BITS, PILANI – DUBAI CAMPUS

Knowledge Village, Dubai

Year IV – Semester I 2005 – 2006

Comprehensive Examination Make-up (Closed Book)

Course No.: **EEE UC 415** Course Title: **DSP**

Date: January 04, 2005 Time: 3Hrs. Max. Marks = 40

(Any assumptions made should be indicated clearly)

1.a) An FIR digital filter has impulse response h(n) defined over the interval $0 \leq n \leq N-1$. Show that if **N=8** and h (n) satisfies the symmetry condition **h (n) = h (N-n-1)** the filter has a linear phase characteristics. (4)

b) Design a linear phase digital FIR filter with the following frequency response specifications and a stop band attenuation >= 40 dB, using window method, with N=7 .

$$H_d(\omega) = e^{-j3\omega} \quad \text{for } -\pi/4 \leq \omega \leq \pi/4$$

$$H_d(\omega) = 0 \quad \text{for } \pi/4 \leq \omega \leq \pi$$

(6)

2. a) Distinguish between the frequency response of Chebyshev type I filter for N is odd and even (2)

b) By pole-zero placement method, obtain the transfer function and the difference equation of a simple digital notch filter that meets the following specifications.

Notch frequency : 50 Hz

3 dB width of notch : +/- 5 Hz

Sampling frequency : 500 Hz (7)

3. a) With a neat block diagram explain the principle of multirate signal processing as applied to Audio signal reproduction in the CD system. (4)

b) Find the effect of coefficient quantisation on pole locations of the given second order IIR system, when it is realized in direct form I and in cascade form. Assume a word length of 4 bits through truncation.

$H(z) = 1/[(1 - 0.5 z^{-1})(1 - 0.45 z^{-1})]$ (4)

4. Starting with the equation for the **mean square error**, derive the Wiener – Hopf equation to estimate the optimum weights of the adaptive filter. (4)

5. With a neat block diagram, explain the internal architecture of **TMS 320 C 5X** Processors. (4)

6. i) The data memory used with C5X processors is split into ________ pages each of ________ words long.

a) 512, 128 b) 256,256 c) 128,512 d) 1024,64

ii) The register in which the the result of multiplication is stored is ________ and its ________ bit wide.

a) PREG, 32 b) PREG, 16 c) TREG0,16 d) TREG0, 32

iii) The status register bit that determines whether multiplier's 32-bit product is left shifted by 0,1,4 or right shifted by 6 with sign extension before it is transferred / added to the ACC is ________

a) CNF b) PM c) HM d) XF e) INTM

iv) The symbol used to indicate the immediate address mode for the operand is ________

a) $ b) * c) # d) & e) %

v) Assume that the contents of ACC, ARP, AR3, and locations 0045H, 40C5H are 1000H, 3, 40C5H , 2400 H and 2300H respectively initially. When the instruction LAMM * is executed, the content of ACC is ________

a) 2400H b) 2300H c) 40C5H d) 0003H

(1x5)

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Table 7.3 Summary of important features of common window functions.

Name of window function	*Transition width* (Hz) (*normalized*)	*Passband ripple* (dB)	*Main lobe relative to side lobe* (dB)	*Stopband attenuation* (dB) (*maximum*)	*Window function* $w(n), \lvert n \rvert \leq (N-1)/2$
Rectangular	$0.9/N$	0.7416	13	21	1
Hanning	$3.1/N$	0.0546	31	44	$0.5 + 0.5\cos\left(\frac{2\pi n}{N}\right)$
Hamming	$3.3/N$	0.0194	41	53	$0.54 + 0.46\cos\left(\frac{2\pi n}{N}\right)$
Blackman	$5.5/N$	0.0017	57	75	$0.42 + 0.5\cos\left(\frac{2\pi n}{N-1}\right) + 0.08\cos\left(\frac{4\pi n}{N-1}\right)$
Kaiser	$2.93/N\ (\beta = 4.54)$ $4.32/N\ (\beta = 6.76)$ $5.71/N\ (\beta = 8.96)$	0.0274 0.002 75 0.000 275		50 70 90	$\frac{I_0(\beta\{1 - [2n/(N-1)]^2\}^{1/2})}{I_0(\beta)}$

BITS, PILANI – DUBAI CAMPUS

Knowledge Village, Dubai
Year IV – Semester I 2005– 2006
Test II Mk – Up (Open Book)

Course No.: **EEE UC 415** Course Title: **DSP**

Date: November 20, 2005 Time: 50 Minutes Max. Marks = 30

(Only Text Book & class notes are Allowed)

1. a. Derive the expression for finding the error variance due to quatisation and hence the variance of the output energy of a digital system

   b. The A/D converter used in a digital system is 12 bit and the quantized signal is processed by a first order IIR digital filter whose transfer function is given by H(z) = z / (z – 0.75). Find the steady state noise power due to quantization that occur at the output of H(z). (5+5)

2. Consider an audio band signal sampled at a rate of 400 KHz. It is required to down rate the sampling frequency to 100 KHz. The highest frequency of interest after decimation is 4KHz. Design a suitable optimum two stage decimator which will satisfy the following overall specifications.

   Pass band ripple = 0.1; Stop band ripple = 0.01

   Filter length $N = \dfrac{-10 \log(\delta_s \delta_p) - 13}{14.6\, \Delta f} + 1$;

   where Δf is the normalized frequency.

   Draw also the frequency response of the designed decimator stages. (12)

3. a. What are the advantages and disadvantages of FIR filters as compared to IIR filters? Why is FIR filters generally preferred over IIR filters in multirate signal processing?

   b. What is a linear phase filter? What is the condition for linear phase? (8)

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BITS, PILANI – DUBAI CAMPUS

Knowledge Village, Dubai
Year IV – Semester I 2005- 2006
Test II (Open Book)

Course No.: **EEE UC 415** Course Title: **DSP**

Date: November 20, 2005 Time: 50 Minutes Max. Marks = 30

(Only Text Book is Allowed)

1. The A/D converter used in a digital system is 8 bit and the quantized signal is processed by a first order IIR digital filter whose transfer function is given by $H(z) = z / (z - 0.999)$. Find the steady state noise power due to quantization that occur at the output of H(z).

(10)

2. Consider an audio band signal with a nominal band width of 4 KHz that has been sampled at a rate of 8 KHz. It is required to down rate the sampling frequency to 200 Hz. The highest frequency of interest after decimation is 75 Hz. Design a suitable optimum two stage decimator which will satisfy the following overall specifications.

Pass band ripple = 0.01; Stop band ripple = 0.0001

$$\text{Filter length } N = \frac{-10 \log (\delta_s \delta_p) - 13}{14.6 \Delta f} + 1 \; ;$$

where Δf is the normalized frequency.

Draw also the frequency response of the designed decimator stages. (12)

3. Discuss the various methods available to design a digital FIR filter for a given specification. Give a comparison of these methods.

(8)

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BITS, PILANI – DUBAI CAMPUS

Knowledge Village, Dubai

Year IV – Semester I 2005– 2006

Test I (Closed Book)

Course No.: **EEE UC 415**

Course Title: **DSP**

Date: October 02, 2005

Time: 50 Minutes

Max. Marks = 40

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1. Specify and sketch a suitable pole-zero diagram of a simple low pass discrete-time filter with the following specifications.
   Cut-off frequency: 1KHz, Sampling frequency: 10KHz
   Obtain the transfer function of the filter from the pole-zero diagram. Determine the amplitude and phase response at 1KHz, 2.5 KHz and 5KHz. Sketch the amplitude response of the filter.

2. The frequency response specification for a band-pass discrete-time filter in normalized form is as follows.
   Pass-band : $0.4\pi - 0.6\pi$;
   stop-bands: $0 - 0.3\pi$ and $0.7\pi - \pi$.
   Sampling interval T= 100us

   a) Express the specifications in rad/s (de-normalised)
   b) Convert the specs from rad/s to standard units of Hz
   c) Convert the specs to normalized frequency form
   d) Sketch the frequency response for (b) in the interval from 0 to sampling frequency.

3. The transfer function of a DT system has poles at z = 0.5, z = 0.1 ± j 0.2 and zeroes at z = -1 and at z = 1.
   a) Derive the system transferfunction H(z).
   b) Develop the fifference equation
   c) Draw the canonic form of realization of the system.

4. Obtain the coefficients of an FIR low pass digital filter to meet the specifications below using window method.
   Pass-band edge frequency : 3.4 KHz ; stop band attn: 50dB.
   Transition width : 0.6KHz
   Sampling frequency : 8 KHz
   Give your comments on the window used and the reason for your choice.

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