



B.E DEGREE EXAMINATIONS: MAY 2018

(Regulation 2015)

Sixth Semester

ELECTRONICS AND COMMUNICATION ENGINEERING

U15ECT502 : Digital Signal Processing

COURSE OUTCOMES

- CO1:** Apply DFT algorithm for signal analysis (K4).
CO2: Design and analyze IIR filter for the given specification (K4).
CO3: Design and analyze FIR filter for the given specification (K4).
CO4: Compare different structures for filter implementations (K4).
CO5: Discuss finite word length effects (K2).
CO6: Describe concepts of stochastic signal processing (K2).

Time: Three Hours

Maximum Marks: 100

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. The DFT of $x(n) = \{2, 2, 2, 0, 0, 0, -2, -2\}$ is CO1 [K₃]
 a) Real and even b) Real and odd
 c) Imaginary and odd d) Complex and symmetry
2. $W_N^{kN} = \underline{\hspace{2cm}}$ CO1 [K₃]
 a) $W_{N/2}^k$ b) W_N^k
 c) W_N^0 d) 0
3. Match List (I) time domain operation with (List II) DFT. CO1 [K₂]
 Given that $x(n) \leftrightarrow X(k)$ and $y(n) \leftrightarrow Y(k)$

LIST I	LIST II
A. Circular Time reversal	i) $X^*(N-k)$
B. Complex conjugate	ii) $X(N-k)$
C. Circular Convolution	iii) $X(k)e^{-j2\pi k l/N}$
D. Circular Time shift	iv) $X(k)Y(k)$

- A B C D
- a) ii i iii iv
 b) i ii iv iii
 c) iii iv i ii
 d) ii i iv iii
4. Which of the following statements are correct? CO2 [K₃]
- For a stable analog system, the poles should lie outside unit circle.
 - For a stable digital system, the poles should lie inside unit circle
 - BLT maps the poles on the left of Y axis in S domain to inside unit circle in Z domain.
 - Poles are the values of Z where H(Z) becomes infinite.
- a) 1,2,3 b) 2,3,4
 c) 1,2,4 d) 2,3

5. Assertion (A): FIR filter is inherently stable. CO3 [K₄]

Reason (R): $\sum_{n=-\infty}^{\infty} |h(n)|$ is a finite value for FIR filter.

- a) Both A and R are Individually true and R is the correct explanation of A b) Both A and R are Individually true but R is not the correct explanation of A
 c) A is true but R is false d) A is false but R is true

6. Match List I with List II CO3 [K₂]

LIST I (Window)	LIST II (Transition BW)
A. Blackmann	1. $4\pi/N$
B. Hamming	2. $12\pi/N$
C. Rectangular	3. $8\pi/N$

A B C

- a) ii iii i
 b) ii i iii
 c) iii i ii
 d) iii ii i

7. _____ realization is more robust in terms of coefficient quantization. CO5 [K₄]

- a) Direct form b) Parallel
 c) Cascade d) Lattice

8. Sequence the steps for A/D conversion CO5 [K₂]

1. Coding
2. Sampling
3. Anti aliasing filter
4. Quantization

- a) 2-4-1-3 b) 3-1-2-4
 c) 2-3-4-1 d) 3-2-4-1

9. Which of the following statements are true CO6 [K₃]

1. Autocorrelation $R_{xx}(\tau) = -R_{xx}(-\tau)$
2. $R_{xx}(\tau)$ is maximum at $\tau=0$.
3. Autocorrelation is an even function
4. For WSS random process autocorrelation depends only on the time lag.

- a) 1,2,4 b) 2,3,4
 c) 1,3,4 d) 2,4

10. Assertion (A): A random process is said to be ergodic if the time average converges to ensemble average. CO6 [K₃]

Reason (R): All the random process are ergodic in nature.

- a) Both A and R are Individually true and R is the correct explanation of A b) Both A and R are Individually true but R is not the correct explanation of A
 c) A is true but R is false d) A is false but R is true

PART B (10 x 2 = 20 Marks)
(Answer not more than 40 words)

11. How many DFTs and IDFTs of length $N=128$ are necessary to linearly convolve a sequence $x[n]$ of length 1000 with a sequence $h[n]$ of length 64 using the overlap add method? What is the number of complex multiplications needed to complete this operation? CO1 [K₄]

12. If $X(K)$ is the DFT of the sequence $x(n)$, determine the N point DFT of the sequence CO1 [K₄]

$$xc(n) = x(n) \cos \frac{2\pi k_0 n}{N}, \quad 0 \leq n \leq N-1$$
13. What do you mean many to one mapping? Give one example. CO3 [K₂]
14. Write the magnitude function of butterworth filter. What is the effect of varying order of the filter on magnitude response? CO3 [K₃]
15. What is Frequency warping in Bilinear Transformation with graph? How is it avoided? CO3 [K₃]
16. What is the merits of linear phase system? What is the necessary condition in the impulse response for a system to have linear phase? CO4 [K₄]
17. Define limit cycle oscillations. CO5 [K₂]
18. What is the range of quantization error introduced in Rounding and Truncation? CO5 [K₃]
19. Define central limit theorem. CO6 [K₂]
20. What are the conditions for a random process to be a wide sense stationary? CO6 [K₂]

Answer any FIVE Questions:-

PART C (5 x 14 = 70 Marks)

(Answer not more than 300 words)

Q.No. 21 is Compulsory

21. a) Obtain 8 point DFT of the sequence $x[n] = \{1,2,3,4\}$ using DIT FFT algorithm. (7) CO1 [K₄]
 Indicate all the intermediate quantities in the signal flow graph. Compare the complexity of 8 point FFT with 8 point direct computation.
- b) Design a FIR low pass filter to meet the following specifications. (7) CO3 [K₄]
- $$Hd(e^{j\omega}) = e^{-j3\omega} \quad -\frac{\pi}{4} \leq \omega \leq \frac{\pi}{4}$$
- $$= 0 \quad \frac{\pi}{4} < |\omega| < \pi$$
- Use rectangular window.
22. a) Use the overlap add method to convolve the two sequences $h(n) = \{1,0,1\}$ and $x(n) = \{1,3,2,-3,0,2,-1,0,-2,3,-2,1,\dots\}$. Assume $N=8$. (8) CO1 [K₃]
- b) What is the advantage of circular convolution over linear convolution? The input and the impulse response of a LTI system is given below. Find the output of the system using circular convolution. (6) CO1 [K₄]
- $$x[n] = \{1,2\} \quad \text{and} \quad h(n) = \{2,2\}.$$
23. Design a maximally flat pass band digital filter satisfying the condition CO2 [K₄]
 $0.8 \leq |H(e^{j\omega})| \leq 1 \quad \text{for } 0 \leq \omega \leq 0.2\pi$
 $|H(e^{j\omega})| \leq 0.2 \quad \text{for } 0.6\pi \leq \omega \leq \pi$. Assume $T=1\text{sec}$. Use IIM method.
 Realize the filter in any one form.
24. a) Find the order of Butterworth and Chebyshev filter to meet the following specification. (6) CO2 [K₄]
 1dB ripples in the pass band $0 \leq \omega \leq 0.2\pi$
 15dB ripples in the stop band $0.3\pi \leq \omega \leq \pi$
 Use Bilinear Transformation.

- b) Realize the system
 $y(n) = -0.1y(n-1) + 0.2y(n-2) + 3x(n) + 3.6x(n-1) + 0.6x(n-2)$ using Direct form I, (8)
 cascade and parallel form. Compare the complexity of each realization. CO4 [K₄]
25. a) Design to obtain the frequency response of a low pass FIR filter using frequency (10) CO3 [K₄]
 sampling method for $\omega_c = \frac{\pi}{4}$ with $N = 15$. Implement the filter using linear phase
 structure. CO3 [K₄]
 b) What are the advantages and limitations of FIR filter over IIR filter? (4)
26. a) what is the steady state noise variance at the output due to the quantization of the (7) CO5 [K₃]
 input for the first order filter $y(n) = ay(n-1) + x(n)$
 b) What is overflow error? Calculate the scaling factor to avoid overflow error at the (7) CO5 [K₃]
 adder 1 of the system $H(z) = \frac{0.5 + 0.4Z^{-1}}{1 - 0.312Z^{-1}}$ when direct form II is used?
27. a) In a random process, derive the relationship between autocorrelation and Power (8) CO6 [K₂]
 spectral density?
 b) What is joint distribution function? State the properties of joint distribution function. (6)
 CO6 [K₂]
