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PES University, Bengaluru
(Established under Karnataka Act No. 16 of 2013)

UE16EE353

MAY 2019: END SEMESTER ASSESSMENT (ESA) B.TECH. VISEMESTER

UE16EE353- DIGITAL SIGNAL PROCESSING

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

1.	a)	Evaluate the sum $S = \sum_{n=0}^{15} x_1(n)\, x_2^*(n)$ using 16 – point DFT if $x1(n) = \cos\left(\frac{3\pi n}{8}\right)$ and $X2(k) = 3$ *in* $0 \le k \le 15$.	6
	b)	If the 10-point DFTs of x(n) = δ(n) – δ(n – 1) and h(n) = u(n) – u(n – 10) are X(k) and H(k), respectively, find the sequence w(n) that corresponds to the 10-point inverse DFT of the product H(k)X(k).	6
	c)	A 498-point DFT *X (k)* of a real valued sequence *x (n)* has the following DFT samples: *X (0) = 2; X (11) = 7 + j3.1; X (k1) = –2.2 – j 1.5; X (112) = 3 – j 0.7; X (k2) = – 4.7 + j 1.9; X (249) = 2.9; X (309) = – 4.7 – j 1.9; X (k3) = 3 + j 0.7; X (412) = –2.2 + j 1.5; X (k4) = 7 – j3.1*; Remaining DFT samples are zero. Evaluate **i)** index k1, k2, k3, k4 ii)energy of x (n).	8
2.	a)	How many DFTs and inverse DFTs of length N = 128 are necessary to linearly convolve a sequence x (n) of length 1000 with a sequence h (n) of length 64 using the overlap-save method. Suppose the length is increased to 1040, how many numbers of DFT's & IDFT are necessary if overlap – add method is preferred?	6
	b)	The impulse response of a system is {1, 2}. Suppose the input is {1, 2, 3, 4, 5, 6}, apply overlap – add technique to compute system response. Assume block length as 3.	6
	c)	Apply radix – 2 DIT – FFT technique to compute 8 – point DFT of the sequence x(n) = {*0, 1, 0, – 1, 0, 1, 0,–1*}.	8
3.	a)	The magnitude squared function of Butterworth filter is $\frac{1}{1+(\frac{s}{2})^4}$. Find the order of the filter, cutoff frequency & the prototype filter function.	6
	b)	Use examples to prove that angle of separation between poles is a function of filter order in analog Butterworth filter.	6
	c)	Design a low pass Chebyshev type 1 analog filter to meet the following specifications: ➢ *–1* dB attenuation in pass band at an edge frequency of 10 rad/s ➢ –12 dB stop band attenuation at an edge frequency of 40 rad/s.	8

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4.	a)	Digitize the analog filter function by impulse invariant method given H (s) $= \frac{s+1}{(s+2)^2}$ Assume T =1 s.	6
	b)	The bilinear transformation design gives the causal IIR digital filter function as H(z) = $\frac{5z^2+4z-1}{8z^2+4z}$ with T =2 s. Determine the parent analog filter function.	6
	c)	Design a first order Butterworth low pass digital filter to have a 3dB cutoff frequency of 0.5 π rad by i) impulse invariant ii) Bilinear transformation technique. Also verify the design and suggest better technique among them, if applicable.	8
5.	a)	Obtain cascaded realization, for the system H (z) $= (1+z^{-1})(1+z^{-1}+\frac{1}{4}z^{-2})(1+\frac{1}{2}z^{-1}+z^{-2})$. Use minimum number of multipliers wherever possible.	6
	b)	Design a 7 – tap lowpass linear phase FIR filter using frequency sampling method to have a cutoff frequency of 1000 Hz. Assume sampling frequency as 8000 Hz.	6
	c)	Design a lowpass linear phase FIR filter to satisfy following requirements: Passband attenuation of – 0.02 dB Stop band attenuation of – 50 dB Passband edge frequency of 100 Hz Stopband edge frequency of 500 Hz Sampling frequency: 1000 Hz.	8

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