



B.E DEGREE EXAMINATIONS: APRIL /MAY 2024

(Regulation 2018)

Fourth Semester

ELECTRONICS AND COMMUNICATION ENGINEERING

U18ECI4201: Digital Signal Processing

COURSE OUTCOMES

- CO1: Apply DFT algorithm for signal analysis.
 CO2: Design and analyze IIR filter for the given specification.
 CO3: Design and analyze FIR filter for the given specification.
 CO4: Compare different structures for filter implementations.
 CO5: Analyze the effect of finite word length.
 CO6: Compare DSP processor Architectures.

Time: Three Hours

Maximum Marks: 100

**Answer all the Questions:-
 PART A (10 x 2 = 20 Marks)
 (Answer not more than 40 words)**

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|---|-----|-------------------|
| 1. Evaluate IDFT of $X(k) = \{2, 1+j, 0, 1-j\}$ | CO1 | [K ₃] |
| 2. Find circular convolution of $\{1, 2, 0, 1\}$ and $\{2, 2, 1, 1\}$ | CO1 | [K ₃] |
| 3. The causal digital transfer function $H(z) = \frac{5}{1 - e^{-4} z^{-1}}$ was designed using Impulse invariance method with $T = 1$ sec. Find the parent analog transfer function $H(s)$. | CO2 | [K ₃] |
| 4. Differentiate between Butterworth and Chebyshev filters. | CO2 | [K ₂] |
| 5. Express the system function,
$H(z) = -4 + 3.5 z^{-1} - 1.5 z^{-2} + 3.5 z^{-3} - 4 z^{-4}$ using direct form FIR filter structure. | CO4 | [K ₃] |
| 6. Recall the desirable characteristics of windows used for designing FIR filters. | CO3 | [K ₂] |
| 7. Show the number $(-7/8)_{10}$ using 2's complement representation. | CO5 | [K ₃] |
| 8. What is the new pole location with 3-bit coefficient representation (after truncation) for the system function $H(z) = \frac{1}{1 - 0.45 z^{-1}}$? | CO5 | [K ₃] |
| 9. Summarize the on-chip peripherals present in DSP processors. | CO6 | [K ₂] |
| 10. Name the interrupts of DSP TMS320C67XX. | CO6 | [K ₂] |

Answer any FIVE Questions:-
PART B (5 x 16 = 80 Marks)
(Answer not more than 400 words)

11. a) Apply Radix-2 DIT-FFT algorithm to find DFT of $x(n) = \{2, 1, 0, -1, 3, 0, -2, 1\}$. 8 CO1 [K₃]
 b) State and prove Parseval's Theorem for DFT. Verify this theorem for the given signal $x(n) = \{1, 2, -2, 4\}$. 8 CO1 [K₂]
12. a) Determine the output $y(n)$ of a filter whose impulse response $h(n) = \{1, 2, -1\}$ and input signal $x(n) = \{1, 2, -1, 2, 3, -2, -3, -1, 1, 1, 2, -1\}$ using overlap save method. 10 CO1 [K₃]
 b) Compare the computational complexity of 8 point and 4 point DFT using Direct method and FFT method. 6 CO1 [K₃]
13. a) Design a digital Butterworth filter satisfying the following constraints, 10 CO2 [K₃]

$$0.9 \leq |H(e^{j\omega})| \leq 1 \quad \text{for } 0 \leq \omega \leq \pi/2$$

$$|H(e^{j\omega})| \leq 0.2 \quad \text{for } 3\pi/4 \leq \omega \leq \pi$$
 Use Bilinear transformation method. Assume $T = 1$ sec.
 b) Realize the direct form I and direct form II realization of the LTI system 6 CO4 [K₃]
 governed by the equation:

$$y(n) = -3y(n-1) + 5y(n-2) + 2y(n-3) + x(n) + 3x(n-1) + 4x(n-2)$$
14. a) Design an ideal 4th order high-pass filter using hanning window with desired 8 CO3 [K₃]
 frequency response,

$$H_d(e^{j\omega}) = \begin{cases} 0, & -\frac{\pi}{4} \leq \omega \leq \frac{\pi}{4} \\ 1 & \frac{\pi}{4} \leq |\omega| \leq \pi \end{cases}$$
 Also obtain its frequency response $H(e^{j\omega})$.
 b) Apply frequency sampling technique to design an FIR filter with the desired 8 CO3 [K₃]
 frequency response of,

$$H_d(e^{j\omega}) = \begin{cases} e^{-j3\omega}, & 0 \leq |\omega| \leq \frac{\pi}{2} \\ 0, & \text{Elsewhere} \end{cases}$$
15. a) Obtain an expression for the Signal-to-Noise Ratio (SNR) at the input of a Scalar 8 CO5 [K₃]
 Quantizer.
 b) Given $y[n] = -0.5y[n-1] + x[n]$, $x[n] = 0.875 \delta[n]$ & $y[-1] = 0$, show that rounding 8 CO5 [K₃]
 will introduce limit cycle.
16. Sketch and elucidate the architecture and functionality of the TMS320C67XX 16 CO6 [K₂]
 processor with a neat block diagram. Also, list the various general-purpose registers present in the TMS320C67XX processor.
