M.TECH/ECE/1st SEM/ECEN 5102/2017
ADVANCED DIGITAL SIGNAL PPROCESSING
(ECEN 5102)

Time Allotted: 3 hrs   **Full Marks: 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and

Any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1=10**

   (i)   Linear Phase system have a constant _____
         (a) phase   (b) group Delay
         (c) magnitude   (d) phase and magnitude.

   (ii) The z-transform of $\delta(n-m)$ is
         (a) z^{-n} (b) $1/(z-n)$
         (c) z^{-m} (d) $1/(z-m)$.

   (iii) A system characterized by the system function $H(z) = \frac{1}{2}(1+ z^{-1})$ is a
         (a) low pass filter   (b) high pass filter
         (c) band pass filter   (d) band stop filter.

   (iv) Number of multiplication in FFT algorithm is
         (a) $n\log(n)$ (b) $n/2*\log(n/2)$
         (c) $n/2*\log(n)$ (d) $n*\log(n/2)$.

   (v)   Why 16 point DFT is preferable than 4 point DFT?
         (a) Resolution of spectrum is poor for 4 point DFT then 16 point DFT
         (b) Resolution of spectrum is high but not reliable in 4 point DFT
         (c) Calculation of 4 point DFT is more complex
         (d) None of these.

   (vi) The algorithm used to compute any set of equally spaced of fourier transform on the unit circle is
         (a) DFT algorithm   (b) goertzel algorithm
         (c) FFT algorithm   (d) chirp transform algorithm.

   (vii) As the length of window increases in designing a FIR filter, the width of main lobe _____ .
         (a) does not change   (b) is Zero
         (c) increases   (d) decreases.

   (viii) The DFT of the sequence $x(n) = \delta(n-2n_0)$ is
         (a) 1   (b) $e^{j2\pi kno}$
         (c) $e^{-j2\pi kno/N}$ (d) $e^{j2\pi kno/N}$.

   (ix) If $h(n) = -5^n u(-n-1)$ then $H(z)$ is equal to
         (a) $-z/z-5$ (b) $z/z-5$
         (c) $-z^{-1}/z-5$ (d) $z^{-1}/z-5$.

   (x)   Down sampler is usually preceded by a LPF. This combination is called
         (a) decimator
         (b) rational sampling rate converter
         (c) interpolator
         (d) none of these.

Group - B

2. (a) Find the inverse z-transformation of $X(z) = z(z + 1) / (z - 1)(z + 3)$ $|z| > 3$ using
       (i) Partial fraction method
       (ii) Residue method.

   (b) Find Inverse z-transformation of $X(z) = \log(1-az^{-1})$ using differentiation property.

                                              (3 + 4) + 5 = 12

3. (a) A system has unit sample response $h(n)$ given by $h(n) = -1/4\ \delta(n + 1) + 1/2\ \delta(n) -1/4\ \delta(n - 1)$. Is the system BIBO stable? Is the filter causal? Justify your answer.

   (b) Evaluate the step response for LTI system represented by the impulse response $h(n) = (1/2)^n u(n)$.

   (c) A linear time invariant system is described by following difference equation $y(n) = ay(n - 1) + bx(n)$. Determine the magnitude and phase of frequency response $H(w)$ of system.

                                              4 + 4 + 4 = 12

Group - C

4. (a) Proof the circular time shifting property $x((n-l))_N = X(k)\ e^{- j2\pi kl/N}$

(b) Using linear convolution find y(n) = x(n) * h(n)   for the sequence x(n) = {1, 2, -1, 1, 1, 2, -1} and h(n) = {1, 2} and compare the result by solving problem using overlap save method for N = 4 .

(c) Give some applications of Multirate signal processing.

4 + 6 + 2 = 12

5. A linear time invariant system is described by the following difference equation y(n) = ay(n-1) + bx(n)   0< a <1

(i) Determine the magnitude and phase of the frequency response H(w) of the system.

(ii) Choose the parameter b so that the maximum value |H(w)| is unity.

(iii) Determine the output of the system to the input signal
x(n) = 5 + 12 sin (π/2)n

4 + 3 + 5 = 12

Group - D

6. (a) Obtain the direct form 2 realization for the system
y(n) = - 0.1 y(n-1) + 0.2 y(n-2) +3 x(n) + 3.6 x(n-1) + 0.6 x(n-2)

(b) Design an ideal low pass filter with frequency response using fourier series method
$H_d(e^{jw})$ = 1   for - π/2 ≤ w ≤ π/2
      = 0   π/2 ≤ w ≤ π
Find the value of h(n) for N = 11and also H(z) .

2 + 3 + 7 = 12

7. (a) What do you mean by decimator and interpolator? Why up sampler is usually followed by low pass filter?

(b) Consider the system shown below. If M=L, show that the output of two configuration are different.

$$x(n) \rightarrow \boxed{\uparrow L} \rightarrow \boxed{\downarrow M} \rightarrow y_1(n)$$
$$x(n) \rightarrow \boxed{\downarrow M} \rightarrow \boxed{\uparrow L} \rightarrow y_2(n)$$

(b) Develop an expression for output given below.

$$x(n) \rightarrow \boxed{\uparrow 4} \rightarrow \boxed{\downarrow 12} \rightarrow \boxed{\uparrow 3} \rightarrow y_1(n)$$

4 + 4 + 4 = 12

Group - E

8. Write short notes on
(i) Analog wavelet transform
(ii) Bi-orthogonal decomposition

6 + 6 = 12

9. (a) What are the characteristic of adaptive filter? What is the need for adaptivity.

(b) Compare the LMS algorithm with RLS algorithm.

(c) What is the need for adaptive equalization in a digital communication system?

4 + 4 + 4 = 12