BITS, PILANI – DUBAI CAMPUS

International Academic City, Dubai

Year IV – Semester II 2012 – 2013

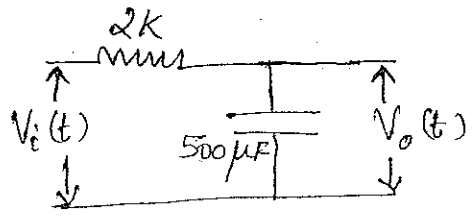
Comprehensive examination

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

Date: June 03, 2013 Time: 3 Hrs.. Max. Marks = 40

(Any assumptions made should be indicated clearly)

1. Using Bilinear – Z transform method of designing digital filters, determine the transfer function and hence the difference equation for the digital equivalent of the analog RC filter shown in figure below. Assume a sampling frequency of 100 Hz and a cut off frequency of 30 Hz. (4M)



2. a) Distinguish between the frequency response of Chebyshev type I filter for N is odd and even (1M)

   b) Determine the frequency response of an IIR filter characterized by

   y (n) = 0.3x (n) - x (n-1) + 0.5 x (n-2) – y(n-1)

   Compute the phase delay and group delay of the filter (6M)

3. Derive the impulse response coefficients $h_D(n)$ of an ideal band pass filter (3M)

4. A 4-point linear phase FIR filter is characterized by the following frequency samples. (4M)

$$|H(k)| = 1, \quad k = 0$$
$$= \tfrac{1}{2}, \quad k = 1, 3$$
$$= 0, \quad k = 2$$

   a) Determine the four coefficients of the filter which could be implemented.

   b) Determine the transfer function of the Recursive FIR frequency sampling filter.

5. a) With a neat block diagram explain the principle of Digital signal processing as applied to any specific application of your choice. (3M)

   b) Consider an audio band signal sampled at a rate of 100 KHz. It is required to down rate the sampling frequency to 12 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. (5M)

6. A digital filter is characterized by the following transfer function.

$H(z) = (1 + 1.5947\, z^{-1} + z^{-2}) / (1 - 0.6152\, z^{-1} + 0.2581\, z^{-2})$

The filter is to be implemented using an 8bit system. Assuming that a second order canonic section is used to realize the filter, and each product has to be quantized to 8 bit,

a) Sketch the realization diagram showing the round of errors within the filter

b) Determine the L_2 - norm scaling factor for the system. (3+3M)

7. Starting with the equation for the **mean square error**, derive the Wiener – Hopf equation to estimate the optimum weights of the adaptive filter. (3M)

8. With reference to TMS320C5X processor, choose the appropriate answer (1x5M)

i) The symbol used to indicate the immediate address mode of operands is

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

ii) VLIW architecture differs from conventional P-DSP in which of the following aspect?

a) Instruction Cache b) Number of functional Units

c) Use pipelining

d) A single word fetch from memory using many instructions.

iii) 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

iv) The addressing mode that is convenient for FFT computation is

a) indirect addressing b) circular mode

c) Bit reversed addressing d) Memory mapped

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

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BITS PILANI, DUBAI CAMPUS

II SEMESTER 2012 – 2013

Course Code: **EEE C415** TEST-2 – **B** Date: 01.**05.2013**

Course Title: **Digital Signal Processing** Max.Marks:30

Duration: **50 minutes** Weightage:**15%**

(All questions carry 10 Marks each)

1. Determine the FIR filter coefficients h(n) of a filter with the following frequency response by frequency sampling method for N= 7

$H_d(e^{jw}) = e^{-j(N-1)\omega 2}$; $0 \leq |\omega| \leq \pi/2$

$= 0$ $\pi/2 \leq |\omega| \leq \pi$

2. Compare the single stage , two stage, three stage and multistage realization of the decimator with the following specifications.
Input sampling frequency is 10KHz, output sampling frequency is 500 Hz. The decimation filter H(z) has the pass band edge frequency 150 Hz, stop band edge frequency 180 Hz, pass band ripple 0.002 and stop band ripple 0.001.

3. Following is a code segment of TMS 320 C50 program.
Comment each code line with its operation and write the function the program executes.

```
ADDRESS1  IN    XN, ADC
          ZAC
          LT    XNM2
          MPY   H2
          LTD   XNM1
          MPY   H1
          LTD   XN
          MPY   H0
          APAC
          SACH  YN,1
          OUT   YN, DAC
          B     ADDRESS1
```

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BITS PILANI DUBAI CAMPUS

Dubai International academic City, Dubai
Year IV – Semester II 2012– 2013
Test I (Closed Book)

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

Date: March 13, 2013 Time: 50 Minutes Max. Marks = 30

(Assume any data missing and clearly state the assumptions made)

1. Specify and sketch a suitable pole-zero diagram of a simple low pass discrete-time filter with the following specifications. (9M)
   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 transfer function of a DT system has poles at $z = 0.5$, $z = 0.1 + j\,0.2$ and zeroes at $z = -0.25$ and at $z = 0.75$.
   a) Derive the system transfer function H(z).
   b) Develop the difference equation
   c) Draw the canonic form of realization of the system. (8M)

3. Derive the impulse response coefficients $h_D(n)$ of an ideal band pass filter (5M)

4. Obtain the coefficients of an FIR low pass digital filter to meet the specifications below using window method.
   Pass-band edge frequency : 3.2 kHz stop band attenuation = 40 dB
   Transition width : 0.6KHz
   Sampling frequency : 8 KHz
   Give your comments on the window used and the reason for your choice. (8M)

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BITS, PILANI – DUBAI

DIAC, Dubai
Year IV – Semester II 2012– 2013
Quiz II

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

Date: May 14, 2013 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. The starting address of the data memory page pointed by the DP register whose content is 7 will be 380 h.

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 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 Compares one register against another register content TC.

   a) CNF b) INTM c) HM d) XF e) PM (f) none of the above

4. When MACD instruction is executed, the product register is shifted by the count specified by the STI - PM bit

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. LAMM * 0 +, AR4 → ARP = 4. AR7 = 2360h. Acc = 00004680h.

6. NEG → 2's Acc. 89ABCDF0

7. ADD 10h, 2 24 → 0904h (shifted) 0010 010000

32 10.

765432A0

BITS, PILANI – DUBAI

DIAC, Dubai
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Quiz II

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PART A

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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 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 Compares one register content against another register
   _____

   a) CNF b) INTM c) HM d) XF e) PM (f) none of these.

4. When MACD instruction is executed, the product register is shifted by the count specified by the _____

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. LAMM * 0 +, AR4

6. NEG

7. ADD 10h, 2

BITS PILANI DUBAI CAMPUS

DIAC, Dubai
Year IV – Semester II 2012– 2013
Quiz I

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

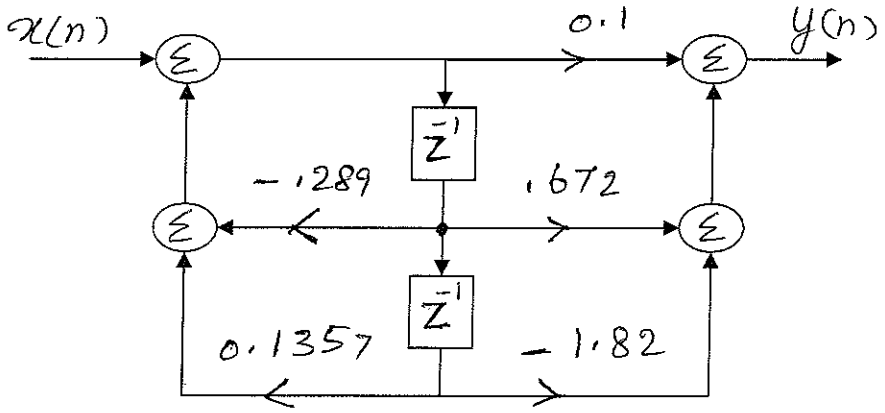
Date: March 05, 2013 Time: 20 Minutes Max. Marks = 10

(All questions **carry 2 marks** each)

1. Match the following with most appropriate connectives

1.	Butterworth Filter	Minimum no. of coefficients ( )
2.	IIR filter	Maximally Flat frequency response ( )
3.	FIR filter	Unstable system ( )
4.	Bilinear Z-transformation	Recursive filter ( )
		Feedback filter ( )
		Linear Phase Characteristics ( )
		Pole zero mapping to discrete domain ( )
		Poles at maximum and zeroes at minimum response ( )

2. Write the transfer function of the digital IIR filter structure shown below.



3. Derive the amplitude response of the digital filter defined by
$y(n) = 0.25\, x(n) + 0.4y(n-1) - 0.25\, y(n-2)$.

4. Sketch the pole –zero diagram of the discrete time system whose transfer function is given by $H(z) = (1 - 1.6\, z^{-1} + z^{-2}) / (1 - 1.5\, z^{-1} + 0.8\, z^{-2})$

5. Obtain the digital filter transfer function of the analog filter with $H(s) = 0.3 / (s - 2)$, by Impulse Invariant method.

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BITS PILANI DUBAI CAMPUS

DIAC, Dubai
Year IV – Semester II 2012– 2013
Quiz I

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

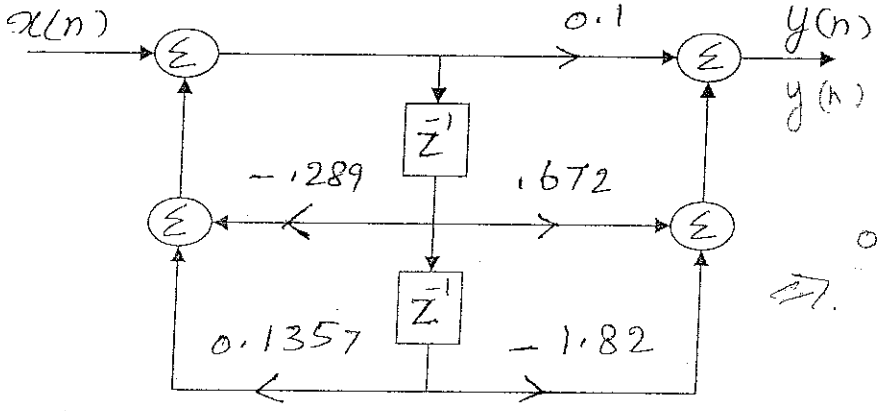
Date: March 05, 2013 Time: 20 Minutes Max. Marks = 10

(All questions **carry 2 marks** each)

1. Match the following with most appropriate connectives

1.	Butterworth Filter	Minimum no. of coefficients ( )
2.	IIR filter	Maximally Flat frequency response (1)
3.	FIR filter	Unstable system ( )
4.	Bilinear Z-transformation	Recursive filter (2)
		Feedback filter (2)
		Linear Phase Characteristics (3)
		Pole zero mapping to discrete domain (4)
		Poles at maximum and zeroes at minimum response ( )

2. Write the transfer function of the digital IIR filter structure shown below.



$y(n) = .1\,x(n) + .672\,x(n-1) - 1.82\,x(n-2)$

$0.1 + .672\,z^{-1} - 1.82\,z^{-2}$

$1 + .289\,z^{-1} - .1357\,z^{-2}$

3. Derive the amplitude response of the digital filter defined by $y(n) = 0.25\,x(n) + 0.4y(n-1) - 0.25\,y(n-2)$.

4. Sketch the pole –zero diagram of the discrete time system whose transfer function is given by $H(z) = (1 - 1.6\,z^{-1} + z^{-2}) / (1 - 1.5\,z^{-1} + 0.8\,z^{-2})$

5. Obtain the digital filter transfer function of the analog filter with $H(s) = 0.3 / (s - 2)$, by Impulse Invariant method.

$h(t) = 0.3\,e^{2t}$ $\therefore H(z) = \dfrac{0.3}{1 - e^{2}\,z^{-1}}$

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3.

$$H(z) = \frac{0.25}{1 - 0.4z^{-1} + .25z^{-2}} = .25 \cdot \frac{1}{1 - 0.4e^{-j\omega T} + 0.25e^{-j2\omega T}}$$

$$\therefore \frac{1}{(1 - .4\cos\omega T + .25\cos^2\omega T) + j(0.4 + \sin\omega T - .25\sin 2\omega T)}$$

$$\therefore \left|H(e^{j\omega})\right| = \frac{.25}{\sqrt{(1 - .4\cos\omega T + .25\cos^2\omega T)^2 + (.4\sin\omega T - .25\sin 2\omega T)^2}}$$

$\omega T = 0$ at $0, \pi/4, \pi/2, 3\pi/4, \pi$

4. Zeros $= \frac{1.6 \pm \sqrt{1.6^2 - 4}}{2}$; poles $= \frac{1.5 \pm \sqrt{1.5^2 - 3.2}}{2}$

$= \frac{1.6 \pm j\sqrt{1.46}}{2}$ $= \frac{1.5 \pm j\sqrt{0.95}}{2}$

$= 0.8 \pm j0.6$. $= 0.75 \pm j.485$

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to:

Asma - 8%

Chaitanya - 4%

Ishani - 3%

Nihad - 2%