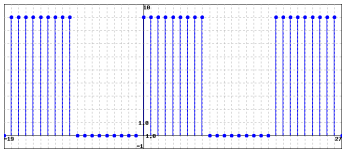
Determine the Fourier series coefficients for each of the following discrete-time periodic signals. For the signal, $x[n]$, shown in the figure below, determine the Fourier coefficients X_k (for $k \neq 0$). Simplify your answer as much as possible.



$X_k =$ ___ e j___ $sin($___$)sin($___$)$

Correct Answers:

- `0.5`
- `k*(-pi/2+pi/18)`
- `k*pi/2`
- `k*pi/18`

JY Note Apr 4, 2020: Explicitly request a specific form for part (b).

A causal discrete-time LTI system is described by the difference equation $y[n] - \frac{1}{9}y[n-1] = 11x[n] + \frac{1}{7}x[n-1]$, where $x[n]$ is the input and $y[n]$ is the output signal.

a) Determine the frequency response, $H(\Omega)$, of the system. *Enter Ω as "O".*

$H(\Omega) =$ ___

b) Find the impulse response, $h[n]$, of the system (enter this as a linear combination of step functions).

$h[n] =$ ___

c) Determine the response of the system, $y[n]$ to the input $x[n] = cos(\frac{n\pi}{9})$.

$y[n] =$ ___

In your answers, enter $z(n)$ for a discrete-time function $z[n]$. WebWork is unable to parse a function that uses square brackets.

Correct Answers:

- `[11+0.142857*2.71828^(-i*O)]/[1-0.111111*2.71828^(-i*O)]`
- `11*0.111111^n*u(n)+0.142857*0.111111^(n-1)*u(n-1)`
- `12.4212*cos(n*pi/9+(-0.0467954))`

Consider an LTI discrete-time system that has impulse response $h[n] = \begin{cases} \frac{sin(\pi(n-10)/4)}{\pi(n-10)} & if \\ n \neq 10 & \\ \frac{1}{4} & if \\ otherwise & \end{cases}$

a) Determine the magnitude $|H(\Omega)|$ and the phase response $\angle H(\Omega)$ for $-\pi < \Omega < \pi$. *Enter Ω as "O" and enter the piecewise function $|H(\Omega)|$ using the heaviside function.*

$|H(\Omega)| =$ ___$\angle H(\Omega) =$ ___

b) Determine the output of the system, $y[n]$, if the input is given by $x[n] = \delta[n-5] + cos(\frac{\pi n}{5})$. Enter your answer in terms of $h[n]$.

$y[n] =$ ___

In your answers, enter $z(n)$ for a discrete-time function $z[n]$. WebWork is unable to parse a function that uses square brackets.

Correct Answers:

- `u(O+pi/4)-u(O-pi/4)`
- `-10*O`
- `h(n-5)+cos(n*pi/5)`

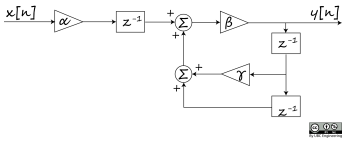
JY Note Mar 31, 2020: Removed ambiguous stipulation that the calculation must be done in the time-domain. I suspect the initial rationale for the remark is that the question was adapted from an exam in which the students were effectively being warned not to leave the answer as a Z-transform.

Consider a discrete-time system that has the impulse response $h[n] = \left(\frac{1}{8}\right)^n u(n)$. Find the response of the system to each of the input signals given in the table below.

	Input signal, $x[n]$	**Output signal,** $y[n]$
1	$e^{j\pi n/2}$	_____
2	$cos(\frac{\pi n}{3} + \frac{pi}{2})$	_____

Correct Answers:

- `2.71828^(i*pi*n/2)/[1-0.125*2.71828^(-i*pi/2)]`
- `[cos(n*pi/3+pi/2)-0.125*cos(n*pi/3+pi/2+pi/3)]/[1.01562-0.`



The block diagram below represents a discrete-time LTI system. Assume $\alpha = 4$, $\beta = -\frac{1}{18}$, $\gamma = 9$.

a) Write the difference equation that describes this system.

_____

b) Find the impulse response of the system (write this as the product of a function with the unit step).

$h[n] =$ _____

c) Evaluate the phase and magnitude of the frequency response of the system at each of the frequencies given in the table below.

Frequency, Ω	$\lvert H(\Omega)\rvert$	$\angle H(\Omega)$ (rad)
0	_____	_____
$\frac{\pi}{4}$	_____	_____
$-\frac{2\pi}{3}$	_____	_____

JY Note Apr 4, 2020: Explicitly note that phase should be entered in radians.

In your answers, enter $z(n)$ for a discrete-time function $z[n]$. WebWork is unable to parse a function that uses square brackets.

Correct Answers:

- `4*x(n-1)+9*y(n-1)+y(n-2) = -18*y(n)`
- `(-1.33333)*(-0.166667)^n*u(n)+1.33333*(-0.333333)^n*u(n)`
- `0.142857`
- `3.14159`
- `0.157155`
- `2.64971`
- `0.271538`
- `-1.53685`

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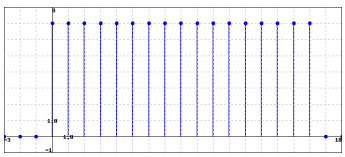
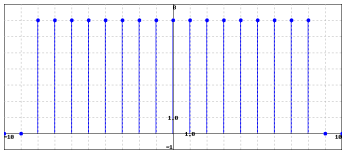
a) Find the Fourier transform of the rectangular pulse sequence, $x_1[n]$, given in the figure below. *Enter Ω as "O".*



$X_1(\Omega) =$ ____

b) Use your answer from part **a** to find the Fourier transform of the rectangular pulse sequence, $x_2[n]$, given in the figure below.



$X_2(\Omega) =$ ____

- ?
- Linearity
- Time-shifting
- Duality
- Reflection
- Modulation

*Part **c** will only be marked correct if part **b** is correct.*

Correct Answers:

- `7*2.71828^(-i*O*8)*sin(O*8.5)/[sin(O/2)]`
- `7*sin(O*8.5)/[sin(O/2)]`
- `Time-shifting`

JY Note Mar 30, 2020: Corrected result from part (d).

The transfer function of a FIR filter is $H(z) = z^{-2}(7.5z + 1.1 + 7.5z^{-1})$.

a) Find the frequency response, $H(\Omega)$ of the system. *Enter Ω as "O".*

$H(\Omega) =$ ____

b) Is the phase response of the system linear? [?/Yes/No]

c) Find the impulse response, $h[n]$, of the system.

$h[n] =$ ____

In your answer, enter $z(n)$ for a discrete-time function $z[n]$ and enter $D(n)$ instead of $\delta[n]$. WebWork is unable to parse a function that uses square brackets.

d) Is the impulse response symmetric in the y-axis? [?/Yes/No]

*Part **b** will only be marked correct if part **a** is correct. Part **d** will only be marked correct if part **c** is correct.*

Correct Answers:

- `2.71828^[(-2i)*O]*[1.1+15*cos(O)]`
- `Yes`
- `7.5*D(n-2+1)+1.1*D(n-2)+7.5*D(n-2-1)`
- `No`