DIGITAL SIGNAL PROCESSING & APPLICATIONS
(ECEN 3202)

Time Allotted : 3 hrs   **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and
<u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) The digital system in $y[n] = x[n^2]$ is
(a) linear and causal   (c) linear and non causal
(b) non linear and causal   (d) non Linear and non causal.

(ii) The system described by the input-output equation $y(n) = nx(n) + bx^3(n)$ is a
(a) static system   (b) dynamic system
(c) identical system   (d) none of the mentioned.

(iii) The system $y(n) = \cos[x(2n)]$ is
(a) stable, linear and time-variant
(b) stable, linear and time-invariant
(c) unstable, non-linear and time-variant
(d) unstable, linear and time-variant.

(iv) What is the z-transform of the signal $x(n) = (0.5)^n u(n)$?
(a) $\frac{1}{1-0.5z^{-1}}$; $ROC: |z| > 0.5$ (b) $\frac{1}{1-0.5z^{-1}}$; $ROC: |z| < 0.5$
(c) $\frac{1}{1+0.5z^{-1}}$; $ROC: |z| > 0.5$ (d) $\frac{1}{1+0.5z^{-1}}$; $ROC: |z| < 0.5$

(v) If $X(z) = z^{-1}(1-z^{-4})/4(1-z^{-1})^2$ then its final value is
(a) i/4   (b) 0   (c) 1   (d) ∞.

(vi) A system characterized by the system function $H(z) = \frac{1}{2}(1+ z^{-1})$ is a
(a) low pass filter   (b) high pass filter
(c) band pass filter   (d) band stop filter.

(vii) Which of the following method is used to restrict the inverse filter to be FIR?
(a) Truncating $h_I(n)$
(b) Expanding $h_I(n)$
(c) Truncating $H_I(z)$
(d) None of the mentioned.

(viii) IIR filter is
(a) recursive and linear
(b) recursive and non linear
(c) non recursive and linear
(d) none of these.

(ix) An FIR filter is
(a) unstable and linear phase
(b) stable and non linear phase
(c) stable and linear phase
(d) unstable and non linear phase.

(x) Down sampler is usually preceded by a LPF. This combination is called
(a) Decimator
(b) Rational sampling rate converter
(c) Interpolator
(d) none of these.

Group – B

2. (a) Determine the range of value of the parameter a for which the linear time invariant system with impulse response $h(n) = a^n$ is stable.

(b) Find the impulse response of the system described by difference equation $y(n) – 3y(n-1) - 4y(n-2) = x(n) + 2x(n-1)$ using z-transform.

(c) Determine the convolution of the following pair of signals:
$x_1(n) = u(n)$ $x_2(n) = \delta(n) + (1/2)^n u(n)$

3 + 5 + 4 = 12

3. (a) What is 'Z' transform & how do you define ROC?

(b) Find out the Z transform of $x(n) = n.a^n.\sin(w.n).u(n)$

(c) What is inverse 'Z' transform? Find out the inverse 'Z' transform of $X(Z) = z/(3z^2 - 4z + 1.)$ With ROC
(i) $|Z| < 1/2$
(ii) $|Z| > 2$.

2 + 4 + 6 = 12

Group – C

4. (a) Prove the circular time shifting property $x((n-l))_N = X(k) e^{-j2\pi kl/N}$.

(b) Using linear convolution find $y(n) = x(n) * h(n)$ for the sequence $x(n) = \{1, 2, -1, 1, 1, 2, -1\}$ and $h(n) = \{1, 2\}$ and compare the result by solving problem using overlap save method for N = 4.

4 + 8 = 12

5. (a) What is FFT? How do you get the Radix 2 FFT algorithm?

(b) Derive the expression of DIT algorithm.

(c) Determine 8 point DFT of $x(n) = \{0, 1, 2, 3\}$ using DIF butterfly structure.

2 + 3 + 7 = 12

Group – D

6. (a) Design a Butterworth filter for the following specification using
(i) Bilinear transformation method

(ii) Impulse invariance method
$0.8 \leq |H(e^{jw})| \leq 1$ $0 \leq w \leq 0.2\pi$
$|H(e^{jw})| \leq 0.2$ $0.6\pi \leq w \leq \pi$

(6 ×2) = 12

7. (a) What is Gibs phenomenon? Explain with diagram. How do you avoid the bad effect of Gibbs phenomenon?

(b) Design an ideal FIR low pass filter with a frequency response
$H_d(e^{jw}) = 1$ for $-\pi/2 \leq \omega \leq \pi/2$
$= 0$ for $\pi/2 \leq |\omega| \leq \pi$
Find the values of h(n) for N = 11. Find H(Z) and plot the magnitude response.

(1 + 1 + 2) + 8 = 12

Group – E

8. (a) Realize the system given by following difference equation
$y(n) = -0.1y(n-1) + 0.72y(n-2) + 0.7x(n) – 0.252x(n-1)$ in parallel form.

(b) Realize the system function
$H(Z) = 1/2 + 1/3(Z^{-1}) + Z^{-2} + \frac{1}{4}(Z^{-3}) + Z^{-4} + 1/3(Z^{-5}) + \frac{1}{2}(Z^{-6})$ using any method.

6 + 6 = 12

9. Write short notes on any two of following.
(i) Butterworth filter
(ii) Bilinear transformation.
(iii) Decimation and Interpolation
(iv) Architecture of TMS 320C5416.

(6 × 2) = 12