Total number of printed pages–5

53 (EC 603) DSPR

2014

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)* Distinguish between discrete-time signal and digital signal.

(b) What is impulse response and what is its significance ?

(c) How can you find the step response of a system if the impulse response is known ?

(d) Compute $y(n) = x(n) * h(n)$; where

$$x(n) = h(n) = \left\{ \underset{\uparrow}{1}, 2, -1 \right\}.$$

(e) Determine the impulse response of the following casual system

$$y(n)-3y(n-1)+2y(n-2)=x(n)+3x(n-1)+2x(n-2)$$

2+2+6+2+8

2. (a) Test the stability of the system :

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

(b) Given $y(n)=x\left(n^2\right)$, determine whether the system is : linear, time invariant, memoryless, causal.

(c) Find the frequency response of the system described by the system function

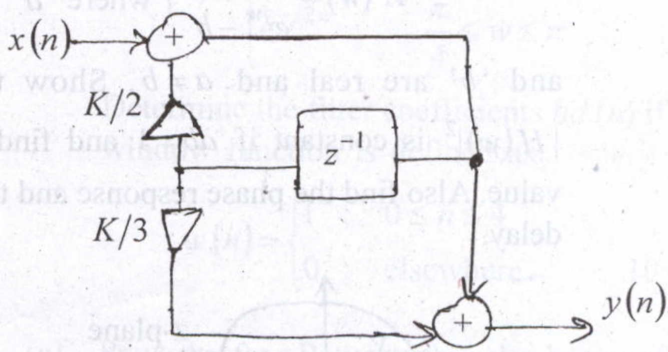
$$H(z)=\frac{1}{1-0{\cdot}5z^{-1}}$$

7+8+5

3. (a) The following transfer function is an FIR filter (N=11). Determine the magnitude response and show that the phase and group delays are constant

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

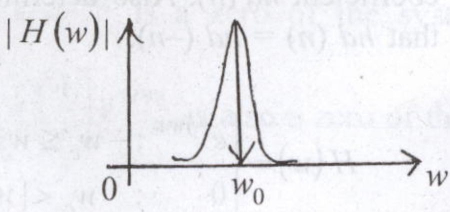
(b) Consider the discrete-time system shown below. For what values of K is the system BIBO stable?



10+10

4. (a) From the given pole-zero plot, determine the system transfer function and explain its filtering property.

(b) What is a digital resonator? Show that the following frequency response can be achieved by a digital resonator.



(c) The frequency response of the system is given by

$$H(w) = \frac{e^{jw} - a}{e^{jw} - b} \text{ ; where } 'a'$$

and 'b' are real and $a \neq b$. Show that $|H(w)|^2$ is constant if $ab = 1$ and find its value. Also find the phase response and time delay.

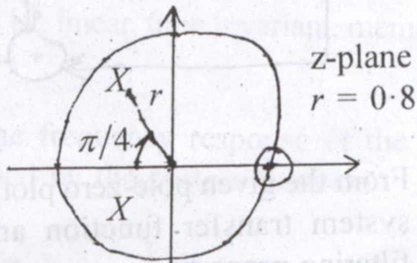


Figure for Q.4(a)

5+5+10

5. (a) A low pass filter should have the frequency response shown below. Find the filter coefficient $hd(n)$. Also determine 'τ' such that $hd(n) = hd(-n)$.

$$H(w) = \begin{cases} e^{-jw\tau} & ; -w_c \leq w \leq w_c \\ 0 & ; \quad w_c < |w| < \pi \end{cases}$$

(*b*) A filter is to be designed with the following desired frequency response

$$Hd(w) = \begin{cases} 0 & ; \ -\frac{\pi}{4} \le w \le \frac{\pi}{4} \\ e^{-j2w} & ; \ \frac{\pi}{4} \le w \le \pi \end{cases}$$

Determine the filter coefficients $hd(n)$ if the window function is defined as

$$w(h) = \begin{cases} 1 & ; \ 0 \le n \le 4 \\ 0 & ; \ \text{elsewhere.} \end{cases}$$

10+10

6. (*a*) Prove that for a Butterworth analog lowpass filter

$$\Omega_C = \frac{\Omega_P}{\left(10^{0\cdot1\alpha P} - 1\right)^{\frac{1}{2N}}} = \frac{\Omega_S}{\left(10^{0\cdot1\alpha S} - 1\right)^{\frac{1}{2N}}}$$

where the symbols have their usual meaning.

(*b*) An FIR LTI system has an impulse response $h(n)$, which is real valued, even and has finite duration of 2N+1. Show that if $z_1 = re^{jw_0}$ is a zero of the system, then $z_1 = \left(\frac{1}{r}\right)e^{-jw_0}$ is also a zero of the system.

10+10

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