Total number of printed pages: 2 **UG/5th Sem/UECE504**

2024

DIGITAL SIGNAL PROCESSING

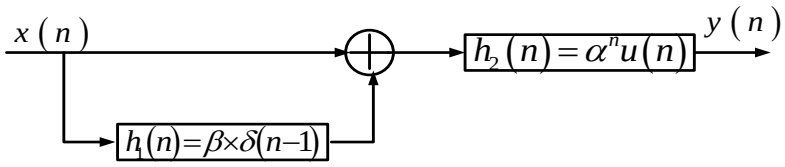
Full Marks: 100

Time: Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions.*

1.	a)	Determine the output sequence of the system with impulse response $h[n]=\left(\frac{1}{4}\right)^n \times u[n]$, when the input is the complex exponential sequence $x[n]=4\times e^{j\pi\frac{n}{2}};\ -\infty<n<\infty.$	10
	b)	Determine the inverse z-transform of $X(z)=\frac{z+2}{2z^2-7z+2}$ using partial fraction expansion method and if the ROC's are (i) $\lvert z\rvert>3$, (ii) $\lvert z\rvert<\frac{1}{2}$ and (iii) $\frac{1}{2}<\lvert z\rvert<3$.	3+3+4
2.	a)	Show that an LTI system with system function '$H(z)$' is BIBO stable if and only if the ROC for $H(z)$ contains the unit circle.	5+5
	b)	Discuss what will happen in z-plane if the poles in s-plane are integer multiples of $\left(\frac{2\pi}{T}\right)$; where 'T' is the sampling time.	
	c)	Two causal systems with impulse responses $h_1[n]=a\times\delta[n]+\delta[n-1]$ and $h_2[n]=b^n\times u[n]$, where $\lvert b\rvert<1$, are connected in cascade as shown below. $x[n] \rightarrow \boxed{h_1[n]} \rightarrow \boxed{h_2[n]} \rightarrow y[n]$ Determine the frequency response $H(e^{j\omega})$ of the overall system. Find the values of 'a' and 'b' for which $\lvert H(e^{j\omega})\rvert = 1.$	10
3.	a)	Consider the system shown below:	10

		 a) Find the impulse response $h(n)$ of the system b) Find the frequency response of the overall system c) Specify a difference equation that relates the output to the input.	
	b)	Discuss the stability criteria of an IIR-system using 'Bi-linear Transformation' technique. What is pre-warping?	7+3
4.	a)	Draw and establish the complete signal flow-graph of an 8-point DIT-FFT technique.	12
	b)	Calculate the 8-point DIT-FFT of the given sequence: $x(n)=\{1,2,3,4,4,3,2,1\}$.	8
5.	a)	A LPF is designed with the following desired frequency response: $H_d\left(e^{j\omega}\right)=\begin{cases} e^{-j2\omega};\ -\pi/4\le\omega\le\pi/4 \\ 0;\ -\pi/4<\lvert\omega\rvert\le\pi. \end{cases}$ Determine the filter coefficients '$h_d(n)$' if the window function is defined as $w(n)=\begin{cases}1;\ 0\le n\le 4\\ 0;\ \text{elsewhere.}\end{cases}$ Also find the modified filter frequency response $\left(H\left(e^{j\omega}\right)\right)$ of the designed filter.	10
	b)	Show that the transfer function of a linear-phase FIR filter is given by $H\left(e^{j\omega}\right)=e^{-j\omega\left(\frac{N-1}{2}\right)}\times\left[h\left(\frac{N-1}{2}\right)+\sum_{k=1}^{(N-1)/2}2h\left(\frac{N-1}{2}-k\right)\times\cos(\omega k)\right]$.	
6.	a)	Show that linear phase FIR filters have symmetric impulse response characteristics, i.e., $h(n)=h(N-n-1)$.	10
	b)	An FIR filter (N=11) is characterized by the following transfer function: $H(z)=\sum_{n=0}^{N-1}h(n)\times z^{-n}$. Determine the magnitude response and also prove that the phase and group delays are constant.	8

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