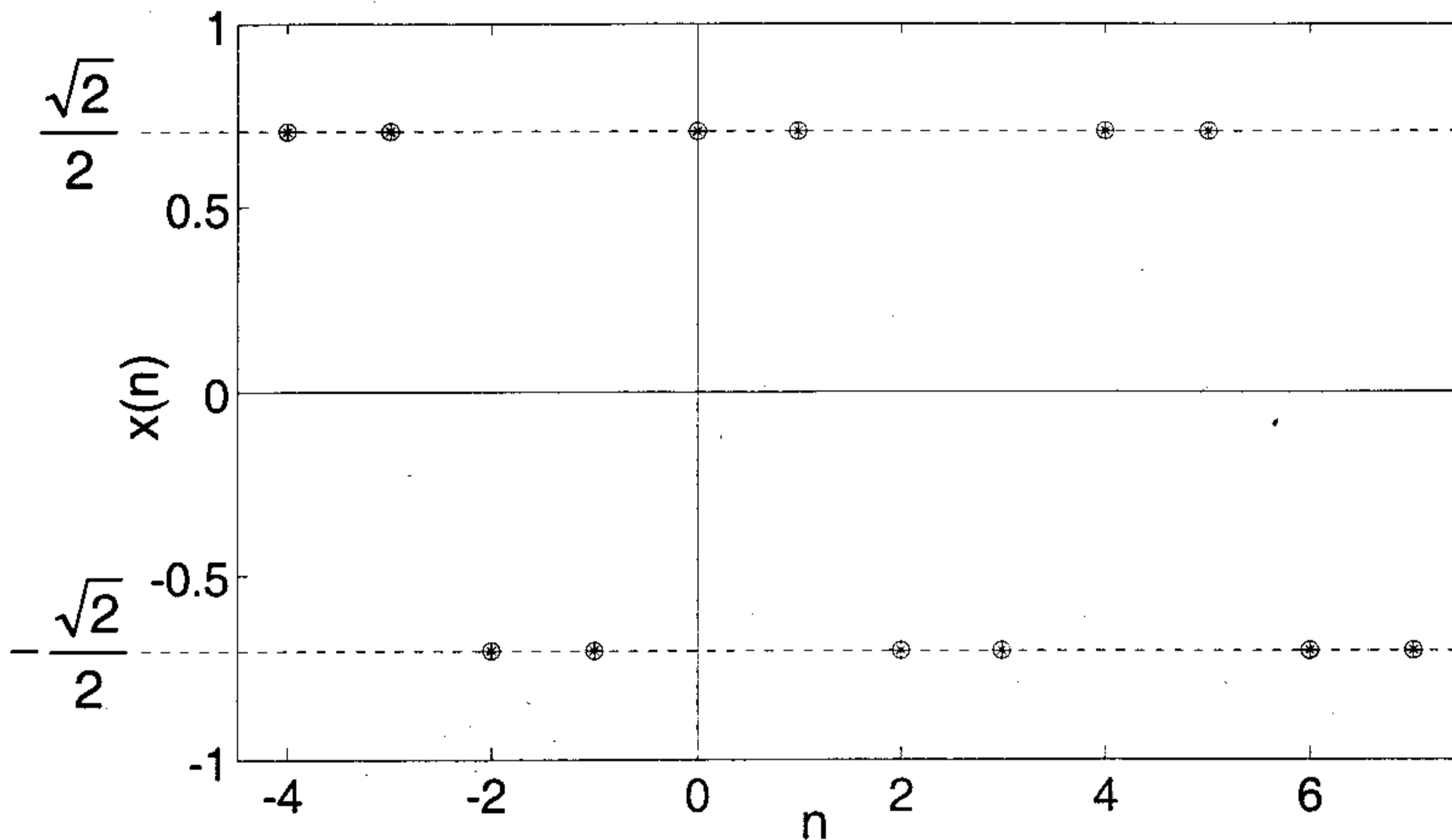
4 points 2 points if method seems right

- b) What is the output y corresponding to the input x ? Express your answer without using imaginary numbers. Clearly indicate your final answer in the space below.

8 points — 2 points for each component

Name: _____

Problem 7: 16 Points Possible

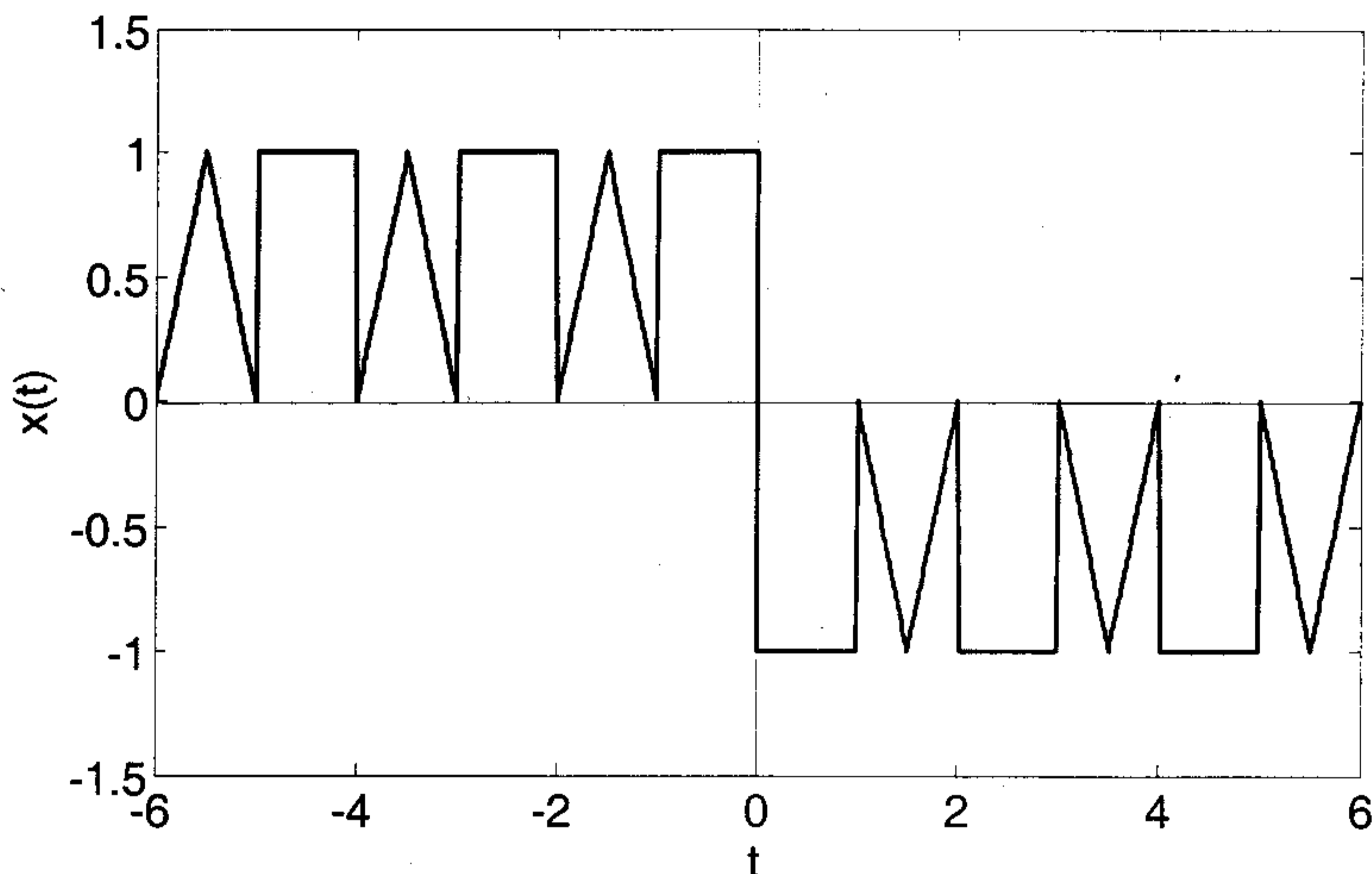
Consider the discrete-time signal x depicted below over three periods:Find both the trigonometric and complex exponential Fourier coefficients for this signal.The simpler your final answer is, the more credit you will receive. Clearly indicate your final answers in the space below.

6 points for trig 6 points for complex
 1 point for formula 3 points for period

Name: _____

Problem 8: 9 Points Possible

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



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

3 points 1 point for $\omega_0 = \frac{2\pi}{P}$

- 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 $\angle X_k$?
Write your choices here. Justify your answer.

3 points per choice

1 point if justification incorrect