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21ECE142

B.N.M. Institute of Technology

An Autonomous Institution under VTU

Fourth Semester B.E. Degree Examination

Model Question Paper

Digital Signal Processing

Duration: 3 Hours **Max. Marks:** 100

Note: 1. Answer any one full question from Module 1,2,3,4,5 (5Q x 20M = 100 Marks)

Q. No	Questions	Marks	CO	PO	Cognitive Level
Module 1					
1(a)	Sketch signals $x[n]$, $x[4-n]$ and $x[2n-3]$ for the given $x[n] = (6-n)\{u[n]-u[n-6]\}$.	8	1	1	Apply
1(b)	Sketch the even and odd components of the following signals. i. $x[n] = 1 + u(n)$ ii. $x[n] = 8(0.5)^n u(n)$	8	1	1	Apply
1(c)	Determine whether the discrete time signal is periodic or not. If periodic, find the fundamental period. $x[n] = \cos(\frac{\pi n}{5}) + \sin(\frac{\pi n}{3})$	4	1	1	Apply
OR					
2(a)	Find and sketch the following signals and their first derivatives: $(i)\ x(t) = u(t) - u(t-a); a > 0$ $(ii)\ y(t) = t[u(t) - u(t-a)]; a > 0$	8	1	1	Apply
2(b)	Classify the following signals as Energy signals, power signals or neither. i. $x[n] = (0.5)^n u(-n)$ ii. $x[n] = e^{j\pi n}$	8	1	1	Apply
2(c)	Determine whether the following signal is periodic or not. If periodic, find the fundamental period $x(t) = e^{j[(\pi/2)t-1]}$	4	1	1	Apply
Module 2					
3(a)	Determine whether the following system is stable, memory less, causal, linear and time invariant? $y(t) = 10x(t) + 5$	10	2	1,2	Apply
3(b)	Perform convolution operation on the following signals & sketch the resulting signal. $x_1(n) = (1/2)^n u(n)$ and $x_2(n) = u(n)$	10	2	1,2	Apply
OR					
4(a)	Determine whether the following system is stable, memory less, causal, linear and time invariant? $y[n] = nx[n]$	10	2	1,2	Apply

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4(b)	Perform convolution operation on the following signals and sketch the resulting signal. $x_1(t) = e^{-\|t-2\|}$ and $x_2(t) = e^{-2t}\, u(t+4)$	10	2	1,2	Apply
	Module 3				
5(a)	Find the z-transform of $x(n) = a^{\|n\|}$ for 0<a<1.	6	3	1,2	Apply
5(b)	Find the DTFT of the signal $x(n) = -(a)^n u(-n-1)$.	6	3	1,2	Apply
5(c)	Compute the 8-point DFT of the sequence x(n) = {1, 2, 3, 4, 4, 3, 2, 1} using the in-place radix-2 DIT FFT algorithm.	8	3	1,2	Apply
	OR				
6(a)	Find z-transform of x(n) = sin(Ωn) u(n).	6	3	1,2	Apply
6(b)	Find the DTFT of the signal. $x(n) = \left(\frac{1}{2}\right)^n u(n) - \left(\frac{1}{3}\right)^n u(n-3)$	6	3	1,2	Apply
6(c)	Compute the 8-point DFT of the sequence x(n) = {1, 2, -1, 2, 4, 2, -1, 2} using the in-place radix-2 DIF FFT algorithm.	8	3	1,2	Apply
	Module 4				
7(a)	Design a Butterworth analog high pass filter meeting the following specifications. (i) Maximum passband attenuation = 2dB (ii) Passband edge frequency = 200 rad/sec (iii) Minimum stopband attenuation = 20 dB (iv) Stopband edge frequency = 100 rad/sec	8	4	1,2,3	Apply
7(b)	Derive the Direct form I & II realization of the system function: $$\mathbf{H(z)} = \frac{(\mathbf{1}+\mathbf{z}^{-1})^{3}}{\left(\mathbf{1}-\frac{1}{4}\mathbf{z}^{-1}\right)\left(\mathbf{1}-\mathbf{z}^{-1}+\frac{1}{2}\mathbf{z}^{-2}\right)}$$	8	4	1,2,3	Apply
7(c)	Find the third order normalized Butterworth polynomial.	4	4	1,2,3	Understand
	OR				
8(a)	Determine the transfer function of the analog Butterworth low-pass filter that must meet the following specifications: (i) Kp = -1 dB at 4 rad/sec (ii) Stop band attenuation greater than or equal to 20dB at 8 rad/sec.	8	4	1,2,3	Apply
8(b)	Obtain the Direct form –I & II realization for the following system: $y(n) = 0.75\, y(n-1) - 0.125\, y(n-2) + 6\, x(n) + 7\, x(n-1) + x(n-2)$	8	4	1,2,3	Apply
8(c)	Explain analog-to-analog transformation for IIR filters. Write the transformation used for lowpass and high pass filters.	4	4	1,2,3	Understand

Module 5					
9(a)	Explain any three different types of windows used in the FIR filter design using mathematical equations and diagrams.	6	5	1,2,3	Understand
9(b)	Determine the FIR filter coefficients using Hamming window with N=7. The desired frequency response of a low pass filter is given by $\mathbf{H(\omega)} = \begin{cases} \mathbf{e^{-j3\omega}}, & \mathbf{\lvert\omega\rvert < \frac{3\pi}{4}} \\ \mathbf{0}, & \mathbf{\frac{3\pi}{4} < \lvert\omega\rvert} < \pi \end{cases}$ Also find the frequency response of the FIR filter.	8	5	1,2,3	Apply
9(c)	Show that FIR filters provide linear phase response when the impulse response of the filter is symmetric for the order being odd.	6	5	1,2,3	Understand
OR					
10(a)	List the steps in the design procedure of a FIR filter using window technique.	6	5	1,2,3	Understand
10(b)	Determine the frequency response of the FIR filter designed using rectangular window as given below and the following desired frequency response. $\mathrm{H_d}(\boldsymbol{\omega}) = \begin{cases} \mathbf{0}, & -\frac{\pi}{4} < \omega < \frac{\pi}{4} \\ \mathbf{e^{-j2\omega}}, & \frac{\pi}{4} < \lvert\boldsymbol{\omega}\rvert < \pi \end{cases}$ $w_R(n) = \begin{cases} 1, & 0 \le n \le 4 \\ 0, & \text{otherwise} \end{cases}$	8	5	1,2,3	Apply
10(c)	Explain the effect of using a rectangular window function to design an FIR filter.	6	5	1,2,3	Understand