Total number of printed pages–4

53 (EC 603) DSPR

2018

DIGITAL SIGNAL PROCESSING

Paper : EC 603

Full Marks : 100

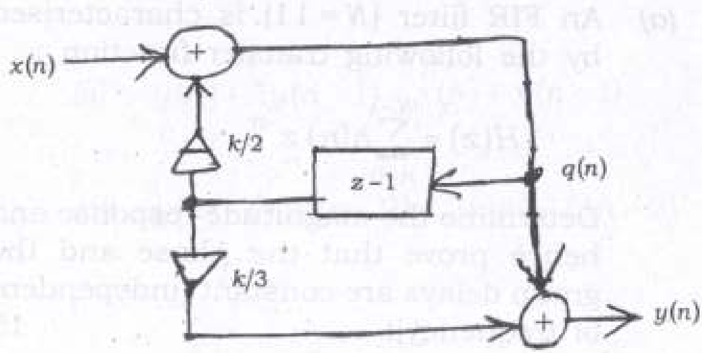
Time : Three hours

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

Answer ***any five*** *questions.*

1. *(a)* Establish the relationship between analog frequency and digital frequency. 5

   (b) Consider the discrete-time system shown below. For what values of *'K'* is the system BIBO stable ? 15



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2. Determine the output sequence of the system with impulse response $h(n) = \left(\frac{1}{2}\right)^n u(n)$, when the input is the complex exponential sequence $x(n) = 4\,exp(j\pi n/2);\ -\infty < n < \infty$. Deduce the necessary theory. 15+5

3. *(a)* If a discrete-time LTI system is BIBO stable, show that the ROC of its system function $H(z)$ must contain the unit circle, i.e. $|z| = 1$. 10

   (b) Find the circular convolution of the two sequences : $x(n) = \{1, -2, 4, 1{\cdot}5\}$ and $h(n) = \{3, 0, -2, 5\}$ using graphical method. 10

4. *(a)* An FIR filter ($N = 11$) is characterised by the following transfer function :

$$H(z) = \sum_{n=0}^{N-1} h(n)\, z^{-n}$$

   Determine the magnitude response and hence prove that the phase and the group delays are constant (independent of frequency). 15

   (b) Design a single-pole low-pass digital filter with a $3dB$ bandwidth of $0{\cdot}2\pi$ using Bilinear transformation. The corresponding analog filter has a system response given by $H(s) = \Omega c/(s + \Omega c)$; where '$\Omega c$' is the $3dB$ bandwidth of the analog filter. 5

5. Find the impulse response $h(n)$ for each of the causal, discrete-time LTI systems satisfying the following difference equations and also indicate the type of the system (FIR or IIR) : 20

   (i) $y(n) = x(n) - 2x(n-2) + x(n-3)$

   (ii) $y(n) + 2y(n-1) = x(n) + x(n-1)$

   (iii) $y(n) - 0{\cdot}5y(n-2) = 2x(n) - x(n-2)$

6. Show that analog transfer function

$$Ha(s) = \frac{b.s}{s^2 + bs + \Omega_0^2};\ b > 0$$

has a band-pass magnitude response with $|Ha(j0)| = |Ha(j\infty)| = 0$ and $|Ha(j\Omega_0)|$ is unity.

Also determine the frequencies Ω_1 and Ω_2 at which the gain is $3dB$ below the maximum value of $0dB$ at Ω_0. Show that $\Omega_1 . \Omega_2 = \Omega_0^2$.

Hence show that $b = \Omega_2 - \Omega_1$; which is the $3dB$ bandwidth of the bandpass transfer function. 10+4+3+3
