Seat No.	

T.E. (E&T/C) (Semester – I) Examination, 2014
DIGITAL SIGNAL PROCESSING
(2012 Course)

Time : 150 Minutes Max. Marks : 70

Instructions : *1) Answer Q. **1** or Q. **2**, Q. **3** or Q. **4**, Q. **5** or Q. **6**, Q. **7** or Q. **8**.*
*2) **Neat** diagrams must be drawn **wherever** necessary.*
*3) Figures to the **right** side indicate **full** marks.*
*4) Assume **suitable** data if **necessary**.*

1. a) An analog signal is given as $x(t) = \sin(10\pi t) + 2\sin(20\pi t) + 2\cos(30\pi t)$. **6**
   i) What is the Nyquist rate of this signal ?
   ii) If the signal is sampled with sampling fequency of 20 Hz, what is the discrete time signal obtained after sampling ?

   b) For a discrete time sequence x(n) = {1 2 3 4}, DFT is given by X(k) = {10 –2+2j –2 –2–2j}. Compute the DFT of x^(n) = {3 4 1 2} using circular time shift property of DFT. **6**

   c) If the impulse response of the system is : **8**
   $h(n) = [(0.5)^n + n(0.2)^n]u(n)$
   i) Compute the transfer function
   ii) Obtain the difference equation of the system.

OR

2. a) A signal $x(t) = \sin(\omega t)$ of frequency 50 Hz is sampled using a sampling frequency of 80 Hz. Obtain the recovered signal if ideal reconstruction is used. **6**

   b) State and prove Parseval's theorem for the following sequence : x(n) = {1 2 3 4}. **8**

   c) Find the Z transform of **6**

   i) $x(n) = e^{\left(-\frac{n}{40}\right)}u(n)$ Draw the pole zero diagram for X(z)

   ii) $x(n) = \left(-\frac{1}{5}\right)^n u(n) + 5\left(\frac{1}{2}\right)^{-n} u(-n-1)$

3. a) Design a digital Butterworth filter that satisfies the following constraint using Bilinear transformation. Assume T = 1 sec. **11**

$$0.9 \le \left|H(e^{j\omega})\right| \le 1 \qquad 0 \le \omega \le \frac{\pi}{2}$$

$$\left|H(e^{j\omega})\right| \le 0.2 \qquad 3\frac{\pi}{4} \le \omega \le \pi$$

b) Convert the analog filter with system function **6**

$$H_a(s) = \frac{s+0.2}{(s+0.2)^2+9}$$

into a digital IIR filter by means of Impulse Invariant technique. Assume T = 1 sec.

OR

4. a) Design a digital Butterworth filter that satisfies the following specification using Bilinear transformation. **11**

Sampling frequency =	8 KHz
Passband	0-500 Hz
Passband ripple	3 dB
Stopband	2-4 KHz
Stopband ripple	20 dB

b) Obtain direct form II and cascade realizations for the system : **6**

y(n) = – 0.1y (n – 1) + 0.2y(n – 2) + 3x(n) + 3.6x(n – 1) + 0.6x(n – 2)

5. a) Design a bandpass FIR filter using Hamming window for M = 11. **11**

$$H(e^{j\omega}) = 1 \qquad \frac{\pi}{4} \le \omega \le \frac{3\pi}{4}$$

$$= 0 \qquad \text{otherwise}$$

b) A signal having values in the range [– 1, + 1], is quantized using 8 bits, with MSB as sign bit **3**

i) Determine the quantization step size.

ii) Calculate the quantization noise power.

c) What is Gibb's phenomenon ? How it is reduced ? **3**

OR

6. a) Using frequency sampling method, design a FIR filter for N = 7. **9**

$$H(e^{j\omega}) = 1 \qquad 0 \le \omega \le \frac{\pi}{2}$$

$$= 0 \qquad \frac{\pi}{2} \le \omega \le \pi$$

b) Show that the symmetric FIR filter has linear phase response. **8**

7. a) Draw the block diagram of a system for sampling rate conversion by a non-integer factor and explain the operation of each block with the help of relevant diagrams and mathematical expressions. Can the positions of the decimator and interpolator be interchanged ? Justify your answer. **10**

b) Explain the factors that influence the selection of a digital signal processor. **6**

OR

8. a) Sampling rate is to be reduced from 96 KHz to 1 KHz. Highest frequency of interest is 450 Hz. $\delta_p = 0.01$, $\delta_s = 0.001$. Design a two stage decimator with decimating factors as 32 and 3. **8**

b) Write note on : **8**

i) MAC unit

ii) Pipelining.

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