Seventh Semester B.Tech. Degree Examination, October 2018
(2013 Scheme)
13.702 : DIGITAL SIGNAL PROCESSING (E)

Time : 3 Hours
Max. Marks : 100

PART – A

Answer all questions. Each question carries 2 marks.

1. Find the Nyquist rate (sampling frequency) for the signal
   \( x(t) = 3\cos(100\pi t) + 2\sin(200\pi t) \).

2. Investigate the stability of the system whose impulse response is given by
   \( h[n] = 0.5^n u[n] \).

3. Name the various operations in the analog to digital conversion.

4. Find the discrete-time Fourier transform of \( \delta[n] \).

5. State Parseval’s theorem for continuous time periodic signals.

6. Compare the number of multiplications required for determining the 8-point DFT by direct computation and fast Fourier transform.

7. State the convolution property of Z-transform.

8. Write the symmetry condition for linear phase realization of a causal FIR filter.

9. What is the location of poles in Z-plane if the analog poles are at \( S_1 = -1 \) and \( S_2 = -1 + j6.28 \) if impulse invariant technique is used with \( T = 1 \) sec.


P.T.O.
PART – B

Answer any one full question from each Module. Each question carries 20 marks.

Module – 1

11. a) State and explain sampling theorem. Also explain aliasing.  
   b) Determine whether the following systems are linear, time-invariant, dynamic and causal.  
      i) \( y[n] = x[n^2] \)  
      ii) \( y[n] = \cos(x[n]) \).  

   OR

12. a) An LTI system is characterized by an impulse response \( h[n] = \left( \frac{3}{4} \right)^n u[n] \). Find the step response.  
   b) Derive the condition for causality of discrete-time systems in terms of its impulse response.  

Module – 2

13. a) Find the Fourier transform and plot the magnitude spectrum of the following aperiodic signal.

   ![Signal](image)

   b) Find the DTFT of \( x[n] = \{1, 0, 1\} \) and draw the amplitude and phase spectrum.  

   OR

14. a) Obtain the linear convolution of the sequences \( x(n) = \{1, 2, 3, 4\} \) and \( h(n) = \{-1, -2, -3\} \) using circular convolution.  
   b) Given a sequence \( x(n) = \{1, 1, 1, 0, 0, -1, -1, -1\} \), determine DFT \( X(k) \) using DIT FFT algorithm.  

Module – 3

15. a) Find the Z-transform and its ROC of \( x(n) = \left( \frac{1}{2} \right)^n u(-n-1) \) where \( u(n) \) denotes unit step signal.  
   b) Find the direct form I and direct form II realization for the system  
      \( y[n] = y[n-1] - \frac{1}{2} y[n-2] + x[n] - x[n-1] + x[n-2] \).  

   OR
16. a) A causal LTI system is described by \( y[n] - \frac{3}{4} y[n - 1] + \frac{1}{8} y[n - 2] = x[n] \)

where \( x[n] \) and \( y[n] \) are the input and output of the system respectively. Find the system function \( H(z) \) and step response.

b) Obtain the cascade realization using the minimum number of multiplications for the system \( H(z) = \left( 1 + \frac{1}{2} z^{-1} + z^{-2} \right) \left( 1 + \frac{1}{4} z^{-1} + z^{-2} \right) \).

Module - 4

17. a) The system function of an analog filter is given as \( H(s) = \frac{1}{s^2 + \sqrt{2} s + 1} \).

Obtain \( H(z) \) using impulse invariant technique.

b) Design a digital Chebyshev filter to satisfy the constraints

\[
0.707 \leq |H(e^{j\omega})| \leq 1, \quad 0 \leq \omega \leq 0.2\pi
\]

\[
|H(e^{j\omega})| \leq 0.1, \quad 0.5\pi \leq \omega \leq \pi
\]

By using bilinear transformation and taking \( T = 1 \) sec.

OR

18. a) A low pass filter is required to be designed with the desired frequency response which is expressed as follows:

\[
H_d(e^{j\omega}) = \begin{cases} 
  e^{-j\omega}, & -\pi / 4 \leq \omega \leq \pi / 4 \\
  0, & \pi / 4 \leq |\omega| \leq \pi 
\end{cases}
\]

Obtain the filter coefficients \( h_d[n] \) if the window function is defined as under:

\[
w[n] = \begin{cases} 
  1, & 0 \leq n \leq 4 \\
  0, & \text{otherwise}
\end{cases}
\]

b) Make use of bilinear transformation to obtain \( H(z) \) if it is given that

\[
H(s) = \frac{1}{(s + 1)} \quad \text{and} \quad T = 1 \text{ sec}.
\]