

ADVANCED DSP AND APPLICATIONS
(ECEN 5202)

Time Allotted : 2½ hrs

Full Marks : 60

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 4 (four) from Group B to E, taking one from each group.*

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

Group – A

1. Answer any twelve:

12 × 1 = 12

Choose the correct alternative for the following

- (i) Which of the following is done to convert a continuous time signal into discrete time signal?
(a) Modulating (b) Sampling
(c) Differentiating (d) Integrating.
- (ii) If $W_4^{100} = W_x^{200}$, then what is the value of x??
(a) 2 (b) 4 (c) 8 (d) 16.
- (iii) Linear Phase system has a constant
(a) phase (b) magnitude
(c) phase and magnitude (d) group delay.
- (iv) As the length of window increases in designing a FIR filter, the width of main lobe
(a) does not change (b) increase
(c) is zero (d) decreases.
- (v) The addition of zeros at the end of the sequence when it is represented as the power of integer is refer as
(a) Region of convergence (b) Bilateral transform
(c) Overlap add method (d) Zero padding.
- (vi) Determine the number of complex additions required for 32 points direct computations of DFT.
(a) 240 (b) 56 (c) 854 (d) 992
- (vii) The main lobe width of length M rectangular window is
(a) $\frac{4\pi}{M}$ (b) $\frac{8\pi}{M}$ (c) $\frac{12\pi}{M}$ (d) variable.
- (viii) In DIF-FFT, sequence is decimated in which domain?
(a) Time (b) Frequency
(c) Both (a) and (b) (d) None of the choices are correct.

- (ix) If $x(n) = \{1, 4, 5, 3, 2, 7\}$ is a periodic sequence with periodicity $N=8$,
 \uparrow
 what should be the value of $x(25)$?
 (a) 5 (b) 2 (c) 4 (d) 7.
- (x) The zeros of Butterworth filters exists at
 (a) Infinity (b) Origin
 (c) Left half of s plane (d) Right half of s plane.

Fill in the blanks with the correct word

- (xi) If $W_8^{50} = W_x^{100}$, then what is the value of x is _____.
- (xii) If a sequence $y(n)$ is obtained from the circular convolution of sequence $x(n)$ of length M , and sequence $h(n)$ of length N , the length of the sequence $y(n)$ is _____ (given $M > N$)
- (xiii) In FIR filters _____ is a linear function of frequency.
- (xiv) The N -point DFT of a finite length signal $x(n) = \delta(n)$ is _____.
- (xv) The _____ of $X(z)$ is the set of all values of z , for which $X(z)$ attain the finite value.

Group - B

2. (a) Represent the sequence $x(n) = \{-1, -2, 3, 4, 2, -2, -3, 5, 0, 7\}$ as sum of shifted unit
 \uparrow
 impulses. [[CO1](Understand/LOCQ)]
- (b) Evaluate the convolution of two sequences
 $h(n) = (0.5)^n u(n)$, $x(n) = 3^n u(n)$. [[CO2](Evaluate/HOCQ)]
- (c) Evaluate the (i) autocorrelation of the sequence $x(n) = \{1, 5, 3, 2\}$
 \uparrow
 (ii) cross-correlation of the sequence $x_1(n) = \{2, 3, 4\}$ and $x_2(n) = \{1, 2, 3\}$
 $\uparrow \quad \uparrow$
[[CO1](Evaluate/HOCQ)]
 $2 + 4 + (3 + 3) = 12$
3. (a) A System is described by the difference equation $y(n) = \frac{1}{2} y(n-1) + x(n)$. If the input to the system is $(1/3)^n u(n)$ and the initial condition is $y(-1) = 1$. Determine (i) zero input response (ii) zero state response. [[CO1,CO2](Evaluate/HOCQ)]
- (b) State and prove the convolution property of z transform. [[CO1,CO2](Remember/LOCQ)]
- (c) Find Inverse z-transformation of $X(z) = \log(1 - az^{-1})$ using differentiation property. [[CO1,CO2](Apply/IOCQ)]
 $6 + 3 + 3 = 12$

Group - C

4. (a) Using radix-2 DIF-FFT algorithm, evaluate the 4-point DFT of the sequence
 $x(n) = \{-2, 1, 2, 3\}$. [[CO4](Evaluate/HOCQ)]
- ↑
- (b) Obtain the result of linear convolution of the following two sequences from circular convolution of the using graphical method
- $x(n) = \{2, 5, 0, 4\}$ and $h(n) = \{4, 1, 3\}$ [[CO4](Apply/IOCQ)]
- ↑ ↑
- 6 + 6 = 12**
5. (a) State the invertibility of linear time invariant system. [[CO1](Remember/LOCQ)]
- (b) Determine the inverse of the system having impulse response $h(n) = \delta(n) - \delta(n-1)$. [[CO1, CO2](Evaluate/HOCQ)]
- (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 $h(n) = \{1, 2, 1\}$? [[CO3](Apply/IOCQ)]
- 2 + 5 + 5 = 12**

Group - D

6. (a) Comment on the stability of FIR filters. [[CO4](Analyse/IOCQ)]
 (b) An FIR filter ($M=11$) is characterized by the following transfer function:

$$H(z) = \sum_{n=0}^{M-1} h(n)z^{-n}$$
 Determine the (i) magnitude response (ii) phase delays and (iii) group delays are constant. [[CO2](Evaluate/HOCQ)]
 (c) A linear phase filter has a phase function $e^{-j2\omega}$. Determine the order of the filter. [[CO2](Analyse/IOCQ)]
3 + (3 + 2 + 2) + 2 = 12

7. (a) What do you mean by decimator and interpolator? Why up sampler is usually followed by low pass filter? [[CO4](Remember/LOCQ)]
 (b) Consider the system shown below if $M=L$, show that the output of two configuration are different

[[CO4](Creative/HOCQ)]

(c) Develop an expression for output given below.

[[CO4] (Evaluate/HOCQ)]

4 + 4 + 4 = 12

Group - E

8. (a) Explain the principle of a decimator that reduces sampling rate of input signal by an integer factor, D . [[C03](Remember/LOCQ)]
(b) Explain polyphase filter structure. [[C05](Understand/LOCQ)]
6 + 6 = 12

9. Write short notes on any two of following:
(i) Window technique for FIR design.
(ii) Multirate Signal Processing.
(iii) Wavelet Transform.
(iv) Kalman filter.

[[C05](Understand/LOCQ)]
(6 + 6) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	33.33	22.92	43.75

Course Outcome (CO):

After completion of the course, the 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.*