Group - E

8. (a) Apply bilinear transformation to $H(s) = \frac{2}{(s+1)(s+2)}$ with $t = 1$ sec and find $H(z)$.

   (b) Realize the system function using minimum no. of multipliers.

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

6 + 6 = 12

9. (a) Find the direct form-II realization of a LTI system governed by the equation, $y(n) = -\frac{3}{8}y(n-1) + \frac{3}{32}y(n-2) + \frac{1}{64}y(n-3) + x(n) + 3x(n-1) + 2x(x-2)$.

   (b) Determine the frequency response of FIR filter defined by $y(n) = 0.25x(n) + x(n-1) + 0.25x(n-2)$. Calculate the phase delay and group delay.

6 + 6 = 12

FUNDAMENTALS OF DIGITAL SIGNAL PROCESSING
(AEIE 3231)

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) The process of conversion of continuous time signal into discrete time signal is known as,
   (a) aliasing (b) sampling
   (c) zero-padding (d) convolution.

   (ii) The sampling frequency of the following analog signal, $x(t) = 4\sin 150\pi t + 2\cos 50\pi t$ should be
   (a) greater than 75 Hz (b) greater than 150 Hz
   (c) less than 150 Hz (d) greater than 50 Hz.

   (iii) If F_s is 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) $f = \frac{2F}{F_S}$.

   (iv) Two parallel connected discrete time systems with impulse responses $h_1(n)$ and $h_2(n)$ can be replaced by a single equivalent discrete time system with impulse response,
   (a) $h_1(n) * h_2(n)$ (b) $h_1(n) + h_2(n)$
   (c) $h_1(n) * [h_1(n) + h_2(n)]$ (d) $h_1(n) - h_2(n)$.

   (v) The Z-transform of correlation of the sequences x(n) and y(n) is,
   (a) $X^*(z)Y^*(z^{-1})$ (b) $X(z)Y(z^{-1})$
   (c) $X(z) * Y(z^{-1})$ (d) $X(z^{-1}) * Y(z^{-1})$.

(vi) If $x(n) = \{1,0,0,1\}$, the DFT value $X(0)$ is
(a) 2 (b) 0
(c) 1+*j* (d) 1-*j*.

(vii) In an N-point sequence, if N=16, the total number of complex additions and multiplications using Radix-2 FFT are,
(a) 64 and 80 (b) 80 and 64
(c) 64 and 32 (d) 24 and 12.

(viii) The transfer function of a normalized lowpass filter can be transformed to highpass filter with cutoff frequency, Ω_c by the transformation,
(a) $s = \frac{1}{s}$ (b) $s = \frac{\Omega_c}{s}$
(c) $s = \frac{s}{\Omega_c}$ (d) $s \to \Omega_c$.

(ix) The complex valued phase factor/ twiddle factor, W_N can be represented as,
(a) $e^{-j2\pi N}$ (b) $e^{\frac{-j2\pi}{N}}$
(c) $e^{-j2\pi}$ (d) $e^{-j2\pi kN}$.

(x) The linear phase realization structure is used to represent,
(a) FIR systems (b) IIR systems
(c) both FIR and IIR systems (d) all discrete time systems.

Group - B

2. (a) Determine if the following signal is periodic or not. If periodic find the fundamental period.
$$x(n) = \sin\frac{\pi}{8}n^2.$$
(b) Test the stability of the system, whose impulse response is $h(n) = 4^n u(-n)$.
(c) Determine the impulse response for the cascade of two LTI systems having impulse responses, $h_1(n) = \left(\frac{2}{5}\right)^n u(n)$ and $h_2(n) = \left(\frac{1}{5}\right)^n u(n)$.

4 + 4 + 4 = 12

3. (a) Determine whether the following signal is energy or power signal.
$x(n) = \left(\frac{1}{4}\right)^n u(n)$.

(b) Test the following system for time invariance
$$y(n) = x(n) - bx(n-1).$$
(c) Determine the response of the relaxed system characterized by the impulse response $h(n) = \left(\frac{1}{2}\right)^n u(n)$ to the input signal $x(n) = 2^n u(n)$.

4 + 4 + 4 = 12

Group - C

4. (a) Prove that $Z\{x(-n)\} = X(z^{-1})$ if $X(z) = Z\{x(n)\}$.
(b) Determine the convolution of the pair of signals by means of the Z-transform $x_1(n) = \left(\frac{1}{2}\right)^n u(n)$; $x_2(n) = \cos\pi n u(n)$.
(c) State the initial value theorem and the final value theorem.

4 + 6 + 2 = 12

5. (a) Determine the inverse Z-transform by partial fraction expansion method. $X(z) = \frac{z+2}{2z^2-7z+3}$ if the ROC are $|z| > 3$ and $\frac{1}{2} < |z| < 3$.
(b) Find the poles of the system $y(n) - \frac{1}{4}y(n-1) + \frac{1}{4}y(n-2) - \frac{1}{16}y(n-3) = 2x(n) + 3x(n-1)$ and determine whether the system is stable.

6 + 6 = 12

Group - D

6. (a) Perform the circular convolution of the following sequences using DFT and IDFT method.
$x(n) = \{1,1,2,1\}$ and $h(n) = \{1,2,3,4\}$.
(b) What is zero padding?

10 + 2 = 12

7. (a) Find the DFT of a sequence $x(n) = \{1,2,3,4,4,3,2,1\}$ using 8 point DIT FFT algorithm.
(b) Why FFT is needed?

10 + 2 = 12