53 (EC 603) DSPR

2016

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)* Two causal systems with impulse responses $h_1(n) = a\delta(n) + \delta(n-1)$ and $h_2(n) = b^n u(n)$; where $|b| < 1$ are connected in cascade as shown below :

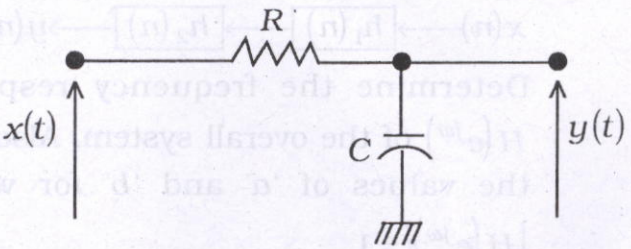
$$x(n) \longrightarrow \boxed{h_1(n)} \longrightarrow \boxed{h_2(n)} \longrightarrow y(n).$$

Determine the frequency response $H(e^{j\omega})$ of the overall system. Also find the values of 'a' and 'b' for which $|H(e^{j\omega})| = 1$. 15

(b) Why folding operation is necessary in convolution formula? 5

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

3. (a) In the given low-pass RC network shown below with $R=1M\Omega$ and $C=1\mu F$, determine the equivalent discrete-time expression for the circuit response $y(n)$, when the input is given by $x(t)=exp(-2t)$ and the sampling frequency is $50Hz$. 17



(b) State sampling theorem for a bandlimited signal $x(t)$. 3

4. Show that the analog transfer function $Ha(s) = \frac{b.s}{s^2 + b.s + \Omega_0^2}$; $b > 0$ has a band-pass magnitude response with $|Ha(j0)| = |Ha(j\infty)| = 0$ and $|Ha(j\Omega_0)| = 1$. 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. 20

5. A digital low-pass filter is to be designed with the following desired frequency response :

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

Calculate the filter's coefficients $hd(n)$ if the window function is defined as

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

Also, find the frequency response $H(w)$ of the designed filter. 15+5

6. Write short notes on : ***(any two)*** 10+10

(i) Digital resonator

(ii) Bilinear transformation

(iii) Subband coding of speech signals.
