Total No. of printed pages = 4

19/5th Sem/UECE504

2021

DIGITAL SIGNAL PROCESSING

Full Marks – 100

Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer any *five* questions.

1. (a) A casual LTI system is characterised by the difference equation

$$y(n)=\frac{1}{4}y(n-1)+\frac{1}{8}y(n-2)+x(n)-x(n-1).$$

Find the system function 'H(z)' and the unit impulse response 'h(n)'. 10

(b) Determine the inverse z-trasnform of $X(z)=\frac{z+2}{2z^2-7z+2}$ using partial fraction expansion method and if the ROC's are

(i) $z>3$, (ii) $|z|<\frac{1}{2}$, (iii) $\frac{1}{2}<|z|<3$.

10

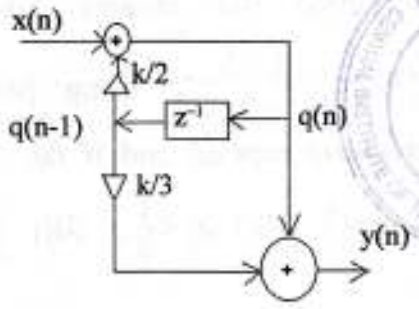
[Turn over

2. (a) There are two kinds of particles inside a nuclear reactor. Every second, an 'α' particle will split into eight 'β' particles and a 'β' particle will split into a 'α' particle and two 'β' particles. If there is a single 'α' particle in the reactor at time $t = 0$, how many particles are there altogether at time $t = 100$? 14

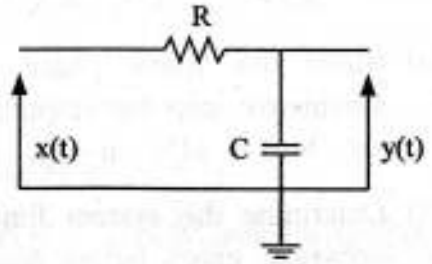
(b) Two casual systems with impulse response $h_1[n] = a \times \delta[n] + \delta[n-1]$ and $h_2[n] = b^n \times u[n]$, where $|b| < 1$, are connected in cascade as shown below : 6

Determine the frequency response $H(e^{jw})$ of the overall system. Find the values of 'a' and 'b' for which $|H(e^{jw})| = 1$.

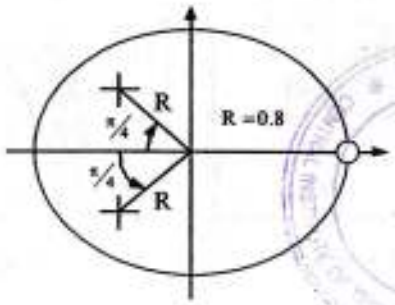
3. (a) Consider the discrete-time system shown below. For what values of 'k' is the system BIBO stable ? 10



(b) For a low pass RC network ($R = 1\ M\Omega$ and $C = 1\mu F$) shown below. Determine the equivalent discrete-time expression for the circuit response y(n), when the input is $x(t) = e^{-2t}$ and the sampling frequency is 50 Hz. 10



4. (a) From the given pole-zero plot, determine the system transfer function and explain its filtering action. 8+4=12



(b) An FIR filter (N = 11) is characterized by the following transfer function : $H(z) = \sum_{n=0}^{N-1} h(n) \times z^{-n}$. Determine the magnitude response and also prove that the phase and group delays are constant. 8

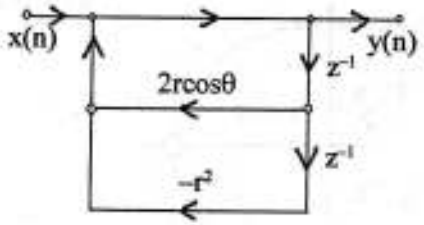
5. (a) Draw and establish the complete signal flow-graph of an 8-point DIT-FFT technique. 15

(b) Calculate the 8-point DIT-FFT of the given sequence : 5

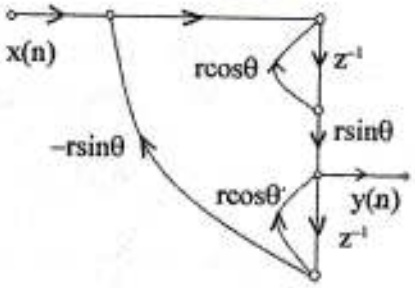
$$x(n) = \{1,2,3,4,4,3,2,1\}$$

6. (a) Show that linear phase FIR filters have symmetric impulse response characteristics, i.e., $h(n) = h(N-n-1)$. 10

(b) Determine the system function of the two networks given below and show that they have the same poles. 10



Network - I



Network - 2