JY Note Apr 13, 2020: Changed notation to avoid any confusion for frequency units (Hz vs rad/s).

Suppose that $x(t)$ is a real signal that has a Nyquist rate $f_N = 30$ Hz. Find the Nyquist rate of each of the signals in the table below.

	Signal, $y(t)$	**Nyquist Rate**
1	$x(t) - x(t-5)$ is not zero for all t	____
2	$\frac{d^3x(t)}{dt^3}$	____
3	$8x^2(t)$	____
4	$x(t)cos(9(2\pi f_N)t)$	____

Correct Answers:

- 30
- 30
- 60
- 570

A periodic signal has a Fourier series representation given by $x(t) = \sum_{k=-\infty}^{\infty} \sqrt{0.1^{|k|}} e^{jkt}$

a) Is this signal band-limited? [?/Yes/No]

b) Find the power, P_x, of the signal.

$P_x =$ ___

c) Now suppose that the signal is approximated by $\hat{x}(t) = \sum_{k=-N}^{N} \sqrt{0.1^{|k|}} e^{jkt}$ by using only $2N+1$ terms instead. Find the minimum N such that $\hat{x}(t)$ has 90% of the original signal's power, P_x.

$N =$ ___

d) Using the N you found in part **c**, determine the maximum sampling period that can be used to sample $\hat{x}(t)$ without aliasing.

$(T_s)_{max} =$ ___

Correct Answers:

- No
- 1.22222
- 1
- pi/1

Consider the causal exponential signal $x(t) = 8e^{-3t}u(t)$.

a) Determine the frequency, ω_M for which the energy of $x(t)$ corresponds to 99% of its total energy.

$\omega_M =$ ___

b) Is $x(t)$ band-limited? [?/Yes/No]

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

Correct Answers:

- 3*tan(0.99*pi/2)
- No

JY Note Mar 11, 2020: Minor code change to avoid some students having phase shifts of $\pi/2$ (which results in trivial answers).

JY Note, Mar 9, 2020: Explicit request added for the sampled signal to be expressed as the simplest discrete-time sinusoid.

JY Note, Mar 3, 2020: Due to an initial programming error, some students were given two (of the three) sampling periods that were identical, resulting in an erroneous table. I believe that this has been corrected now though the reprogramming may have resulted in you having different numbers now (apologies for any inconvenience). Thank you to the student who alerted me to this problem. The number of attempts for this question has been increased by 10.

Consider the signal $x(t) = 7cos(2\pi t + \pi/3)$. Determine if the signal is band-limited or not. Then for each of sampling periods $T_s = 0.4$, 0.5 and 1 sec/sample, determine if the Nyquist condition is satisfied, if the sampled signal is aliased, give the expression for the sampled signal, $x_s[n]$, as the simplest discrete-time sinusoid to be used for ideal reconstruction and determine its period.

Sampling Period, T_s	**Nyquist condition satisfied?**	**Signal Aliased?**
0.4	[?/Yes/No]	[?/Yes/No]
0.5	[?/Yes/No]	[?/Yes/No]
1	[?/Yes/No]	[?/Yes/No]

Correct Answers:

- Yes
- No
- 7*cos(2*pi*0.4*n+pi/3)
- 5

- No
- No
- 7*cos(pi/3)*cos(pi*n)
- 2
- No
- Yes
- 7*cos(pi/3)
- 1

A continuous-time signal, $x(t) = 9cos(37\pi t) + 9sin(38\pi t) + 4cos(44\pi t + \pi/9)$ is sampled at 38 Hertz. Determine the signal $\omega(t)$, reconstructed using an ideal interpolator with sampling rate $T = (1/38)\ s$.

$\omega(t) =$ _____

Correct Answers:

- 9*cos(37*pi*t)+4*cos(32*pi*t-pi/9)

For each of the signals given in the table below, determine whether or not it is periodic and find its period if it is. If the signal is aperiodic, enter *NA* for its period.

	Signal, $x[n]$	**Periodic/Aperiodic**	**Period**
1	$cos\left(\frac{\pi n}{2}\right)cos\left(\frac{\pi n}{4}\right)$	[?/Periodic/Aperiodic]	_____
2	$4cos\left(\frac{\pi n}{12}\right) - sin\left(\frac{\pi n}{24}\right) + 8cos\left(\frac{\pi n}{6} - \frac{\pi}{2}\right)$	[?/Periodic/Aperiodic]	_____
3	$6 + cos\left(\frac{\pi n^2}{10}\right)$	[?/Periodic/Aperiodic]	_____
4	$5e^{j(n-7)/7}$	[?/Periodic/Aperiodic]	_____
5	$-16cos(7n) + 1sin(2\pi n) - cos(3n)$	[?/Periodic/Aperiodic]	_____
6	$-6e^{j\pi(n-7)/7}$	[?/Periodic/Aperiodic]	_____

Correct Answers:

- Periodic
- 8
- Periodic
- 48
- Periodic
- 10
- Aperiodic
- NA
- Aperiodic
- NA
- Periodic
- 14

Given the following discrete-time signals, compute their energy and power. If either is infinite, enter "INF".

	Signal, $x[n]$	**Energy**	**Power**
1	$3\left(\frac{1}{2}\right)^n u[n]$	_____	_____
2	$13e^{j10n}u[n]$	_____	_____

Correct Answers:

- 12
- 0
- infinity
- 84.5