2022

ELECTRONICS — HONOURS

Paper : DSE-A-2

(Digital Signal Processing)

Full Marks : 50

The figures in the margin indicate full marks.

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

Answer ***question no.*** **1** and ***any four*** questions from the rest.

1. Answer ***any ten*** multiple choice questions from the following : 1×10

(a) A discrete time sequence $x(n) = u(-n)$ is a

(i) Causal signal (ii) Non-causal signal

(iii) Even signal (iv) Both (ii) and (iii).

(b) A discrete-time system is a system which transforms

(i) discrete-time input signals into continuous-time output signals

(ii) discrete-time input signals into discrete-time output signals

(iii) continuous-time input signals into discrete-time output signals

(iv) all of the above.

(c) In a shift-invariant system,

(i) a time shift in the input results in a corresponding time shift in the output

(ii) a time shift in the input does not result in a corresponding time shift in the output

(iii) an input results in a corresponding time shift in the output

(iv) all of the above.

(d) Which DFT property denotes, $x(n-m) \rightarrow \exp(-j2\pi km)\times(k)$?

(i) Linearity (ii) Time shifting

(iii) Time reversal (iv) Periodicity.

(e) In case of a stable system, the poles lie

(i) in the right half of S-plane (ii) in the left half of S-plane

(iii) on the imaginary axis (iv) at the origin.

(f) Which filter from below is best described as flat-flat filter?

(i) Chebyshev filter (ii) Notch filter

(iii) Butterworth filter (iv) Elliptic filter.

(g) State whether $h(n) = 4^n u(-n)$ is

(i) Stable

(ii) Unstable

(iii) None of these.

(h) The width of the main lobe in Hanning window spectrum is,

(i) $8\pi/N$ (ii) π/N

(iii) $2\pi/N$ (iv) $4\pi/N$.

(i) The direct form realization, cascade realization, lattice structure realization are the different forms of realizing

(i) FIR system

(ii) IIR system

(iii) Both.

(j) In circular convolution, the length of the sequences x(n) and h(n) should be

(i) unequal (ii) same

(iii) $x(n) \leq h(n)$ (iv) $x(n) \geq h(n)$.

(k) The relation between analog and digital frequencies in impulse invariant transformation is

(i) $\omega T = \Omega$ (ii) $\omega = \Omega$

(iii) $\omega\Omega = T$ (iv) $\omega = \Omega T$.

(l) FIR filter is always stable because

(i) no pole at the origin (ii) all its poles are at the origin

(iii) all its zeros are at the origin (iv) no pole at the origin.

2. (a) Find the DTFT of the sequence, $x(n) = \{1, -2, 2, 3\}$.

(b) What do you mean by LTI system? Mention its properties.

(c) Differentiate between a causal and non-causal system. 4+(1+3)+2

3. (a) Write a difference equation that characterizes a system whose frequency response is :

$$H(\omega) = \frac{1 - e^{-j\omega} - 3e^{-j2\omega}}{1 + \left(\frac{1}{3}\right)e^{-j\omega} + \left(\frac{1}{6}\right)e^{-j2\omega}}$$

(b) State BIBO stability criterion.

(c) Check the stability of the system defined by, $y(n) = ax(n - 7)$. 4+2+4

4. (a) Find the circular convolution of the following sequence using DFT and IDFT,

$x(n) = \{\underset{\uparrow}{1}, 1, 2, 2\}$; $h(n) = \{\underset{\uparrow}{1}, 2, 3, 4\}$

(b) What is the relation between z-transform and DFT? (4+4)+2

5. (a) How FFT improves the speed of computation compared to DFT?

(b) Compute 4-point radix-2 DIT FFT of the square wave sequence $x(n) = \{1, 1, -1, -1\}$.

(c) Compare the radix-2 DIT and DIF FFTs. 2+6+2

6. (a) What are the requirements for an analog filter to be causal and stable?

(b) What is Notch filter? State its use.

(c) What are the different types of filters based on impulse response?

(d) What are the advantages and disadvantages of FIR filters? 2+(2+1)+2+3

7. (a) The system function of a filter is given as,

$$H(s) = \frac{(s+0.1)}{(s+0.1)^2 + 16}$$

Obtain the system function using bilinear transformation which is resonant at $\omega_r = \pi/2$.

(b) Briefly explain Butterworth low pass filter. (4+4)+2

8. (a) What do you mean by reactive network?

(b) State Foster's reactance theorem.

(c) An impedance function is given by,

$$Z(s) = \frac{2(s+1)(s+3)}{(s+2)(s+4)}$$

Find the RL representation of Foster's first form of network. 2+2+6
