ADVANCED DSP AND APPLICATIONS
(ECEN 5202)

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

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and
<u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> 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)   ROC of causal finite duration discrete time signal is
          (a) the entire z plane except z=0   (b) the entire z plane except z=α
          (c) the entire z plane   (d) a ring in z plane

    (ii)   Linear Phase system have a constant
          (a) Phase   (b) Magnitude
          (c) Group Delay   (d) Phase and Magnitude.

    (iii)   A system characterized by the system function
          H(z) = ½(1+ z^{-1}) is a
          (a) low pass filter   (b) band pass filter
          (c) high pass filter   (d) band stop filter.

    (iv)   Which property of periodic signal in DTFS gets completely clarified / identified by the equation x (n – n$_0$)?
          (a) Conjugation   (b) Time Shifting
          (c) Frequency Shifting   (d) Time Reversal.

    (v)   All pass system and minimum phase system constitute
          (a) pole must lie on left plane   (b) minimum phase system
          (c) non-minimum phase system   (d) both must lie on right plane.

    (vi)   What is the possible range of frequency spectrum for discrete time Fourier series (DTFS)?
          (a) 0 to 2π (b) -π to +π
          (c) Both (a) & (b)   (d) None of the above.

    (vii) If x(n) and X(k) are an N-point DFT pair, then X(k+N) = ?
          (a) X(-k)   (b) -X(k)
          (c) X(k)   (d) None of the mentioned.

(viii) Which among the following represent the characteristics of an ideal filter?
(a) Linear phase response   (b) Zero gain in stop band
(c) Constant gain in pass band   (d) All of above.

(ix) Circular shift of an N point is equivalent to?
(a) Circular shift of its periodic extension and its vice versa
(b) Linear shift of its periodic extension and its vice versa
(c) Circular shift of its aperiodic extension and its vice versa
(d) Linear shift of its aperiodic extension and its vice versa.

(x) Which window function is also regarded as 'Raised-cosine window'?
(a) Hamming window   (b) Hanning window
(c) Barlett window   (d) Blackman window.

Group- B

2. (a) Find the inverse z-transformation of $X(z) = z(z+1)/(z-1)(z+3)$ $|z| > 3$ using partial fraction method.   [(CO1)(Analyze/IOCQ)]

(b) Two discrete time signal x(n) and h(n) are both nonzero only for n = 0,1,2 and are zero otherwise. It is given that x(0) =1 , x(1) = 2 , x(2) = 1 and h(0) =1. If y(n) be the linear convolution of x(n) and h(n), then find the value of expression 10 y(3) + y(4) where y(1) =3 and y(2)= 4.   [(CO2)(Analyze/IOCQ)]

6 + 6 = 12

3. (a) Generate the impulse response and frequency response of a discrete time LTI system that has foregoing property, if the input and output are given by;
$x(n) = (\frac{1}{2})^n \, u(n) - \frac{1}{4} (\frac{1}{2})^{n-1} \, u(n-1)$
and $y(n) = (\frac{1}{2})^n \, u(n)$
also find the difference equation relating to x(n) and y(n) that characterizes the system.   [(CO1, CO2)(Evaluate/HOCQ)]

(b) Test the given system for linearity and causality properties; y(n) = x(n). u(n).
     [(CO1,CO2)(Analyse/IOCQ)]

(c) Compare energy and power signals?   [(CO1,CO2)(Analyse/IOCQ)]

6 + 3 + 3 = 12

Group - C

4. (a) Consider a sample sequence $x(n) = \{\begin{smallmatrix} 0 & 3 & 6, 9 & 12 \\ \uparrow & & & \end{smallmatrix}\}$. Using linear interpolation method, increase the sampling rate for L = 2.
     [(CO3)(Create/HOCQ)]

(b) State the need for multi-rate signal processing? Explain with examples?
     [(CO3)(Remember, Understand/LOCQ)]

(c) Explain sampling-rate conversion of bandpass signals?
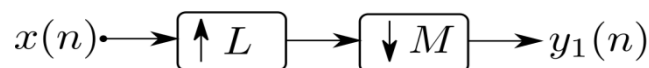   [(CO3)(Understand/LOCQ)]

5 + 4 + 3 = 12

5. (a) State the invertibility of linear time invariant system.

   [(CO2)(Understand/LOCQ)]

   (b) Determine the inverse of the system having impulse response h(n) = δ(n) - δ(n-1).

   [(CO2)(Analyze/IOCQ)]

   (c) What is the input signal x(n) that will generate the output sequence y(n) = {1,5,10,11,8,4,1} for a system having impulse response h(n) ={1,2,1}.

   [(CO2)(Analyze/IOCQ)]

   (d) What do you mean by Homomorphic deconvolution? [(CO2)(Understand/LOCQ)]

   2 + 3 + 5 + 2 = 12

Group - D

6. (a) Why there is a need of windowing technique?   [(CO2)(Remember/LOCQ)]

   (b) Design a filter with using Hamming window with M=7

   $H(e^{jw}) = e^{-3jw}$ $-\pi/4 \le |w| \le \pi/4$

      $= 0$ otherwise.   [(CO2,CO5)(Evaluate/HOCQ)]

   3 + 9 = 12

7. (a) Calculate the result of circular convolution of the following sequences and compare the results with linear convolution:-

   x(n) = {1, 1, 1, 1, -1, -1, -1, -1} and h(n) = {0, 1, 2, 3, 4, 3, 2, 1}

   [(CO4)(Evaluate/HOCQ)]

   (b) Let $x(n) = \sin\frac{n\pi}{2}$. Devise 4-point DFT of the sequence using decimation in time algorithm.   [(CO4)(Evaluate/HOCQ)]

   (c) State the properties of W_N?   [(CO4)(Remember/LOCQ)]

   6 + 4 + 2 = 12

Group – E

8. (a) What do you mean by decimator and interpolator? Why up sampler is usually followed by low pass filter?   [(CO3)(Remember/LOCQ)(Analyze/IOCQ)]

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

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

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

[(CO3)(Evaluate/HOCQ)]

   (c) Develop an expression for output given below.

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

[(CO3)(Analyse/IOCQ)]

4 + 4 + 4 = 12

9. (a) State and describe about Hilbert transformers?

[(CO6)(Remember, Understand/LOCQ)]

(b) Compare between FIR and IIR filters? [(CO5, CO6)(Analyse/IOCQ)]

(c) Summarize the properties of Butterworth lowpass filters and Chebyshev filters?

[(CO5, CO6)(Create/HOCQ)]

4 + 4 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	20.84	39.58	39.58

Course Outcome (CO):

After the completion of the course students will be able to
1. Students will know about the different transforms applied in signal processing.
2. They will have knowledge about LTI systems, Digital filters.
3. The students will know about multi- rate processing, wavelet transforms.
4. They will solve problems on FFT and DFT.
5. The students will know about the comparison of filters. 6. They will be able to apply the knowledge of wavelets.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question