7. (a) Find the DFT of a sequence $x(n) = \{1, 1, 1, 1, 2, 2, 2, 2\}$ using DIT FFT algorithm.

   (b) What is bit reversal?

**10 + 2 = 12**

## Group – E

8. (a) Convert a third order Butterworth analog filter into digital filter using impulse invariant technique. Assume sampling period T = 1 sec.

   (b) Differentiate between FIR and IIR filters.

   (c) What is wrapping effect?

   (d) What is windowing?

**7 + 2 + 2 + 1 = 12**

9. (a) Determine the direct form II realization for the following system $y(n) = -0.1y(n-1) + 0.72y(n-2) + 0.7x(n) - 0.25x(n-2)$.

   (b) Determine the cascade realization of system function of an FIR filter $H(z) = \left(1 + 2z^{-1} - z^{-2}\right)\left(1 + z^{-1} - z^{-2}\right)$.

**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 relation between unit impulse and unit step functions may be described by
   (a) $\delta(n) = u(n) - u(n+1)$ (b) $\delta(n) = u(n) - u(n-1)$
   (c) $\delta(n) = u(-n) - u(n+1)$ (d) $\delta(n) = u(n) - u(-n+1)$

   (ii) If $x_1(n)$ and $x_2(n)$ are finite length sequences of lengths *L* and *M* respectively, their linear convolution has the length
   (a) *L + M* - 2 (b) *L + M* - 1
   (c) *L + M* (d) *max* (*L, M*)

   (iii) A discrete-time LTI system is known as causal system if its,
   (a) $h(n) = 0,\ n < 0$ (b) $h(n) = 0,\ n > 0$
   (c) $h(n)$ is positive, $n < 0$ (d) none of these.

   (iv) If the Z-transform of $x(n)$ is $X(z)$, then Z-transform of $(0.5)^n x(n)$ is,
   (a) $X(0.5z)$ (b) $X(0.5^{-1}z)$
   (c) $X(2^{-1}z)$ (d) $X(0.5z^{-1})$

   (v) The direct evaluation of DFT requires
   (a) $N^2$ multiplications and $N^2$ additions
   (b) $N^2$ multiplications and $N(N-1)$ additions
   (c) $N(N-1)$ multiplications and $N^2$ additions
   (d) $N(N-1)$ multiplications and $N(N-1)$ additions.

(vi) The value of the twiddle factor $W_8^4$ is given by

(a) 1 (b) $-j$ (c) $\frac{1}{\sqrt{2}}-\frac{j}{\sqrt{2}}$ (d) $-1$.

(vii) The poles of Butterworth transfer function lie,
(a) Symmetrically on a circle in s-plane
(b) Symmetrically on a ellipse in s-plane
(c) Asymmetrically on a circle in s-plane
(d) Asymmetrically on a ellipse in s-plane.

(viii) In impulse invariant transformation the digital frequency '$\omega$' for a given analog frequency, $\Omega$ is given by

(a) $\omega = \Omega T$ (b) $\omega = \frac{\Omega}{T}$

(c) $\omega = \frac{T}{\Omega}$ (d) $\omega = \tan \Omega T$

(ix) Bit reversal is applicable to,
(a) DFT (b) FFT (c) CFT (d) STFT.

(x) The direct form-I and direct form II structures of IIR system will be identical in,
(a) all pole system
(b) all zero system
(c) both a and b
(d) first-order and second-order systems.

## Group – B

2. (a) What are energy and power signals?

(b) Determine whether the following signal is energy signal, power signal or none of them.

$$x(n) = e^{2n}u(n)$$

(c) Determine the response of the LTI system whose input *x(n)* and impulse response *h(n)* are given by,

$$x(n) = \begin{cases} 1, & n = -2, 0, 1 \\ 2, & n = -1 \\ 0, & elsewhere \end{cases} \text{ and } h(n) = \delta(n) - \delta(n-1) + \delta(n-2) - \delta(n-3).$$

**2 + 4 + 6 = 12**





3. (a) Find the cross-correlation of two finite length sequences *x(n)* = {1, 2, 1, 1}; *y(n)* = {1, 1, 2, 1}.

(b) Represent the sequence $x(n) = \{4, 2, -1, \underset{\uparrow}{1}, 3, 2, 1, 5\}$ as sum of shifted unit impulses.

(c) Find the circular convolution of the two finite duration sequences $x_1(n) = \{1, -1, -2, 3, -1\}$ and $x_2(n) = \{1, 2, 3\}$.

**4 + 3 + 5 = 12**

## Group – C

4. (a) Find the Z-transform and the ROC of $x(n) = (n + 0.5)\left(\frac{1}{3}\right)^n u(n)$.

(b) Determine the causal signal *x(n)* having the Z-transform $X(z) = \frac{z^3}{(1-2z^{-1})(z-1)^2}$ by using Partial Fraction Expansion Method.

(c) What is the relationship between Z-transform and Fourier transform?

**5 + 5 + 2 = 12**

5. (a) Determine the pole-zero plots for the system described by difference equation $y(n) - \frac{3}{4}y(n-1) + \frac{1}{8}y(n-2) = x(n) - x(n-1)$.

(b) Find the initial value $x(0)$ and final value $x(\infty)$ of the z-domain signal

$$X(z) = \frac{1}{1-z^{-2}}.$$

**6 + 6 = 12**

## Group – D

6. (a) Determine the IDFT of the sequence $X(k) = \{5, 0, 1-j, 1, 0, 1+j, 0\}$

(b) Prove, if $X_3(k) = X_1(k) \times X_2(k)$, then $x_3(n) = \sum_{m=0}^{N-1} x_1(m)\, x_2((n-m))_N$

**6 + 6 = 12**