Sardar Patel Institute of Technology

Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India
(Autonomous Institute Affiliated to University of Mumbai)

End Semester Examination
December 2021

Max. Marks: 60 **Duration: 120 min**
Class: T.E. **Semester: V**
Course Code: EC/ET303 **Branch: EXTC/ETRX**
Name of the Course: Digital Signal Processing

Instructions:

(1) All Questions are Compulsory and must be solved in the order. Solving randomly may result in penalty. No marks will be given to answer without question number.
(2) Draw neat and clear diagrams. Units must be mentioned wherever necessary.
(3) Use your own UCID number as data wherever asked in the questions.

Question No.		Max. Marks	CO	BL
Q1A	The impulse response of LTI System h(n) = $\left(\frac{1}{a}\right)^n \cdot u(n)$ Find the response of the system when input x(n) = $(a)^n \cdot u(n)$ by Fold, Shift, Multiply and sum concept. Verify your results using Tabular Method. **where $'a'$ is the last digit of your UCID Number.** **for example: if your UCID is 2020201063, then take a =3,** **If the last digit is zero then a =1**	06	CO1	L2
Q1B	A discrete time signal is given by x(n) = {1, 3, 2, a, 4}, Sketch the following signals and name the type of operation involved a) x (n – 2) b) x (3 – n) c) x (n – 1) · δ (n – 1) d) Even part of x(n) e) x(2n) **where $'a'$ is the last digit of your UCID Number – 1.** **for example: if your UCID is 2020201060, then take a = 0 – 1 = –1** **underlined integer indicates sample value at n = 0**	06	CO1	L2
Q2A	For a given 8-point discrete signal x(n), the Fourier equivalent is given as X(k)= {36, 4 - j9.656, -4 + j4, 4 - j1.6569, -4}. Find X(k) for k= 5, 6 and 7 **If your UCID Number is ODD, Find the original signal x(n) using IFFT-DIT** **If your UCID Number is EVEN Find the original signal x(n) using IFFT-DIF**	06	CO2	L3

Q2B	Compute the 5-point DFT of causal sequence x(n) = cos ($\frac{n\pi}{2}$) using DFT standard formulae. **OR** Compute the 5-point DFT of causal sequence x(n) = sin ($\frac{n\pi}{2}$) using DFT standard formulae.	06	CO2	L3
Q2C	Perform Linear Filtering of the following sequences x(n) = {1, 2, 3, 4, 5, 6, 7, 8} and h(n) = {1, 1, 1} **if your last UCID Number is odd, use Overlap Add Method** **else if your last UCID Number is even, use Overlap Save Method**	06	CO2	L3
Q3A	Interpret the z-transform and ROC of the discrete time signal given below: $x(n) = [-\frac{1}{\boldsymbol{a}+1}]^n\, u(n) + 5[\frac{1}{\boldsymbol{b}+1}]^{-n}\, u(-n-1)$ **Where 'a' is the last digit of your UCID No. and 'b' is second last digit of your UCID No.**	03	CO3	L2
Q3B	Find the inverse z-transform of $X(z) = \log\left[\frac{\boldsymbol{a}+1}{(\boldsymbol{a}+1) - z^{-1}}\right];\ \lvert z\rvert > \frac{1}{\lvert \boldsymbol{a}+1\rvert}$ **Where 'a' is the last digit of your UCID No.**	03	CO3	L2
Q4	Consider a communication system in which a digital filter block has the following characteristics: 1. Low frequency signals are passed through communication system. 2. A digital filter has two poles. 3. Constant signals do not pass through the system 4. The pole is at a distance r = '**a**' from the origin of the Z plane. 5. The input signal is given by $x(n) = 5 + \boldsymbol{b}\sin\left(\frac{\pi}{6}n + 30^o\right) \qquad -\infty \le n \le \infty$ 6. **Data: a is the last two digit of your UCID in decimal. b is the last two digit of your UCID.** **For example: UCID: 2020101002 then a=0.02 and b = 02** a. Sketch the pole-zero patterns of the digital filter and determine the system function H(z). (1M) b. Calculate the normalized frequency response H(w) so that |H (0)| = 1. (1M)	12	CO4	L4

	c. Compute and draw the magnitude response and the phase response of the filter. (3M) d. Determine the input-output difference equation of the filter in time domain. (1M) e. Is it possible to implement this system using finite number of adders, multipliers, and unit delays? If yes, how? (2M) f. Illustrate whether the system is minimum, maximum, or mixed phase system with proper justification. (1M) g. Compute the output of the communication system if the input given in 5. (2M) h. How should we improve the performance characteristic of this filter? Justify your answer. (1M)			
Q5A	Design a second order digital low pass filter using Chebyshev Filter Design Procedure that meets the following specifications: Attenuation in passband is 3dB constant for frequencies below 1KHz and stopband attenuation of at least 16dB for frequencies above 2KHz. Fs= 20KHz **Students whose UCID no is Even- Use Bilinear Transformation Method.** **Students whose UCID no is Odd- Use Impulse Invariant Method.** **OR** An IIR LPF is required to meet the following specifications: $0.6 \leq \lvert H(ejw) \rvert \leq 1$; $0 \leq \omega \leq 0.35\pi$ $\lvert H(ejw) \rvert \leq 0.1$; $0.7\pi \leq \omega \leq \pi$ The filter is to be designed by performing BLT/Impulse Invariant Method on an analog system function of second order Butterworth filter to meet the specifications in the implementation with T=0.1sec. **Students whose UCID no is Even- Use Bilinear Transformation Method.** **Students whose UCID no is Odd- Use Impulse Invariant Method.**	06	CO5	L3
Q5B	A company making AM-FM receivers and Digital filters appointed you as a Design Engineer. A company expects you to investigate following products and give your solution regarding client requirements. A client requires a 10KHz bandwidth bandpass Finite Impulse Response Filter which should have lower cut-off frequencies of '**a**' KHz. Assume Sampling frequency is three times of upper cut-off frequencies. Required length of window is 7 and window peak of first sidelobe is -58dB. As a Designer you try your best to	06	CO5	L3

	design an Ideal Filter for given requirements. Identify the window function required. **Data: 'a' is last two digit of your UCID No.**			

BL – Bloom's Taxonomy Levels (1-Remembering, 2-Understanding, 3–Applying, 4–Analyzing, 5–Evaluating, 6-Creating)
CO – Course Outcomes; PO – Program Outcomes.