**PROBLEM Spring-04-Q.2.1:**
A periodic signal $x(t)$ is represented as a Fourier series of the form

$$x(t) = \sum_{k=-\infty}^{\infty} \left(\delta[k] - 2k^2 + 1\right) e^{j50\pi kt}$$

(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 $x(t)$

$$y(t) = 14\cos(100\pi t + \pi/2) + x(t)$$

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

$$y(t) = \sum_{k=-\infty}^{\infty} b_k e^{j50\pi kt}$$

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 |
|---|---|---|
| $b_{-3}$ | | |
| $b_{-2}$ | | |
| $b_{-1}$ | | |
| $b_0$ | | |
| $b_1$ | | |
| $b_2$ | | |
| $b_3$ | | |

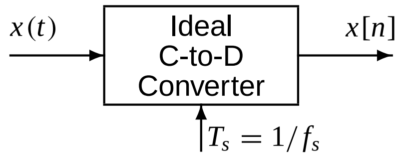
## PROBLEM Spring-04-Q.2.2:

For each short question, pick a correct frequency[5] (from the list on the right only) and enter the number in the answer box[6]:

**Question**

(a) If the C/D converter output is $x[n] = A\cos(0.75\pi n)$, when the input signal is defined by: $x(t) = A\cos(1900\pi t)$, then determine one possible value for the sampling frequency of the ideal C-to-D converter:

**ANS =**

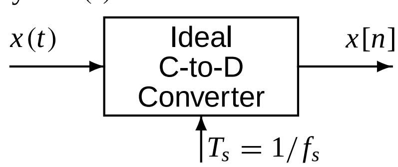



(b) Determine the Nyquist rate for sampling the signal $x(t)$ defined by: $x(t) = \Re e\{e^{j2000\pi t} + e^{j1500\pi t}\}$.

**ANS =**

(c) If the C/D converter output is $x[n] = A\cos(0.75\pi n)$, and the sampling rate is 4000 samples/sec, then determine one possible value for the input frequency of $x(t)$:

**ANS =**




**Frequency**

4000 Hz

2000 Hz

1500 Hz

800 Hz

600 Hz

500 Hz

400 Hz

250 Hz

200 Hz

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

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

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

**ANS =**

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

**ANS =**

(c) $y[n] = (\delta[n-1] - \delta[n-2]) * (\delta[n] + \delta[n-1])$

**ANS =**

(d) $x[n] = \sqrt{3}\sin(2\pi n/3)$

and $y[n] = x[n-1] - x[n-3]$

**ANS =**

(e) $x[n] = \delta[n-3]$

and $y[n] = x[n] - x[n-2]$

**ANS =**

**Output Signal**

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

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

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

**4** $y[n] = \delta[n-1] - \delta[n-3]$

**5** $y[n] = \delta[n-2] - \delta[n-4]$

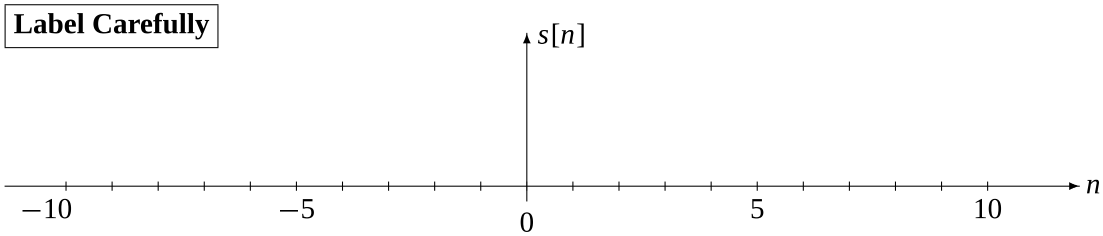
**6** $y[n] = 3\sin(2\pi n/3 - 5\pi/6)$ for all $n$

**7** $y[n] = \delta[n-3] - \delta[n-5]$

**8** None of the above

(f) Plot the signal $s[n] = \delta[n+2] - u[n-2]$.

**Label Carefully**



## PROBLEM Spring-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) $y[n] = \sum_{k=0}^{3} x[n-k]$

**ANS =**

(b) $h[n] = \delta[n] + \delta[n-1] + \delta[n-2]$

**ANS =**

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

**ANS =**

(d) $\{b_k\} = \{0,\ 1,\ 0,\ -1\}$

**ANS =**

(e) $\{b_k\} = \{1,\ 0,\ -1\}$

**ANS =**

(f) Select **all** systems (from the list on the right) that **null out** $\cos(0.5\pi n)$. Enter all numbers that apply.

**ANS =**

**Frequency Response**

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

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

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

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

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

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

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

**8** None of the above