B. Tech Degree VI Semester Examination, April 2010

CS/EE 602 DIGITAL SIGNAL PROCESSING

(2006 Scheme)

Time : 3 Hours Maximum Marks : 100

PART – A

(Answer ***ALL*** questions)

(8 x 5 = 40)

I. (a) Show that for a discrete LTI system with zero initial conditions, the o/p is $y[n] = x[n] * h[n]$, $x[n]$ and $h[n]$ the i/p and impulse response respectively.

(b) Find the stability of the system given by the impulse response $h[n] = 0.5^n u[n] + 1.5^n u[n]$. Plot its ROC.

(c) Show that for a periodic sequence $x_p[n]$ with DFS $X_p[k]$, DFS of $x_p^*[n] = X_p^*[-k]$, and DFS of $x_p^*[-n] = X_p^*[k]$ where * represents complex conjugation.

(d) Find the circular convolution of the two sequences $x_1[n] = [1\ 2\ 1]$ and $x_2[n] = [1\ 4\ 2]$, so that it gives the same result as linear convolution. Verify that both convolutions give the same result.

(e) Write a short note on the rectangular window method for FIR filter design. What is its disadvantage?

(f) What is the impulse invariant method for designing IIR filters? Using this transformation, transform the following filter into its discrete equivalent $H_a(s) = \dfrac{1}{(s+1)(s-1)}$.

(g) If the quantization step size is IV and the number of bits used for quantization $m = 3$, find the RMS quantization error. How will it be reduced if m is increased to 8? Calculate the percentage reduction in the RMS quantization error in the second case.

(h) Enumerate some features that distinguish DSP processors from general purpose processors.

PART – B

(4 x 15 = 60)

II. (a) For the impulse response below, determine if the systems are causal and stable.

(i) $h[n] = 2^n u[-n]$

(ii) $h[n] = Sin\left(\dfrac{n\pi}{2}\right)$

(iii) $h[n] = \delta[n] + Sin\,\pi n$

(iv) $h[n] = e^{2n} u[n-1]$. (8)

(b) For the systems given by

(i) $y[n] = Cos(x[n])$

(ii) $y[n] = Ax[n] + B$,

check whether the systems are linear. (7)

OR

(Turn Over)

III. (a) Find the inverse $\mathcal{Z}$ transform of $X(\mathcal{Z}) = \dfrac{1}{2\mathcal{z}^{-2} + 2\mathcal{z}^{-1} + 1}$. (7)

(b) Determine the causal signal $x[n]$ having the $\mathcal{Z}$ transform

$$X(\mathcal{Z}) = \frac{1}{\left(1 - 2\mathcal{z}^{-1}\right)\left(1 - \mathcal{z}^{-1}\right)^2}.$$ (8)

IV. Show how the 8 point Radix – 2 Signal flow graph may be used to compute the DFTs of $x_1[n] = [1\ 4\ 3\ 2\ 2\ 3\ 2\ 2\ ]$ and $x_2[n] = [1\ 4\ 1\ 2\ 2\ 3\ 4\ 2\ ]$, simultaneously, using the signal flow graph only once. Hence, compute $X_1[k]$ and $X_2[k]$. (15)

OR

V. (a) What is the improvement in speed in terms of number of complex additions and multiplications in calculating the 64 point DFT of a sequence using Direct Computation and FFT algorithm? (5)

(b) Derive the 8 point D.I.F FFT Signal Flow graph. (10)

VI. (a) Design a Low Pass FIR filter for the following specifications :

Cut off frequency	=	500 Hz
Sampling frequency	=	2kHz
Order of the filter	=	10, and use the rectangular window for truncating the impulse response.

(8)

(b) For the given FIR filter with $H(\mathcal{z}) = 1 + 2\mathcal{z}^{-1} + 3\mathcal{z}^{-2} + 4\mathcal{z}^{-4} + 3\mathcal{z}^{-5} + 2\mathcal{z}^{-2} + \mathcal{z}^{-6}$, implement the filter using least number of delay elements. Will the filter have linear phase? (7)

OR

VII. (a) Consider the recursive relation given by $y[n] = 3y[n-1] + y[n-2] + 5x[n] + 2x[n-1]$. Obtain its

(i) Direct Form - 1

(ii) Direct Form - 2 implementations. (6)

(b) Obtain the linear constant coefficient difference equation of the discrete filter obtained by discretising the analog filter $H(s) = \dfrac{s+1}{(s+3)(s+5)}$. (9)

VIII. (a) Write notes on :

Limit cycle oscillations in a First Order FIR System. Hence calculate the dead band amplitude if the quantization step size is 0.5 volt and 3 bits are used for binary encoding the quantization levels. (8)

(b) Describe using a suitable diagram an application of a DSP to image processing. (7)

OR

IX. With a neat block diagram explain the architecture of the Texas Instruments TMS 320C – 54 X fixed point processor. (15)

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