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NPTEL

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Courses » Mathematical Methods and Techniques in Signal Processing

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# Week 5 - Sampling Theorem and Multirate Systems - I

Register for Certification exam

## Course outline



## Assignment 05

**The due date for submitting this assignment has passed.**
**As per our records you have not submitted this assignment.** **Due on 2019-03-06, 23:55 IST.**

**Instructions:**

1. **Attempt all questions.**
2. **Submission deadline**: 6th March 2019 23:55 IST
3. **Solutions to be posted**: 7th March 2019
4. Older browsers might show **unnecessary vertical bars** at the end of math equations

1) A baseband signal $s\left(t\right)$ with 150Hz bandwidth is sampled at a rate of $F_s$. The resultant signal is upsampled by a factor 2 and then downsampled by a factor 16 to obtain the discrete samples $\hat{s}\left[n\right]$. What is the largest lower bound on $F_s$ in Hz to reconstruct back the signal $s\left(t\right)$ from the samples $\hat{s}\left[n\right]$?

No, the answer is incorrect.
Score: 0

**Accepted Answers:**
*(Type: Numeric) 2400*

***1 point***

2) (True/False) A signal is known to have frequency response such that $X\left(z\right)=X\left(-z\right)$. The signal can be reconstructed after decimation by factor 2. ***1 point***

- True
- False

No, the answer is incorrect.
Score: 0

**Accepted Answers:**
*True*

$\frac{1}{4}E_s$

Cannot comment

**No, the answer is incorrect.**
**Score: 0**

**Accepted Answers:**
$E_s$

4) Let $s[n]$ be any discrete-time signal with energy $E_s$. The signal is downsampled by 2. What is the energy of the resultant signal if there is no aliasing after decimation? ***1.5 points***

$E_s$

$\frac{1}{2}E_s$

$\frac{1}{4}E_s$

Cannot comment

**No, the answer is incorrect.**
**Score: 0**

**Accepted Answers:**
$\frac{1}{2}E_s$

5) A band limited signal $s(t)$ has the frequency response as follows and is sampled at a rate $F_s$ Hz. For what values of $F_s$ is the reconstruction of original signal $s(t)$ possible? ***1.5 points***

- 40 Hz
- 50 Hz
- 70 Hz
- 150 Hz

**No, the answer is incorrect.**
**Score: 0**

**Accepted Answers:**
*50 Hz*
*70 Hz*
*150 Hz*

6) A signal $s[n]$ is downsampled by factor 3. Choose the correct statements. ***2 points***

- The original signal can be recovered if it is bandlimited to $\frac{\pi}{3}$
- The original signal can be recovered always
- The original signal can be recovered if the signal $s[n]$ has non-zero entries only for $n = 6k, k \in \mathbb{Z}$
- None of the above are correct.

**No, the answer is incorrect.**
**Score: 0**

**Accepted Answers:**

*The original signal can be recovered if it is bandlimited to* $\frac{\pi}{3}$

*The original signal can be recovered if the signal* $s[n]$ *has non-zero entries only for* $n = 6k,\ k \in \mathbb{Z}$

7) A signal $s\,(t)$ with bandwidth 100 Hz is amplitude modulated to 100 Hz carrier frequency. What is the Nyquist sampling rate of the modulated signal in Hz?

(A signal $s(t)$ modulated to carrier frequency $F_c$ is given by $s(t)\cos(2\pi F_c t)$)

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

*(Type: Numeric) 400*

***2 points***

8) The frequency response of a downsampled signal is given as follows: ***2 points***

Which among the following can be the frequency response of the original signal before downsampling?

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

9) A student has system A and system B which are 2-fold decimator and 2-fold expander respectively. He has to observe and report the output of the overall system, where the input signal $x(n)$ is passed through system A followed by system B. By mistake, the student exchanges the systems A and B. For which of the following inputs, will he not obtain the desired output? ***2.5 points***

$$x(n) = \begin{cases} n & (n-k) \bmod 4 = 0, \ \text{ for some constant } k \\ 0 & \text{else.} \end{cases}$$

$$x(n) = \delta(n)$$

$$x(n) = u(n)$$

$$x(n) = \begin{cases} n & n \bmod 3 = 0 \\ 0 & \text{else.} \end{cases}$$

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

$$x(n) = \begin{cases} n & (n-k) \bmod 4 = 0, \ \text{ for some constant } k \\ 0 & \text{else.} \end{cases}$$

$$x(n) = u(n)$$

$$x(n) = \begin{cases} n & n \bmod 3 = 0 \\ 0 & \text{else.} \end{cases}$$

10) The signal $s\,(t) = \begin{cases} 1-|t| & -1 \le t \le 1 \\ 0 & \text{otherwise,} \end{cases}$ is passed through a system to obtain the

output $\hat{s}(t)$. The system has a resonant frequency of $\frac{2}{3}$ Hz and hence allows only frequencies of $\frac{2}{3}$ Hz and its harmonics along with the d.c. component. What is the value of $8\int_{-1}^{1}|\hat{s}(t)|^2 dt$?

No, the answer is incorrect.
Score: 0

**Accepted Answers:**
*(Type: Numeric) 15*

***2.5 points***

11) Consider the following system with input $X(z)$ and output $Y(z)$. ***3 points***

Let the input to the system be $X(z)=\frac{1}{1-z^{-1}}$. Which of the following statements are true?

- $y[n]=\delta[n]$
- The system is non-LTI
- The overall impulse response of the system is $1-z^{-1}$
- The overall impulse response of the system is $1-z^{-2}$

No, the answer is incorrect.
Score: 0

**Accepted Answers:**
$y[n]=\delta[n]$
The system is non-LTI
*The overall impulse response of the system is* $1-z^{-2}$

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