Sample Set 2 MID-SEMESTER TEST

A1 The discrete impulse function is defined by

(a) $\delta(n) = 1, n = 0$
$= 0, n \neq 0$
(b) $\delta(n) = 1, n = 0$
$= 0, n \neq 1$
(c) $\delta(n) = 1, n = 1$
$= 0, n \neq 1$
(d) $\delta(n) = 1, n = 0$
$= 1, n \neq 1$

A2 A sinusoidal signal with unknown frequency is sampled at 16000 samples per second. If there is no aliasing distortion and the magnitude spectrum of an unknown sinusoidal signal is given below, what is the value of the unknown frequency?

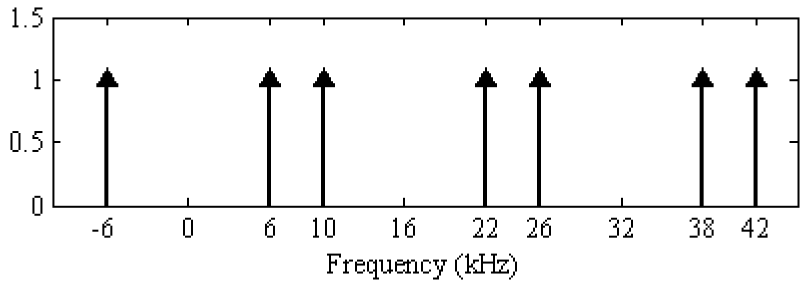


Figure A2: Magnitude spectrum of an unknown sinusoidal signal

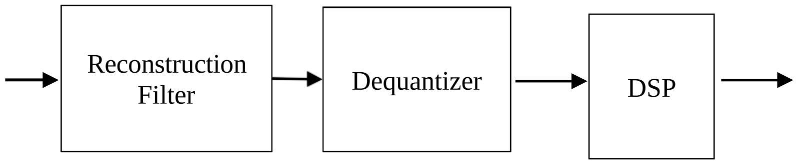
(a) 6 kHz.
(b) 10 kHz.
(c) 22 kHz.
(d) 24 kHz.

A3. Let $x(n) = \{1, -2, 4, 6, -5, 8, 10\}$ and $y(n) = 3x(n - 2) + x(n - 4) - 2x(n)$. Find the values of y(n).

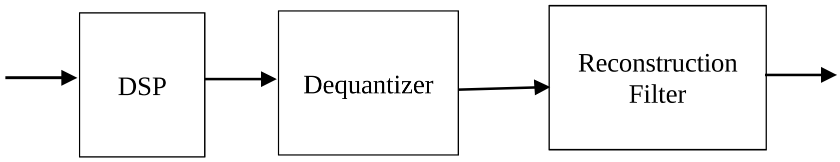
(a) { -2 4 -5 -17 20 6 -29 19 38 10}
(b) { -2 4 -5 -17 20 6 -29 19 38 1}
(c) { -2 4 -5 -17 20 6 -29 19 38 0}
(d) { 0 -2 4 -5 -17 20 6 -29 19 38}

A4 Which one of the following diagrams correctly identifies the last three functional blocks of a typical DSP system?

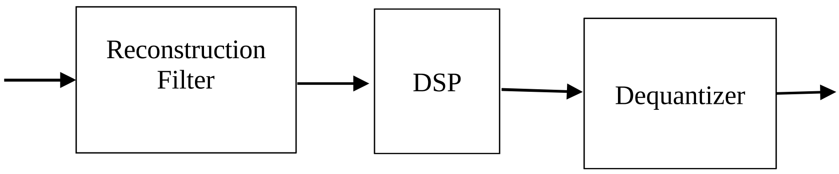
(a)



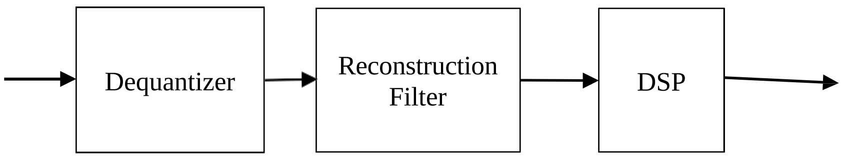
(b)



(c)



(d)



A5. The most suitable cut-off frequency for a reconstruction filter is:

(a) Equal to the lowest spectral component of the original signal
(b) Equal to twice the cut-off frequency of the anti-aliasing filter
(c) Equal to half the sampling frequency
(d) Equal to twice the highest spectral component of the original signal

A6. If the input voltage range of an ADC is doubled, how can the quantization error be kept nearly constant?

(a) By halving the number of quantization levels
(b) By increasing the sampling frequency
(c) By increasing the word length of the ADC by one bit
(d) By changing the cut-off frequency of the anti-aliasing filter

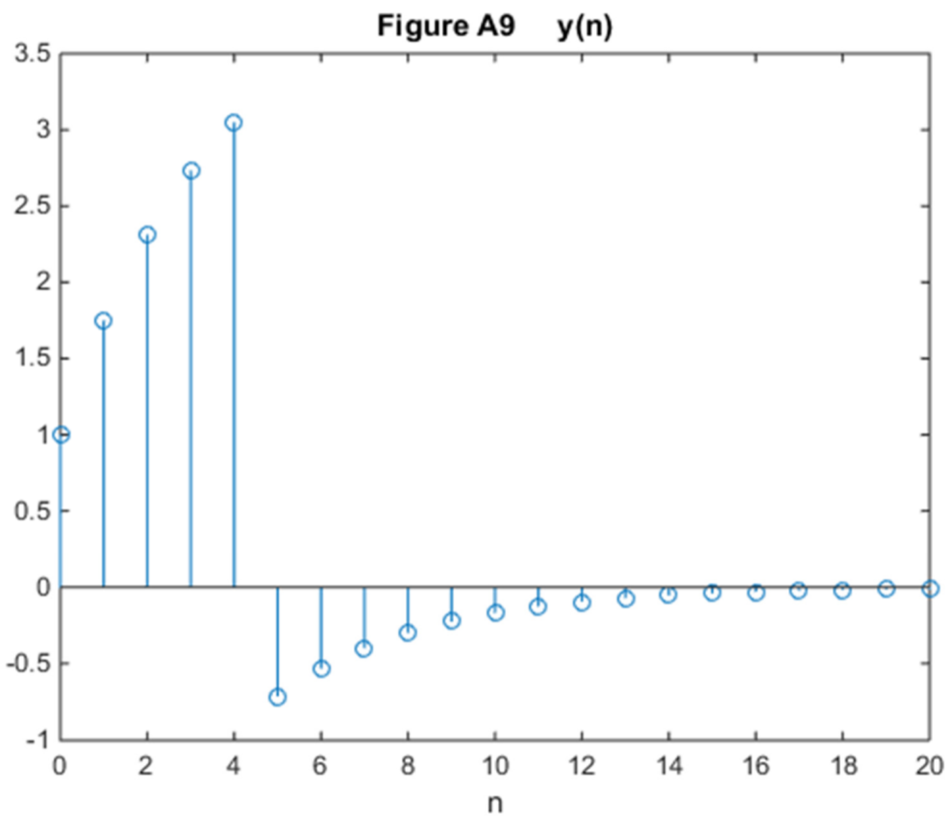
A7. Calculate the autocorrelation of $x_1(n) = [1, 0, -1]$.

(a) $r_{11}(m) = [-1, 0, 2, 1, -1]$
(b) $r_{11}(m) = [-1, 0, 2, 0, -1]$
(c) $r_{11}(m) = [-1, 1, 2, 1, -1]$
(d) $r_{11}(m) = [-1, 1, 2, 0, -1]$

A8. Given $y(n) = 9\,x(n)$ where $y(n)$ is the output of a system and $x(n)$ is the input to the system. This is a

(a) linear and time-invariant (LTI) system
(b) time-invariant but not linear system
(c) linear but not time-invariant system
(d) non-linear and not time-invariant system

A9. Given the following figure A9, what is the $y(n)$ sequence?



(a) $y(n) = 4\,u(n) - 4\,u(n-5) - 3\,(3/4)^n\,u(n)$
(b) $y(n) = 4\,u(n) - 4\,u(n-5)$
(c) $y(n) = 4\,u(n) - 3\,(3/4)^n\,u(n)$
(d) none of the above

A10. Consider the following analog sinusoidal signal, $x(t) = 3\sin(100\pi t) + 6\cos(200\pi t)$. The signal $x(t)$ is sampled at $f_s = 500$ samples/sec, determine the discrete time sequence, $x(n)$.

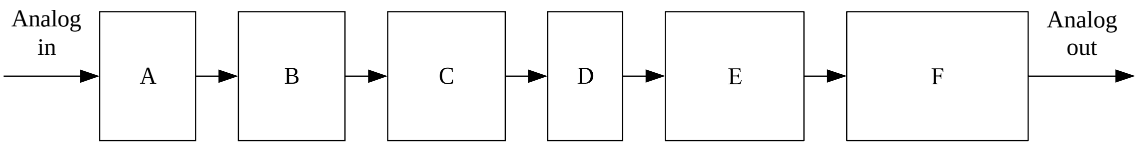
(a) $x(n) = 3\sin(0.2\pi n) + 4\cos(0.4\pi n)$
(b) $x(n) = 3\sin(0.2\pi n) + 6\cos(0.4\pi n)$
(c) $x(n) = 3\sin(0.4\pi n) + 6\cos(0.2\pi n)$
(d) $x(n) = 3\sin(0.02\pi n) + 4\cos(0.04\pi n)$

SECTION B

B1 Answer the following short questions. Please note that the questions are not related to each other.

(a) (i) Define Sampling and Quantization.

(ii) Identify the functional blocks: A, B, C and D.



(b) Plot the signal x(n) = 5u(n) - u(n − 30) + δ(n-3) for $0 \le n \le 4$. Calculate sample value to four decimal places.

B2 The difference equation of a digital system is given as

y(n) = 4y(n-1) - 4y(n-2)+x(n) + x(n-2)

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

(a) Compute the systems impulse response 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) Based on the impulse response, what can you conclude about the stability of this system?

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

(a) The impulse response of the system, h(n) = [2, 1, 3]. Find the input x(n) to the system if the response is y(n) = [2, 5, 11, 9, 9].

Hint:

$$x(0) = \frac{y(0)}{h(0)}$$

$$x(n) = \frac{y(n) - \sum_{k=1}^{n} h(k)x(n-k)}{h(0)}$$ assuming that $h(0) \neq 0$.

(b) Determine the convolution $y(n) = x(n) * h(n)$, given x(n)=[1, 1, 0, 1,1] and

h(n)=[1,-2,-3,4].

(c) Given x1(n)=x2(n)=h1(n)=h2(n)=[1, 1], find y(n)= [h1(n)+h2(n)]*x1(n)*x2(n)

B4 An exponential signal, $x(t) = 4te^{-t}$, is sampled at a frequency of 10 Hz, beginning at time t=0.

(a) Express the sampled sequence, x[n], up to the fifth term.

(b) If the signal were delayed by 0.2 s, what would now be the first five terms?

(c) Determine the resulting sequence by adding x[n] and the delayed sequence of (b) above.

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

Some z-transform properties:

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