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Roll No. ....

328651(28)

BE (6^{th} Semester)

Examination, Nov.-Dec., 2017

(New Scheme)

Digital Signal Processing

Time Allowed : 3 hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : (*i*) Part (*a*) of each question is compulsory.

(*ii*) The figures in the right-hand margin indicate marks.

Unit-I

Attempt any **Two** parts from (*b*), (*c*) and (*d*)

1. (*a*) Write a short note on discrete cosine transformation. [2]

(*b*) Explain discrete Fourier transform and calculate DFT for the input signal $x(n) = \{0, 1, 2, 3\}$. [7]

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(*c*) Let $x_1(n)$ and $x_2(n)$ be the following two 4-point sequences :

$$x_1(n) = \{1, 2, 2, 1\}$$

$$x_2(n) = \{1, -1, -1, 1\}$$

(*i*) Determine their linear convolution $x_3(n)$.

(*ii*) Compute the circular convolution $x_4(n)$ so that it is equal to $x_3(n)$. [7]

(*d*) Explain discrete time Fourier transform (DTFT). Also explain its properties. [7]

Unit-II

Attempt any **One** part from (*b*) and (*c*)

2. (*a*) Design transfer function for the 1^{st} and 2^{nd} order of Butterworth filter. [2]

(*b*) Obtain direct form I, II and cascade form realization of a system transfer function described by

$$y(n) - \frac{3}{4}y(n-1) + \frac{1}{8}y(n-2) = x(n) + \frac{1}{2}x(n-1)$$ [14]

(*c*) Write short notes on signal flow graph and frequency sampling. Draw cascade canonical IIR filter for the transfer function shown below : [14]

$$H(z) = (1 + Z^{-1})/(1 - Z^{-1} + \tfrac{1}{2}Z^{-2})(1 - Z^{-1} + Z^{-2})$$

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Unit-III

Attempt any **One** part from (*b*) and (*c*)

3. (*a*) What is Gibbs phenomenon? [2]

(*b*) Design an ideal low-pass filter with a frequency response

$$H_d(e^{j\omega}) = 1 \quad \text{for } -\pi/2 \le \omega \le \pi/2$$
$$= 0 \quad \text{for } \pi/2 \le \omega \le \pi$$

Find the values of $h(n)$ for the order of filter N=9. Find $H(z)$ using rectangular window method. Also find $H(e^{j\omega})$. [14]

(*c*) Design a filter with

$$H_d(e^{j\omega}) = e^{-j3\omega} \quad -\pi/4 \le \omega \le \pi/4$$
$$= 0 \quad \text{otherwise}$$

Find $H(z)$ using Hamming and Hamming window for the order of filter N=7. [14]

Unit-IV

Attempt any **Two** parts from (*b*), (*c*) and (*d*)

4. (*a*) Define impulse invariance method of transformation. [2]

(*b*) An analog filter has a transfer function $H(s) = 1/(s^2 + 6s + 9)$. Design a digital filter using BLT. [7]

(*c*) Prove that $\Omega c = \Omega p \,/\, (10^{0.1\,Ap}-1)^{1/2N} = \Omega s \,/\, (10^{0.1\,As}-1)^{1/2N}$. [7]

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(*d*) Design a Chebyshev filter with a maximum passband attenuation of 2.5 dB, at $\Omega p = 20$ rad/sec and stopband attenuation of 30 dB at $\Omega s = 50$ rad/sec. [7]

Unit-V

Attempt any **Two** parts from (*b*), (*c*) and (*d*)

5. (*a*) What is the need for anti-imaging filter after upsampling a signal? [2]

(*b*) Assume that the input signal $x(n) = \{1, 2, 3, 2, 3, -1, 3, 5, 6, 9, 1, -1, ...\}$.

Find the output $y(n)$ for the following cases and give comments : [7]

(*i*) Up sampled by 2-fold then down sample by 3-fold

(*ii*) Down sample by 3-fold then up sample by 2-fold

(*iii*) Up sample by 4-fold then down sample by 2-fold

(*iv*) Down sample by 2-fold then up sample by 4-fold

(*c*) Plot the signals and their corresponding spectra for rational sampling rate conversion by (*i*) I/D=5/3 and (*ii*) I/D = 3/5. Assume that the spectrum of the input signal $x(n)$ occupies the entire range $-\pi \le \omega \le \pi$. [7]

(*d*) Answer the following : [7]

(*i*) Show that the Up-sampler and Down-sampler are time-variant systems.

(*ii*) Give any five cases where the multirate DSP is used.