BITS, PILANI – DUBAI

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

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

Date: November 02, 2008 Time: 50 Minutes Max. Marks = 30

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1. Realise the system given by the following difference equation in parallel form.
   $y(n) + 0.1\, y(n-1) - 0.72\, y(n-2) = 0.7\, x(n) - 0.252\, x(n-2)$ (5M)

2. Plot the frequency response of an analog low pass filter whose transfer function is given by
   $H(s) = 1/(s^2 + s - 2)$ (5M)

3. Design an analog low pass Butterworth filter that has a 2 dB pass band attenuation at a frequency of 20rad/sec and at least 10dB stop band attenuation at 30 rad/sec. (8M)

4. Using a rectangular window, design a low pass filter with pass band gain of unity, cut off frequency of 1000 Hz and working at a sampling frequency of 5 kHz. The length of the impulse response should be 7. (7M)

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

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

$$= 2(f_2 - f_1) \quad \text{for } n = 0$$

(5M)

***************** GOOD LUCK *******************

BITS, PILANI – DUBAI

DIAC, Dubai

Year IV – Semester I 2008– 2009

Test II (Open Book)

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

Date: December 14, 2008 Time: 50 Minutes Max. Marks = 30

(Clearly mention the assumptions made if any)

1. Determine the FIR filter coefficients h(n) obtained by sampling
   $H_d(e^{j\omega}) = e^{-j(N-1)\omega/2}$ $0 <= |\omega| <= \pi/2$
   $= 0$ $\pi/2 <= |\omega| <= \pi$
   For N = 7 (10)

2. Consider an audio band signal with a nominal band width of 2 KHz that has been sampled at a rate of 4 KHz. It is required to down rate the sampling frequency to 150 Hz. The highest frequency of interest after decimation is 60 Hz. Design a suitable optimum two stage decimator along with an interpolator if necessary which will satisfy the following overall specifications.
   Pass band ripple = 0.01; Stop band ripple = 0.001
   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. (15)

3. Discuss the various algorithms available to design an adaptive digital FIR filter for a given situation. Give a comparison of these algorithms (5)

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BITS, PILANI – DUBAI

Dubai International Academic city, Dubai
Year IV – Semester I 2008– 2009
Comprehensive examination (Closed Book)

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

Date: January 03, 2009 Time: 3 hours Max. Marks = 40

(Clearly state any assumptions made)

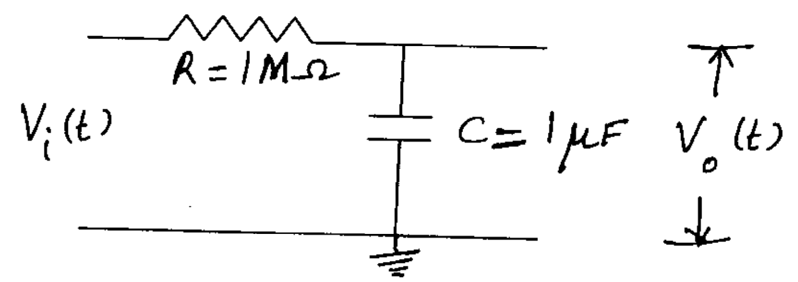
1. Find the effect of coefficient quantization on pole locations of the given second order IIR system, when it is realized in i) direct form I ii) cascade form.
   $H(z) = 1/[(1 - 0.5 z^{-1})(1 - 0.45 z^{-1})]$ **6M**

2. Design a two pole band-pass digital filter that has the center of its pass band at $\omega = \pi/2$, zero in its frequency response at $\omega = 0$ and $\omega = \pi$ and its frequency response is 0.707 at $\omega = \pi / 9$. 4M

3. A high quality efficient narrow band filter is required to extract and assess the main component in a signal. The filter should satisfy the following specifications.
   Pass band = 49 to 51 Hz
   stop band edge frequencies = 48 and 52 Hz
   pass band ripple = 0.01 dB
   stop band attenuation = 60dB
   The input sampling frequency is 1000Hz.
   Using the multirate approach, design a suitable filter assuming an output frequency of 200Hz 5M

4. Starting with the steepest descent algorithm, $W_{k+1} = W_k - \mu\nabla_k$, derive the Widrow – Hopf LMS algorithm for adaptive noise cancellation. Clearly mention all the parameters used. What are the practical limitations of basic LMS algorithm? 4M

5. Using Bilinear – Z transform method of designing digital filters, determine the transfer function and hence the difference equation for the digital equivalent of the Resistance - Capacitance filter shown in figure below. Assume a sampling frequency of 1kHz and a cut off frequency of 250 Hz.



5M

6. Obtain the coefficients of an FIR low pass digital filter to meet the specifications given below using window method.
   Pass-band edge frequency : 3.4 KHz; Stop band attenuation : 50 dB
   Transition width : 0.6 KHz
   Sampling frequency : 8 KHz
   Give your comments on the window used and the reason for your choice. 6M

7. Answer the following questions with reference to the P-DSP TMS 320C 5X series

i) VLIW architecture differs from conventional P-DSP in which of the following aspect?
a) Instruction Cache b) Number of functional Units
c) Uses pipelining
d) A single word fetch from memory using many instructions.

ii) 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

iii) The addressing mode that is convenient for FFT computation is
a) indirect addressing b) circular mode
c) Bit reversed addressing d) Memory mapped

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

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

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

DP = 6	[300h] = 04h;	[310h] = 53h;	[08F00H] = 04h
TREG0 = 12h		ACC = 76543210h	ARCR = 2530h
ARP = 2	AR2 = 2350h	INDX = 20h	[2350h] = 132h
[50h] = 4680h		[2330h] = 00FFh	

v) LACC * 0 - , AR0
vi) AND # 0F0B2 h, AR6
vii) ADD 10h, 2

(1 x 4 + 2 x 3 M)

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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* $w(n), \lvert n \rvert \leqslant (N-1)/2$
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	