Total No. of printed pages = 3

ECE 181601

27/7/22

Roll No. of candidate | | | | | | | | | | |

2022

B. Tech 6th Semester (Regular) End-Term Examination

DIGITAL SIGNAL PROCESSING

(New Regulation & New Syllabus)

Full Marks – 70 Time – Three hours

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

Answer question No. 1 and any *four* from the rest.

1. Answer the following: (10 × 1 = 10)

(i) An energy signal is one which has finite energy and ———— average power.

(ii) The system described by the equation $y(n) = a(n-1) + bx(n)$ is a recursive system
(a) True
(b) False

(iii) An FIR system is also called as "recursive system"
(a) True
(b) False

(iv) If the system is initially relaxed at time n = 0 and memory equals to zero, then the response of such state is called as ————
(a) Zero-state response
(b) Zero-input response
(c) Zero-condition response
(d) None of the above

(v) The z-transform of the following finite duration sequence $x(n) = \{2,4,5,7,\dot{0},1\}$ is ————

(vi) If $x(n)$ and $X(K)$ are an N-point DFT pair, then $x(n + N) = x(n)$
(a) True
(b) False

(vii) The total number of complex multiplications required to compute N-point DFT by radix-2 FFT is ————

[Turn over

(viii) The direct form realization is often called a transversal or tapped-delay-line filter.

(a) True

(b) False

(ix) Which of the following rule Is used in the bilinear transformation?

(a) Simpson's rule

(b) Backward difference

(c) Forward difference

(d) Trapezoidal rule

(x) The process of reducing the sampling rate by a factor D is called _____

2. (a) Determine whether $x(n)=\cos\frac{2\pi n}{5}+\cos\frac{2\pi n}{7}$ is periodic or non-periodic. If periodic, find the period. (3)

(b) Determine whether the system y(n) = n x(n) is time variant or time invariant. (2)

(c) Obtain linear convolution of the following sequences using graphical method.
$x(n)$ {1,2,1,2} and $h(n)$ = {1,1,1} (7)

(d) State the sampling theorem. Determine the Nyquist rate for the signal $x_a(t)=10\cos 2\pi(1000)t+5\cos 2\pi(5000)t$. (2+1 = 3)

3. (a) A discrete time signal is expressed as $x(n)=\delta(n+1)+2\delta(n)+5\delta(n-3)-2\delta(n-4)$. Find its z-transform. (2)

(b) Realize the system given by the difference equation in parallel form
$y(n) = -0.1\, y(n-1) + 0.72\, y(n-2) + 0.7\, x(n) - 0.252\, x\,(n-2)$ (8)

(c) Compute the N-point DFT of the following exponential sequence: $x(n) = a^n$ u(n) for $0 \le n \le N-1$ (5)

4. (a) State and prove the circular shift of a sequence property of DFT. (6)

(b) Find the 4-point circular convolution of the following sequences: (5)
$x(n)=\delta(n)+2\delta(n-2)+\delta(n-3)$
$h(n)=\delta(n)+\delta(n-2)+2\delta(n-3)$

(c) Calculate the percentage saving in calculations in a 512-point radix-2 FFT, when compared to direct DFT. (4)

5. (a) The system function of the analog filter is given as $H_a(s)=\frac{s+0.1}{(s+0.1)^2+9}$
Obtain the system function of the IIR digital filter by using impulse invariance method. (6)

(b) Derive the relation $\omega = 2\tan^{-1}\frac{\Omega T}{2}$ (5)

(c) Consider a second order IIR filter with $H(z)=\frac{1}{(1-0.5z^{-1})(1-0.5z^{-1})}$
Find the effect on quantization on pole locations of the given system function in direct form and in cascade form by taking b = 3 bits. (4)

6. (a) Design a digital FIR low-pass filter using rectangular window by taking 9 samples of $w(n)$ and with a cut off frequency of 1.2 rad/sec. (8)

(b) Derive DIT- FFT flowgraph for N=4 and hence find DFT of $x(n) = \{12,3,4\}$ (7)

7. (a) Consider a signal $x(n) = nu(n)$ (10)

(i) Determine the magnitude spectrum of the signal

(ii) The signal is applied to a decimatorthat reduces the sampling rate by a factor 3. Determine the output spectrum.

(iii) Show that the spectrum in part (ii) is simply Fourier Transform of $x(3n)$

(b) Discuss parametric and non-parametric methods of power spectrum estimation. (5)