Sample Set 1 MID-SEMESTER TEST

MULTIPLE CHOICE QUESTIONS

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1. What is the signal processing unit, A in Figure A1.

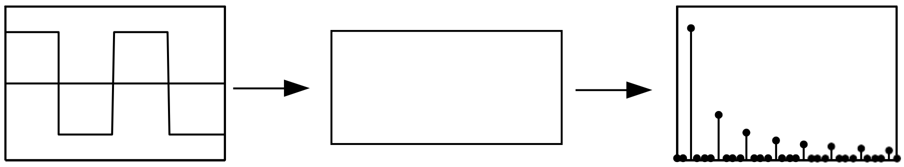


Figure A1

(a) Low pass filter
(b) Modulator
(c) Rectifier
(d) Fourier Transform

2. What is the purpose of sampling?

(a) Convert a continuous-time analog signal to a discrete time signal
(b) Convert a discrete time signal to a continuous-time analog signal
(c) Convert a continuous-time analog signal to a higher frequency continuous analog signal
(d) Convert a discrete time signal to a continuous-time digital signal

3. The first two samples of a discrete time signal $x(n) = \cos(0.5\pi\, n)u(n) + 2\sin(0.5\pi\, n)\,\delta(n-1)$ are :

(a) {0}
(b) {2.0000, 0.7071}
(c) {1, 2}
(d) {2, 1}

4. If aliasing occurs, what is the most likely result?

(a) Signal distortion
(b) Signal amplitude amplification
(c) Signal amplitude reduction
(d) No changes to the signal

5. A square wave having period T = 1 ms, is filtered by an ideal low pass filter having cutoff frequency f_c = 4 kHz. What are the frequency components at the output of the low pass filter?

(a) 1 kHz and 10 kHz.
(b) 1 kHz and 4 kHz.
(c) 1 kHz and 3 kHz.
(d) 0.1 kHz

6. A signal consisting of 2 kHz, 3 kHz and 6 kHz frequency components is sampled at 10 kHz. After sampling, what frequency components are there between 0 and 5 kHz?

(a) 2 kHz, 5 kHz, 7 kHz
(b) 2 kHz, 3 kHz, 4 kHz
(c) 2 kHz, 3 kHz, 5 kHz, 6 kHz
(d) 2 kHz, 5 kHz, 8 kHz

7. Spectrum of a continuous signal, x(t) , shown in Figure A7. What is the proper sampling frequency for this signal?

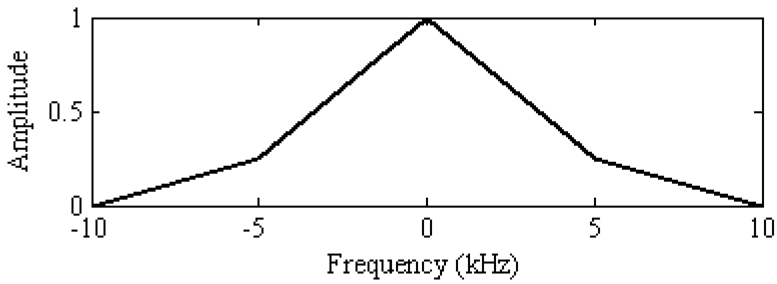


Figure A7

(a) f_s = - 4 kHz
(b) f_s = 4 kHz
(c) f_s = - 2 kHz
(d) f_s = + 20 kHz

8. A system is described by the following equation: y(n) = δ(n-1) – x(n-3). What is the output if x(n) = δ(n)?

(a) {0, 0, 1, 1}
(b) {0, 1, 0, -1}
(c) {1, 0, 0, -1}
(d) {1, 1, -1, -1}

9. A 6 kHz wave is sampled at 18 kHz. How many samples are there in one cycle?

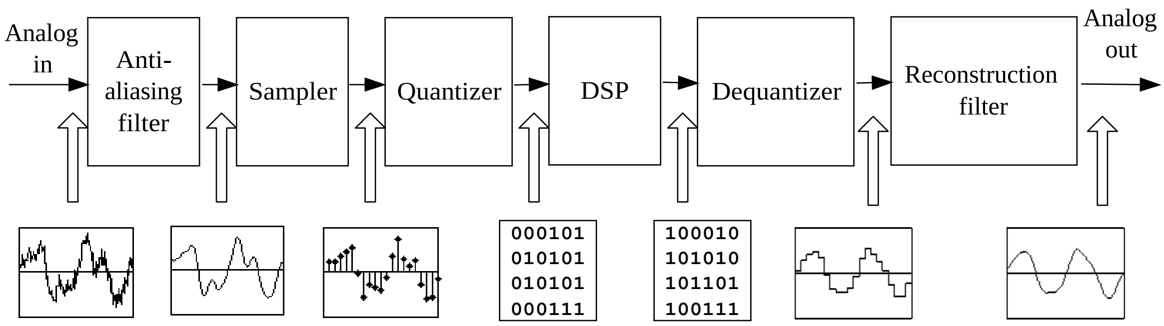
(a) 2
(b) 3
(c) 4
(d) 5

10. The output of the reconstruction filter is a

(a) continuous-time and continuous-amplitude signal.
(b) continuous-time and discrete-amplitude signal.
(c) discrete-time and continuous-amplitude signal.
(d) discrete-time and discrete-amplitude signal.

SECTION B

B1 A typical DSP system is shown below.



(a) What are functions of Quantizer and Reconstruction filter?

(b) Given the sampling frequency is 10kHz, signal x(n) is composed of three sine wave:

$$x(n)= \cos(0.1\pi n)+2\sin(0.25\pi n)+\sin(0.3\pi n)$$

(i) Find the magnitude of the first two samples, x(0) and x(1).

(ii) Derive the equation for the continuous time signal x(t).

(iii) If the signal x(n) is applied to a high pass filter of 1.3 kHz, what will be frequency at the output of the high pass filter.

B2 A digital signal system is described by the difference equation

$$y(n) = 0.9\, y(n-2) + x(n-1)$$

<u>Assume that</u> $y(n) = 0$ when $n < 0$,

(a) Compute the system impulse response, h(n) for a given input signal $x(n) = \delta(n)$ for n = 0,1,2,3.

(b) Sketch the equivalent digital network for this system.

(c) Is this system stable based on the system impulse response?

B3 Answer the following short questions. Please note that the questions are not related to each other.

(a) Given a sequence,

$$x(n) = \{1,2,3,4,5,6,7\}$$

Find $x_1(n) = 2x(n-2)+x(n)$ and $x_2(n) = x(3n)+x(n-2)$

(b) Given the signal, $y(n) = 2^{0.1n} \sin(0.1\pi n)$, plot the first 4 signal samples and indicate their amplitude values.

B4 Given a special device that transmits a signal, $x_1(n) = \delta(n) + 2\delta(n-2) + 3\delta(n-3)$ and and $x_2(n) = u(n) - u(n-2)$.

(a) Determine the convolution of $x_1(n) * x_2(n)$.

(b) Find the cross-correlation of $y(n) = x_1(n) \otimes x_2(n)$ where '$\otimes$' denotes <u>**cross correlation**</u>?

(c) Evaluate the autocorrelation of $x_1(n)$.

END OF PAPER

Appendix

The z-transform is defined as $X(z) = \sum_{n=-\infty}^{\infty} x[n]z^{-n}$

Sequence	Transform
$\delta[n]$	1
$u[n]$	$\frac{1}{1 - z^{-1}}$
$\delta[n - m]$	z^{-m}
$a^n u[n]$	$\frac{1}{1 - az^{-1}}$
$na^n u[n]$	$\frac{az^{-1}}{(1 - az^{-1})^2}$
$[\cos \omega_0 n]u[n]$	$\frac{1 - [\cos\omega_0]z^{-1}}{1 - [2\cos\omega_0]z^{-1} + z^{-2}}$
$[\sin \omega_0 n]u[n]$	$\frac{[\sin \omega_0]z^{-1}}{1 - [2\cos \omega_0]z^{-1} + z^{-2}}$
$[r^n \cos \omega_0 n]u[n]$	$\frac{1 - [r\cos \omega_0]z^{-1}}{1 - [2r\cos \omega_0]z^{-1} + r^2 z^{-2}}$
$[r^n \sin \omega_0 n]u[n]$	$\frac{[r\sin \omega_0]z^{-1}}{1 - [2r\cos \omega_0]z^{-1} + r^2 z^{-2}}$

Some z-transform properties:	
Sequence	Transform
$x[n]$ $x_1[n]$ $x_2[n]$	$X(z)$ $X_1(z)$ $X_2(z)$
$ax_1[n] + bx_2[n]$	$aX_1(z) + bX_2(z)$
$x[n - m]$	$z^{-m}X(z)$