

M.TECH/AEIE/1st SEM/AEIE 5102/2017
DIGITAL SIGNALS AND SYSTEMS
(AEIE 5102)

Time Allotted: 3 hrs

Full Marks: 70

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
Any 5 (five) from Group B to E, taking at least one 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) If F_s is the sampling frequency then the relation between analog frequency F and digital frequency f is
- (a) $f = \frac{F}{2F_s}$ (b) $f = \frac{F_s}{F}$ (c) $f = \frac{F}{F_s}$ (d) $f = \frac{2F}{F_s}$.
- (ii) For energy signals, the energy will be finite and the average power will be
- (a) infinite (b) finite
 (c) zero (d) cannot be defined.
- (iii) Find the response of an FIR filter with impulse response $h(n) = \{1, 2, 4\}$ to the input sequence $x(n) = \{1, 2\}$.
- (a) $y(n) = \{1, 2, 8, 8\}$ (b) $y(n) = \{1, 4, 6, 6\}$
 (c) $y(n) = \{1, 4, 8, 8\}$ (d) none of the above.
- (iv) The zero input response or natural response is mainly due to
- (a) initial condition of the system
 (b) initial stored energy in the system
 (c) specific input signal
 (d) both a and b.
- (v) The DFT of $x(n) = \delta(n)$ is
- (a) 1 (b) 0 (c) $W = e^{-i(\frac{2}{N})}$ (d) ∞ .

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- (vi) Wavelet series equation is sum of
- (a) scaling coefficients (b) detail coefficients
 (c) span coefficients (d) both (a) and (b).
- (vii) The factor that influence the choice of realization of digital filter structure is
- (a) memory requirements
 (b) computational complexity
 (c) parallel processing and pipelining
 (d) all the above.
- (viii) If $X(k)$ consists of N-number of frequency samples, then its discrete frequency locations are given by
- (a) $f_k = \frac{kF_s}{N}$ (b) $f_k = \frac{F_s}{N}$
 (c) $f_k = \frac{kN}{F_s}$ (d) $f_k = N$.
- (ix) The output of two digital filters can be added or the same effect can be achieved by,
- (a) adding their coefficients
 (b) subtracting their coefficients
 (c) convolving their coefficients
 (d) averaging their coefficients and then using a Blackman window.
- (x) $E[X - E(X)]^2$ is:
- (a) $E(X)$ (b) $E(X^2)$ (c) $\text{Var}(X)$ (d) $\text{SD}(X)$.

Group - B

2. (a) Consider the analog signals, $x_1(t) = 2 \cos 2\pi(10t)$ and $x_2(t) = 2 \cos 2\pi(50t)$. Find a sampling frequency so that 50 Hz signal is an alias of the 10Hz signal.
- (b) What are energy and power signals? Test whether the signal $x(n) = u(n)$ is energy or power signal?
- 5 + (2 + 5) = 12**
3. (a) What do you mean by FIR and IIR systems?
 (b) Determine the linearity of the system given by $y(n) = Ax(n) + B$.

- (c) Perform correlation of the two sequences, $x(n) = \{1, 2, 3\}$ and $y(n) = \{2, 4, 1\}$.

2 + 6 + 4 = 12

Group - C

4. (a) Show that the DFT of a N -point sample sequence can be expressed as a weighted sum of DFTs of an even sample sequence and an odd sample sequence. Use the above result to construct the butterfly diagram of DFT calculation for a two-point sequence.

- (b) Compute 4-point DFT of the discrete time signal, $x(n) = \{1, 3, 1, 2\}$, using radix-2 DIT-FFT algorithm.,

(4 + 2) + 6 = 12

5. (a) Compute the circular convolution of the following two sequences using DFT: $x_1(n) = \{2, 1, 2, 1\}$ and $x_2(n) = \{1, 2, 3, 4\}$.

- (b) Describe how subband coding is extended for image analysis and synthesis.

6 + 6 = 12

Group - D

6. (a) Determine the order and the poles of lowpass Butterworth filter that has a 3dB attenuation at 500 Hz and an attenuation of 40dB at 1000Hz.

- (b) What is wrapping effect?

- (c) Obtain the direct form-I realization for the system described by difference equation $y(n) = 0.5y(n-1) - 0.25y(n-2) + x(n) + 0.4x(n-1)$.

5 + 2 + 5 = 12

7. (a) What is the advantage in cascade and parallel realization of IIR systems?

- (b) Realize the following system with minimum number of multipliers:

$$H(z) = \frac{1}{4} + \frac{1}{2}z^{-1} + \frac{3}{4}z^{-2} + \frac{1}{2}z^{-3} + \frac{1}{4}z^{-4}$$

2 + 10 = 12

Group - E

8. Design one stage and two stage interpolator to meet the following specification:

$$I = 20$$

Input sampling rate: 10,000 Hz

Pass band: $0 \leq F \leq 90$

Transition band: $90 \leq F \leq 100$

Ripple: $\delta_1 = 10^{-2}, \delta_2 = 10^{-3}$

12

9. (a) What do you mean by wide sense stationary (WSS) process?

- (b) A discrete time random process is generated as follows:

$$x(n) = \sum_{k=1}^P a(k)x(n-k) + \omega(n), \text{ where } \omega(n) \text{ is a white noise process}$$

with variance σ_ω^2 . Another process $z(n)$, is formed by adding noise to $x(n)$ as $z(n) = x(n) + v(n)$, where $v(n)$ is white noise with variance of σ_v^2 that is uncorrelated with $\omega(n)$.

- i. Find power spectrum of $x(n)$.

- ii. Find the power spectrum of $z(n)$.

4 + (4 + 4) = 12