PROBLEM SPR-04-Q.2.1:

A periodic signal $x(t)$ is represented as a Fourier series of the form

$$x(t) = \sum_{k=-\infty}^{\infty} (-j3k - 3\delta[k])\, e^{j400\pi kt}$$

(a) Determine the fundamental period of the signal $x(t)$, i.e., the minimum period.

$T_0 =$ sec. (Give a numerical answer.)

(b) Determine the DC value of $x(t)$. Give your answer as a number.

$DC =$

(c) Define a new signal by adding a sinusoid to $x(t)$

$$y(t) = 5\cos(800\pi t) + x(t)$$

The new signal, $y(t)$ can be expressed in the following Fourier Series with new coefficients $\{b_k\}$:

$$y(t) = \sum_{k=-\infty}^{\infty} b_k\, e^{j400\pi kt}$$

Fill in the following table, giving *numerical values* for each $\{b_k\}$ in polar form:.
Hint: Find a simple relationship between $\{b_k\}$ and $\{a_k\}$.

b_k	Mag	Phase
b_{-3}		
b_{-2}		
b_{-1}		
b_0		
b_1		
b_2		
b_3		

PROBLEM SPR-04-Q.2.2:

For each short question, pick a correct frequency[3] (from the list on the right only) and enter the number in the answer box[4]:

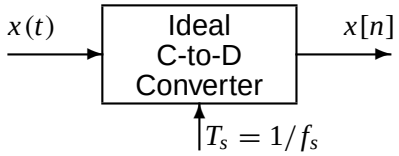
Question

(a) Determine the Nyquist rate for sampling the signal $x(t)$ defined by: $x(t) = \Re e\{e^{j4000\pi t} + e^{j3000\pi t}\}$.

ANS =

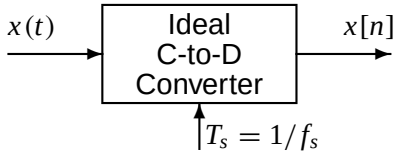
(b) If the C/D converter output is $x[n] = 1000\cos(0.25\pi n)$, when the input signal is defined by: $x(t) = 1000\cos(1800\pi t)$, then determine one possible value for the sampling frequency of the ideal C-to-D converter:

ANS =



(c) If the C/D converter output is $x[n] = 1000\cos(0.25\pi n)$, and the sampling rate is 8000 samples/sec, then determine one possible value for the input frequency of $x(t)$:

ANS =



Frequency

400 Hz

500 Hz

800 Hz

1000 Hz

1200 Hz

1600 Hz

2000 Hz

4000 Hz

8000 Hz

[3] Some questions might have more than one answer, but you only need to pick one correct answer.

[4] It is possible to use an answer more than once.

PROBLEM SPR-04-Q.2.3:

Pick the correct output signal (from the list on the right) and enter the number in the answer box:

System Description and Input Signal

(a) $x[n] = \delta[n-3]$
and $y[n] = x[n] - x[n-2]$

ANS =

(b) $x[n] = \sqrt{3}\sin(2\pi n/3)$
and $y[n] = x[n-1] - x[n-3]$

ANS =

(c) $y[n] = \cos(\pi n/2) * (u[n] - u[n-4])$

ANS =

(d) $x[n] = \delta[n-2]$
and $h[n] = \delta[n-1]$

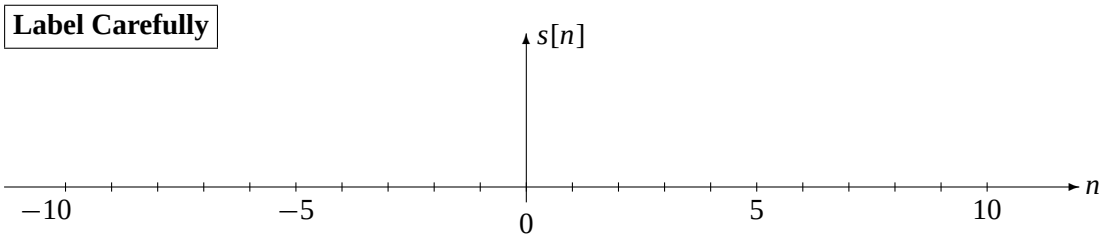
ANS =

(e) `yy=conv([1,1],[0,1,-1,0,0,0])`

ANS =

(f) Plot the signal $s[n] = u[n-4] - u[n+3]$.

Label Carefully



Output Signal

1 $y[n] = 3$ for all n

2 $y[n] = 0$ for all n

3 $y[n] = \delta[n-3]$

4 $y[n] = \delta[n-3] - \delta[n-5]$

5 $y[n] = 3\sin(2\pi n/3 - 5\pi/6)$ for all n

6 $y[n] = \delta[n-2] - \delta[n-4]$

7 $y[n] = \delta[n-1] - \delta[n-3]$

8 None of the above

PROBLEM SPR-04-Q.2.4:

Pick the correct frequency response (from the list on the right) and enter the number in the answer box:

Time-Domain Description

(a) $y[n] = x[n] - x[n-2]$

ANS =

(b) $h[n] = u[n] - u[n-4]$

ANS =

(c) $y[n] = x[n-1] - x[n-3]$

ANS =

(d) $h[n] = \delta[n-1]$

ANS =

(e) $\{b_k\} = \{\,1,\ 1,\ 1\,\}$

ANS =

(f) Select **all** systems (from the list on the right) that **null out** $(-1)^n$. Enter all numbers that apply.

ANS =

Frequency Response

1 $H(e^{j\hat{\omega}}) = e^{-j\hat{\omega}}(1 + 2\cos(\hat{\omega}))$

2 $H(e^{j\hat{\omega}}) = \dfrac{\sin(2\hat{\omega})}{\sin(\frac{1}{2}\hat{\omega})}\, e^{-j3\hat{\omega}/2}$

3 $H(e^{j\hat{\omega}}) = e^{-j\hat{\omega}}$

4 $H(e^{j\hat{\omega}}) = 1 - e^{-j2\hat{\omega}}$

5 $H(e^{j\hat{\omega}}) = 2je^{-j2\hat{\omega}}\sin(\hat{\omega})$

6 $H(e^{j\hat{\omega}}) = 2e^{-j2\hat{\omega}}\cos(\hat{\omega})$

7 $H(e^{j\hat{\omega}}) = \dfrac{\sin(\hat{\omega})}{\sin(\frac{1}{2}\hat{\omega})}\, e^{-j\hat{\omega}/2}$

8 None of the above