BITS, PILANI – DUBAI

Dubai International Academic City, Dubai

Year IV – Semester II 2008 – 2009

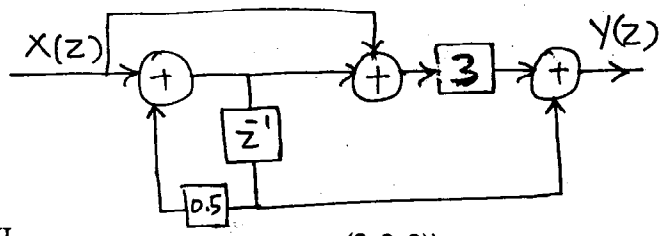
Comprehensive Examination (Closed Book)

COURSE NO.: EEE C 415 COURSE TITLE: DSP

DATE: MAY 26, 2009 TIME: 3HRS. MAX. MARKS = 40

(Any assumptions made should be indicated clearly)

1. For the digital system shown in figure below,



a) Determine the transfer function

b) Determine the poles and zeroes of the function

c) Realise the transfer function using direct form II. (3+2+2))

2. Show that the impulse response of an ideal band pass filter is given by

$$h_D(n) = \frac{2 f_2 \sin n\omega_2}{n\omega_2} - \frac{2 f_1 \sin n\omega_1}{n\omega_1} \quad ; n \neq 0$$

$$= 2(f_2 - f_1) \; ; \quad n = 0$$

where f_1 and f_2 are lower and upper pass band edge frequencies. (4)

3. 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 .

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

$H_d(\omega) = 0$ for $\pi/4 \leq \omega \leq \pi$ (6)

4. A digital filter is characterized by the transfer function $H(z) = \frac{1 - 0.5331 z^{-1} - z^{-2}}{1 - 0.2711 z^{-1} - 0.9028 z^{-2}}$

If the filter coefficients are implemented using 8 bit word length , find the effect of quantization on the filter response. (6)

5. By pole zero placement method, obtain the transfer function and hence the difference equation of a simple digital notch filter that meets the following specifications. Notch frequency : 50Hz; 3dB width of notch : +/- 5 Hz, Sampling frequency is 250 Hz. (5)

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

The following instructions are excecuted in a TMS 320c 50 processor. The data in the registers before the execution are also given. Find the relevant register and memory contents after execution of the instructions independently.

7. i) ADD 02h, 3 Before execution, DP = 7, ACC = 0123 h

a) What is the data memory location pointed by the instruction?

b) If the data available in the data memory is 024h, what will be the ACC content after the instruction is executed?

ii) CMPR 1 ; with ARP = 3, AR3= 1234h, ARCR = 4321, ST1 = 8765h, ACC = 0000h

iii) AND #0BC87h, 2 ; ACC = 12345678h;

iv) MAC 8F00h, 00h, DP =6, PM=1, CNF= 1, DM 300 = 64h, 8F00 = 04h,

TREG0 = 22h, PREG = 01234567h, ACC = 76543210h, carry C= 0;

(2 x 4)

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	$2.93/N$ ($\beta = 4.54$)	0.0274		50	$\frac{I_0(\beta[1-[2n/(N-1)]^2]^{1/2})}{I_0(\beta)}$
	$4.32/N$ ($\beta = 6.76$)	0.002 75		70	
	$5.71/N$ ($\beta = 8.96$)	0.000 275		90	

BITS, PILANI – DUBAI

International Academic City, Dubai
Year IV – Semester II 2008– 2009
Test II (Open Book)

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

Date: April 30, 2009 Time: 50 Minutes Max. Marks = 30

(Only Text Book & Hand written notes are 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 $H(z) = 0.5z / (z - 0.5)$. Find the output noise power due to quantization that occur at the output of H(z). (10)

2. Consider an audio band signal sampled at a rate of 400 KHz. It is required to down rate the sampling frequency to 15 KHz. The highest frequency of interest after decimation is 4KHz. Design a suitable optimum frequency converter which will satisfy the following overall specifications.

   Pass band ripple = 0.1; Stop band ripple = 0.01

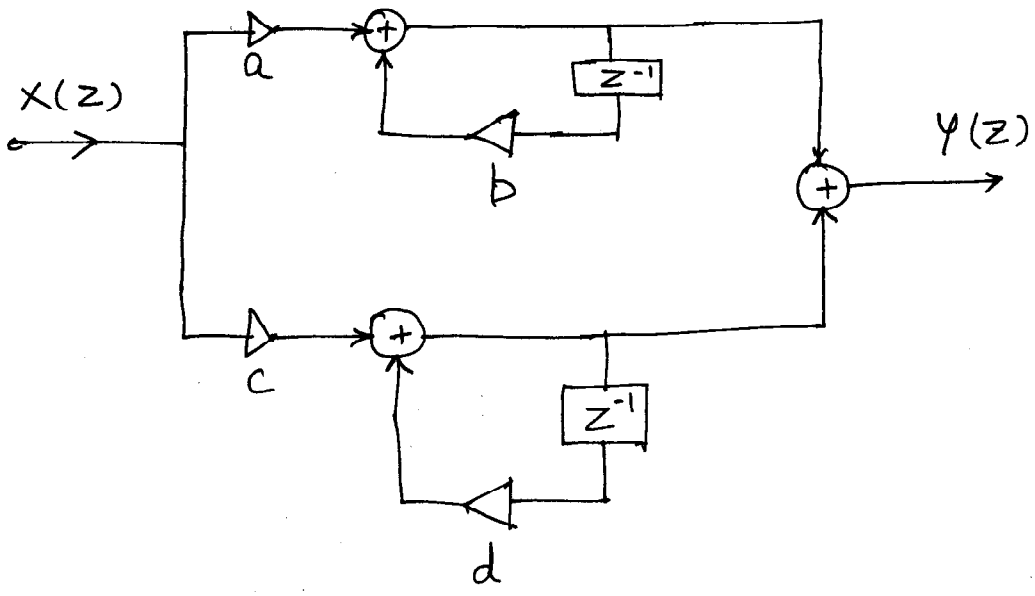
   Filter length $N = \frac{-10 \log (\delta_s \delta_p) - 13}{14.6 \Delta f} + 1$;

   where Δf is the normalized frequency.

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

3. The transfer function of a digital filter is given by $H(z) = \frac{5z (3z - 2)}{(z+0.5)(2z - 1)}$

   Determine the values of the multiplier coefficients of the realization structure shown in figure below. (8)



BITS, PILANI – DUBAI

International Academic City, Dubai
Year IV – Semester II 2008– 2009
Test I (Closed Book)

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

Date: March 22, 2009 Time: 50 Minutes Max. Marks =30

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1. Determine the order and poles of a type I low pass Chebyshev filter that has a 1dB ripple in the pass band at a frequency of 500Hz. The stop band attenuation has to be more than 40dB at a frequency of 1 kHz

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

   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 $z = 0.5$, $z = 0.1 \pm j\ 0.2$ and zeroes at $z = -1$ and at $z = 1$.
   a) Derive the system transfer function H(z).
   b) Develop the difference equation
   c) Draw the canonic form of realization of the system.

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Year IV – Semester II 2008– 2009
Quiz III

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

Date: May 12, 2009 Time: 20 Minutes Max. Marks = 10

(Question nos. **1- 4 carries one mark** each and **Question Nos 5- 7 carries 2 marks** each)

PART A

1. Using RPT #k instruction, the maximum no. of times a single instruction can be repeatedly executed is _____

2.. 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

3. 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

4. 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

PART B
(Assume the data missing if any)

Following are the register contents before execution of the instructions given below.
Write the content of the relevant registers which will get changed after execution for each of the instructions given below.

DP = 6 [300h] = 04h; [310h] = 24h; [08F00H] = 03h

TREG0 = 22h ACC = 76543210h ARCR = 2530h

ARP = 7 AR7 = 2350h INDX = 10h [2350h] = 132h [50h] = 4680h

5. SAMM * 0 - , AR0

6. AND # 05DB2 h, 2

7. ADD 10h, 2

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Year IV – Semester II 2008– 2009

Quiz II (Closed Book)

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

Date: March 23, 2009 Time: 30 Minutes Max. Marks = 20

(Question nos. **1- 3 carries one mark** each and **Question Nos 4- 10 carries 2 marks** each)

1. A digital Filter is said to be FIR if
   a.) All its pole lie inside the unit circle
   b.) One or more denominator coefficients is non zero
   c.) Current output depends on previous output
   d.) Current output do not depend on previous output

2. Match the following

a) Recursive filter	i) Constant phase delay and group delay
b) linear phase characteristics	ii) Infinite impulse response
c) Positive symmetry	iii) Equiripple
d) Optimum filter design	iv) Finite impulse response

3. A discrete time filter transfer function is given by
   $H(z) = (1 - 2z^{-1} + z^{-2}) / (1 - 1.3z^{-1} + 0.42z^{-2})$ What is its DC amplitude response?

4. For the system transfer function given in question no.3, What are the radii of the poles and zeroes?

5. What will be the order of a Butterworth low pass filter having a 1dB ripple in the pass band at a frequency of 2.5 kHz and gives an attenuation of 30 dB at a frequency of 6kHz?

6. What will be the bandwidth of the low pass Butter worth filter mentioned in question no.5?

7. Given below is the canonic form realization of a digital filter. Write the transfer function of the filter.

8. Write the difference equation of the digital filter shown in the figure above

9. Draw the direct form I realization of the above filter

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BITS, PILANI – DUBAI

Dubai International Academic City
Year IV – Semester II 2008– 2009
Quiz I (Closed Book)

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

Date: February 16, 2009 Time: 30 Minutes Max. Marks = 10 (5%)

(Question nos. **1- 10 carries 0.5 mark** each
Question Nos **11- 15 carries one marks** each)

1. The Audio signal frequency range is between
a) 300Hz – 3400Hz b) 400Hz- 500Hz c) 20Hz 20 KHz d) 3400 Hz – 3500Hz

2. The Laplace transform of $e^{-at}u(t)$ is
a) 1/s b) 1/(s+a) c) 1/ (s-a) d) 1/ (s+t)

3. The analog filter characteristics required for Audio applications is

4. Which filter gives maximum linear phase characteristics?
a) Butterworth b) Chebyshev (Type-I) c) d) Elliptic Bessel

5. Which analog filter has minimum order for a given set of specification?
a) Butterworth type b) Chebyshev Type I c) Bessel d) Elliptic

6. Which analog filter has smallest transition band?

7. An Analog band pass signal is to be sampled in accordance with the band pass sampling theorem. Assuming the signal has the frequency band of 3 kHz – 20kHz , what should be the minimum theoretical sampling rate to avoid aliasing?

8. An analog band stop filter specifications are as follows : pass band edge frequencies 2kHz, 8kHz and stop band edge frequencies 4kHz, 6kHz with a minimum attenuation of 45dB. Draw the frequency response of the filter

9. An analog signal is given by $f(t) = 2.72 + 2 \sin 40\Pi t - \sin 120\Pi t$. What is its fundamental frequency and constant amplitude?

10. What will be the impulse response of an analog low pass filter whose transfer function is given by $H(s) = 1/ (s^2 + s + 2)$

PART B

11. Draw the pole zero diagram of the transfer function $\mathbf{H(s) = (s+0.5) / (2s^2 + 3s + 2)}$
12. What are the performance measures of an analog filter. Write their expressions.
13. Find the frequency response of the system with the transfer function given in question No. 11 at a frequency of 1 rad/sec.
14. Determine whether the system whose transfer function is given as $\mathbf{H(s) = (s+0.11) / s(s^2 + s + 1)}$ is stable
15. Determine the phase delay of the function 1/ (1+3s)