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PES University, Bangalore

(Established under Karnataka Act 16 of 2013)

UE16EC253

END SEMESTER ASSESSMENT (ESA) B.TECH. IV SEMESTER- MAY. 2018

UE16EC253 - DIGITAL SIGNAL PROCESSING

Time: 3 Hrs | Answer All Questions | Max Marks: 100

1.	a)	Compute DFT of the following length-N sequence $$x(n) = \begin{cases} 1 & \text{for n even, } 0 \le n \le N-1 \\ 0 & \text{for n odd, } 0 \le n \le N-1 \end{cases}$$	4
	b)	Find the 10-point inverse DFT of $$X(k) = 1 + 2\delta(k) = \begin{cases} 3 & k = 0 \\ 0 & 1 \le k \le N-1 \end{cases}$$	4
	c)	Let $X(k)=\{1, j, -1, -j\}$ be the DFT of a 4-point sequence $x(n)$, using properties of the DFT determine the following: a) DFT$\{x((n-1))_4\}$ b) DFT$\{j^n\, x(n)\}$	6
	d)	Given two 8-point sequences, $x_1(n)=(1, 1, 1, 1, 1, 1, 1, 1)$ and $x_2(n)=cos(0.25\pi n)$ for $n=0.....7$, using properties of DFT compute $Y(k)=DFT\{y(n)\}$ where $y(n)= x_1(n)\,.\,x_2(n)$.	6
2.	a)	Determine 8-point DFT of a sequence $x(n)= cos(0.5\pi n)$, using radix-2 DIT-FFT algorithm. Provide all intermediate results.	6
	b)	Compute a 4-point sequence $x(n)$, using radix-2 inverse DIT-FFT algorithm, of a four point DFT $X(k)=\{X(0), X(1), X(2), X(3)\}$. Draw the butterfly diagram.	5
	c)	The linear convolution of an 1100-point sequence with a 55-point sequence is to be computed using 64-point radix-2 FFTs and IFFTs. Determine the smallest number of FFTs and IFFTs needed to compute this linear convolution using the overlap add method.	3
	d)	Find the output $y(n)= x(n) \circledcirc h(n)$, where $x(n)=(1,0,-1,1)$ and $h(n)=(1, -1)$, using 4-point radix-2 DIF and IDIF FFTs. [Note: $\circledcirc$ denotes circular convolution]	6
3.	a)	Compute the poles of an analog lowpass Butterworth filter transfer function that satisfies the following constraints and find the system function H(s): $$0.707 \le \lvert H(j\Omega)\rvert \le 1 \qquad 0 \le \Omega \le 2\ rad/sec$$ $$\lvert H(j\Omega)\rvert \le 0.1 \qquad \Omega \ge 4\ rad/sec$$	8
	b)	Determine the poles of an analog lowpass Chebyshev Type-I filter to meet the following specifications: (i) $1\ dB$ ripple in passband $\quad 0 \le \Omega \le 1.5\ rad/sec$	8

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		(ii) At least *40 dB* attenuation in the stopband $\Omega \geq 2.5\ rad/sec$ Also, sketch the poles of the system on an ellipse finding the lengths of major and minor axes.	
	c)	Derive a recursive relation to obtain higher order Chebyshev polynomial. Using the relation determine the Chebyshev polynomial for *N=3*.	4
4.	a)	Use the impulse invariant method to find the digital transfer function of $$H(s) = \frac{4(3s+7)}{(s+2)(s^2+4s+5)}$$ *Assume T=1 sec.*	5
	b)	Using bilinear transformation design a digital Chebyshev type-I bandpass filter that meets the following specifications: (i) Desired order: *N=2*, assume *T=1 sec* (ii) Cutoff frequencies: $\omega_l = 0.55\pi$ rad and $\omega_u = 0.65\pi$ rad (iii) Passband ripple: *3 dB*	6
	c)	Consider the causal LTI system with system function *H(z)* given below: $$H(z) = \frac{z^{-1}(1-6z^{-1}+8z^{-2})}{(1-0.5z^{-1})}$$ Draw a direct form II structure for the system.	4
	d)	Obtain parallel form realization structure for the following transfer function *H(z)* $$H(z) = \frac{0.7 - 0.25\,z^{-2}}{(1+0.1\,z^{-1} - 0.72\,z^{-2})}$$	5
5.	a)	Design a linear phase FIR filter to satisfy the following constraints: Passband edge frequency: 4 *kHz* Stopband edge frequency: 2 *kHz* Passband ripple: *2 dB* Stopband attenuation: *40 dB* Sampling Frequency: *20 kHz*	8
	b)	Using frequency sampling method, design a bandpass filter with the following specifications: Sampling frequency: *8 kHz* Cutoff frequencies Fc_1 = *1 kHz* and Fc_2=*3 kHz* Determine the filter coefficients for *M=7*.	6
	c)	Determine the lattice coefficients corresponding to the FIR filter with system function $$H(z) = A_3(z) = 1 + 0.18\,z^{-1} + 0.236\,z^{-2} + 0.3\,z^{-3}$$ Draw the lattice structure using the reflection coefficients	6