BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION MO2022)

CLASS: B.Tech. **SEMESTER:** V
BRANCH: EEE **SESSION:** MO2022

SUBJECT: EE305 DIGITAL SIGNAL PROCESSING

TIME: 03 Hours **FULL MARKS:** 50

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates

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Q.1(a)	Identify the type of digital filter whose impulse responses are given below: (i) $h(n) = 5\delta(n) - 7\delta(n-1) + 7\delta(n-3) - 5\delta(n-4)$ (ii) $h(n) = \delta(n) + \delta(n-2)$ (ii) (iii) $h(n) = \delta(n) - \delta(n-1)$ (iv) $h(n) = \delta(n) + \delta(n-1)$	[2] **CO-4**
Q.1(b)	A length 9 Type-1 real coefficient FIR filter has the following zeros $Z_1 = -0.5$, $Z_2 = 0.3+j\,0.5$, $Z_3 = 0.5 + j\sqrt{3}/2$ (i) Determine the locations of the remaining zero's. (ii) What is the causal type linear phase transfer function?	[3] **CO-4**
Q.1(c)	Design an FIR filter to meet the following specifications: (i) Pass-band edge: F_P = 2 KHz (ii) Stop-band edge: F_S = 5 KHz (iii) Pass-band attenuation: A_P = 2 dB (iv) Stop-band attenuation: A_S = 42 dB (v) Sampling frequency: F_T = 20 KHz. (using fixed window functions)	[5] **CO-4**
Q.2(a)	Consider the function $g(t) = e^{-t}\sin(2\pi t)\,u(t)$, where u(t) is the step function. Calculate the area under g(t). (Using DSP tools)	[2] **CO-2**
Q.2(b)	Explain in detail the pipelining of instruction execution.	[3] **CO-5**
Q.2(c)	Explain Harvard and SHARC architectures. Also, describe the various addressing modes used in DSP processor.	[5] **CO-5**
Q.3(a)	The following causal IIR digital transfer function was designed using the impulse invariant method with T= 0.3s: $H(z) = \frac{2z}{z - e^{-0.9}} + \frac{3z}{z - e^{-1.2}}$ Determine its parent causal analog transfer function.	[2] **CO-4**
Q.3(b)	Develop the recursive relation to determine the Chebyshev polynomial $C_N(x)$. Find out the value of $C_3(x)$ and $C_4(x)$ using recursive relation. Also, plot the graph $C_N(x)$ versus x for N= 3,0 and 4.	[3] **CO-4**
Q.3(c)	Design an IIR low-pass Butterworth filter using bilinear transformation for the following specifications: $\textit{Pass band}: 0.8 \le \lvert H(e^{j\omega})\rvert \le 1, \quad \lvert\omega\rvert < 0.2\pi$ $\textit{Stop band}: \lvert H(e^{j\omega})\rvert \le 0.2, \quad 0.6\pi \le \lvert\omega\rvert \le \pi$ (Assume T= 1s)	[5] **CO-4**
Q.4(a)	What is FFT? Calculate the number of complex multiplications, number of complex additions and number of memory locations needed in the calculation of DFT using DIT-/DIF-FFT algorithm with 32-point sequence.	[2] **CO-3**
Q.4(b)	Determine the z-transform for $x(n) = \lvert n\rvert\left(\frac{1}{2}\right)^{\lvert n\rvert}$. Sketch the pole-zero plot and indicate the ROC. Indicate whether or not the DTFT of the signal exist. (Give the proper justification)	[3] **CO-3**
Q.4(c)	Consider the length-12 sequence, defined for **0 ≤ n ≤ 11** $x(n) = \{\underline{3}$, **-1, 2, 4, -3, -2, 0, 1, -4, 6, 2, 5}** with a 12 point DFT given by X(k). Evaluate (i) X (0), (ii) X (6), (iii) $\sum_{k=0}^{11} X(k)$, $(iv) \sum_{k=0}^{11} e^{-j\frac{4\pi k}{6}}$ **X(*k*)** and **(iv)** $\sum_{k=0}^{11} \lvert X(k)\rvert^2$.	[5] **CO-3**
Q.5(a)	Input x(t) and output y(t) of an LTI system are related by differential equation $y''(t) - y'(t) - 6\,y(t) = x(t)$. Find the impulse response h(t) of the system, which is neither causal nor stable (Sketch the ROC).	[2] **CO-2**

Q.5(b)	A continuous-time periodic signal *x*(t) is real-valued and has a fundamental period T = 8. The nonzero Fourier series coefficients for *x*(t) are $X_1 = X_{-1} = 2, X_3 = X_{-3}^* = 4j$. Express *x*(t) in the form $x(t) = \sum_{n=0}^{\infty} A_n \cos(\omega_n t + \phi_n)$	[3] **CO-3**
Q.5(c)	Define and describe the following terms (i) Dirichlet Conditions (ii) Energy and Power Signal (iii) Sampling theorem (iv) Linearity and stability	[5] **CO-1**

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