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MANIPAL INSTITUTE OF TECHNOLOGY
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A Constituent Institution of Manipal University

V SEMESTER B.TECH. (MECHATRONICS ENGINEERING)

END SEMESTER EXAMINATIONS, NOV 2017

SUBJECT: DIGITAL SIGNAL PROCESSING [MTE 3105]

REVISED CREDIT SYSTEM
(20/11/2017)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Data not provided may be suitably assumed
- Use of Transform Table is permitted.

1A. Obtain the direct form –I and direct form –II realization for the system described by difference equation (1). **5**
y[n]= 2y[n-1]+3y[n-2]+x[n]+2x[n-1]-3x[n-2] --------(1)
Also obtain impulse response h[n] of the equation given in (1) if the system is causal.

1B. Sketch the even and odd part of the signal x (t) shown in **Fig. Q1(B)** **3**

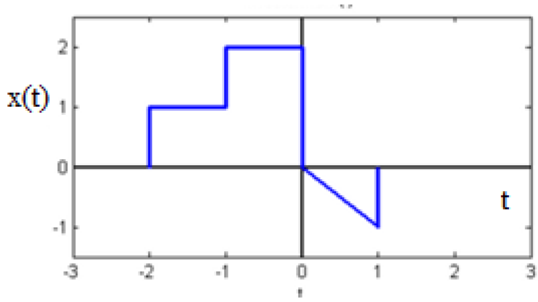

Fig. Q1(B)

1C. Two LTI systems are cascaded as shown in **Fig. Q1(C).** The Second system B, is known to be the inverse of the first system A. Let $y_1(t)$ denote the response of system A to $x_1(t)$, and let $y_2(t)$ denote the response of system A to $x_2(t)$. **2**

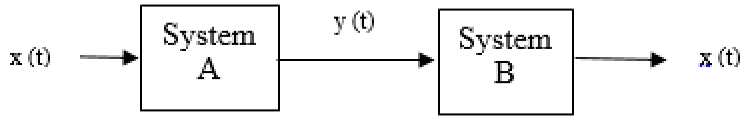

Fig. Q1(C)

i) Determine the response of the system B to the input $ay_1(t) + by_2(t)$, where a and b are constants.
ii) Determine the response of system B to the input $y_1(t - \tau)$.

2A. Consider the z-transform H(z) whose pole-zero is shown in **Fig Q2(A).** **4**

i) Determine the region of convergence of H (z), if it is known to be a stable system? For this case, determine whether the corresponding sequence x[n] is right sided, left sided or two-sided.

ii) Indicate the two-sided sequences that are possible from the pole-zero plot shown in **Fig. Q2(A).**

iii) Is it possible for the pole-zero plot in **Fig. Q2(A)** to be associated with a sequence that is both stable and causal? If so give the appropriate region of convergence.

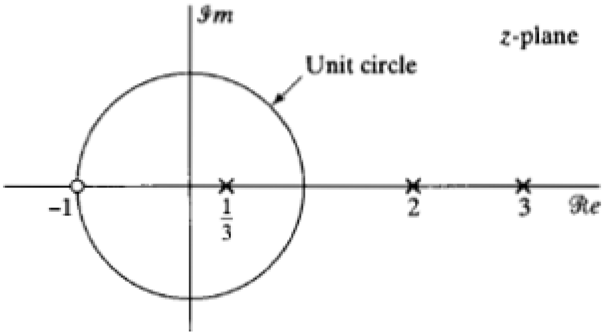

Fig. Q2(A)

2B. Discuss the various addressing modes available in DSP Processor TMS320C24x and Describe any 4 in detail. **4**

2C. Describe Warping in Bilinear transformation. Suggest a technique to overcome the warping effect while designing a digital filter. **2**

3A. Assume that you are recording in a studio or theater and you hear the low-frequency vibrations from someone walking across a wooden floor. This low frequency vibrations is also recorded. To eliminate this you have to use a high pass filter. Design a high pass filter using Hamming window with following specifications: **5**

cutoff frequency = 150Hz

Sampling frequency = 1kHz

Filter length = 7

3B. Determine the 8 point DFT of the given sequence x(n)=[4, 2, 2, 1, 2,2,1,2] using DIF FFT algorithm **5**

4A. Consider a System S with input x[n] and output y[n] related by y[n] = x[n] { g[n] + g[n-1] }. Determine whether the system is time variant or time invariant for the following cases. **3**

i) If g[n] =1 for all n

ii) If g[n] = n

iii) If g[n] = 1+ $(-1)^n$

4B. Express the sequence shown in **Fig.Q4(B)** as a sum of step function, i.e in the form $s[n] = \sum_{k=-\infty}^{\infty} a_k u[n-k]$ **2**

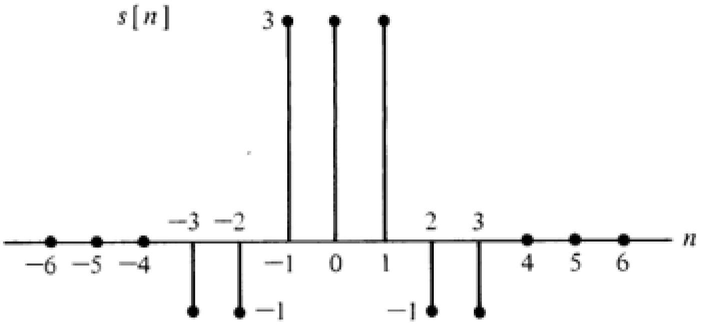

Fig.Q4(B)

4C. Consider the digital filter structure shown in **Fig. Q4(C)** **5**

i) Compute H(z) for this causal filter. Indicate the region of convergence.

ii) Determine the values of k for which the system is stable?

iii) Determine y[n] if k=1 and x[n] = $\left(\frac{1}{2}\right)^n u[n]$

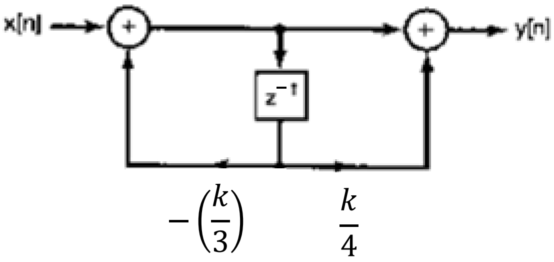

Fig. Q4(C)

5A. In a telephone system it is desired that only the signal having human voice frequency i.e 300 to 3khz should be allowed to pass. If any sound which is above or below is played it should not be heard by the person on the other side of the call. As a design engineer you are asked to design a digital band pass filter with following specification: **6**

- Stopband attenuation ≥20dB
- Passband frequency = 300 to 3000Hz
- $Passband\ attenuation > 1dB$
- Stopband frequencies are 100Hz and 4000Hz respectively, Sampling frequency =10 kHz.

Use Bilinear transformation to design the filter.

5B. Let x[n] be a discrete time signal and let $y_1[n]=x[2n]$ and **4**

$$y_2[n] = \begin{cases} x\left[\frac{n}{2}\right], & for\ n\ even \\ 0, & for\ n\ odd \end{cases}$$

The signals $y_1[n]$ and $y_2[n]$ respectively represent the speed up and slowed down versions of x[n].Consider the following statements:

(i) If x[n] is periodic , then $y_1[n]$ is periodic

(ii) If $y_1[n]$ is periodic , then x[n] is periodic

(iii) If x[n] is periodic, then $y_2[n]$ is periodic

(iv) If $y_2[n]$ is periodic, then x[n] is periodic.

For each of these statements, determine whether it is true, and if so compute the relationship between the fundamental periods of the signals considered in the statement.