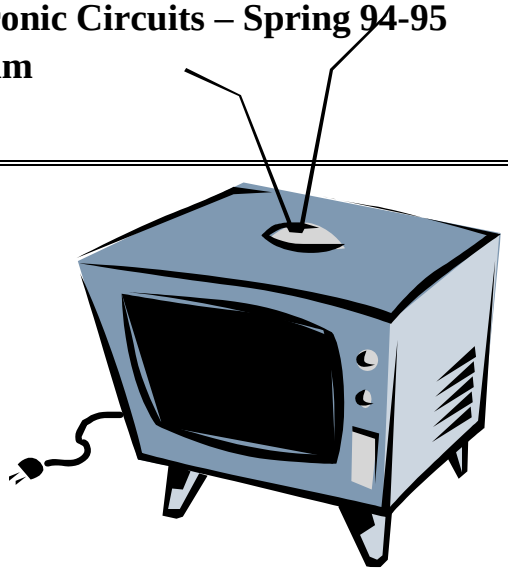
UNIVERSITY OF TEHRAN
Electrical and Computer Engineering Department
ECE (8101) 432

Object Oriented Modeling of Electronic Circuits – Spring 94-95
Final Exam



Computer Account#_____

First Name:_____

Last Name:_____

Student Number:_____

Signature:_____

Grade:

Problem 1. _____/25

Problem 2. _____/25

Problem 3. _____/25

Problem 4. _____/25

Total: _____/100

Hekmataneh, Hamedan, Iran

DO NOT USE LAPTOPS
EXTRA SHEETS WILL NOT BE ACCEPTED
YOU MUST SHOW COMPLETE WORK ON ALL PROBLEMS
YOU HAVE EXACTLY 150 MINUTES FOR WORKING ON THIS TEST
THIS IS AN OPEN BOOK OPEN NOTE EXAM, NO SHARING ALLOWED

SystemC Linguistics

1. In This problem you should answer the bellow questions:

- Define *a, b, s, i, j, k* and *w* as signals in SystemC. In an SC_THREAD process, do the following assignments with a correct SystemC syntax:

  Initial condition: a=1, b=1, s=1, i=0, j=0, k=0, w=0.
  i = NOT s
  j = a AND i
  k = b AND s
  w = j OR k

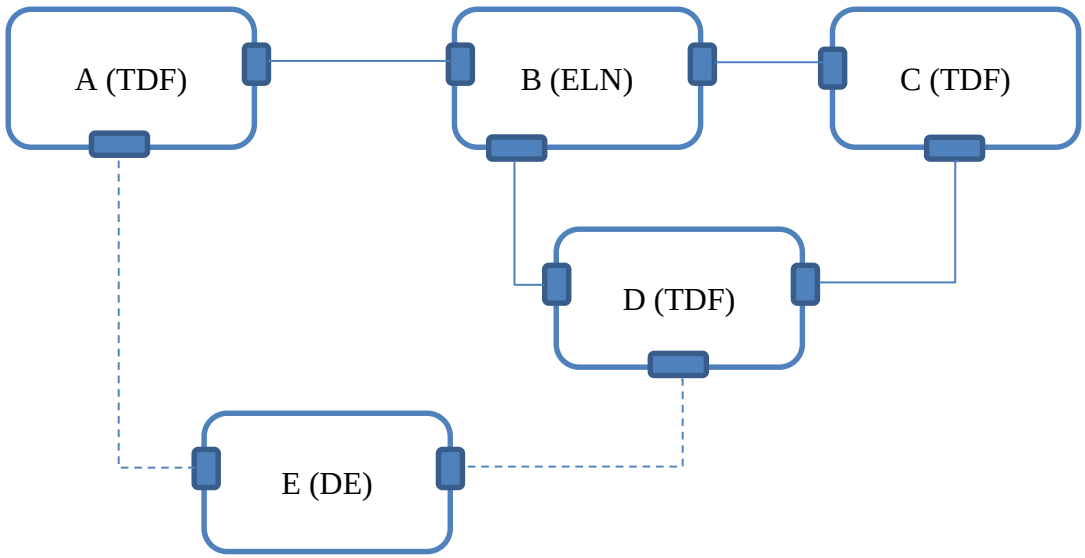
  Define an SC_THREAD process that reports the time at which a new data is written on any of the above signals, and its corresponding value.
- Define *a, b, s, i* and *j* as variables and *k* and *w* as signals in SystemC and do all procedures of the previous part again.

SystemC Design

2. In this problem you are to design and implement a circuit for finding the maximum value among the incoming clocked data. This circuit has two input signals called *Start* and *Stop* and a data bus, *Databus*. After a positive pulse that is synchronized with the clock appears on the *Start* signal, the circuit starts reading data from *Databus* on the positive edges of the clock. This process continues until a positive pulse appears on the *Stop* signal. At this point, the circuit puts the maximum value of all data it received on the *Max* output and issues the *Ready* output signal. Draw a schematic that shows the details of the datapath and the controller part of the circuit. Then implement the circuit using SystemC. Show how datapath and controller are to be wired. Write a testbench that applies data to your circuit and verify your design.

SystemC-AMS Concepts

3. In this problem you are to describe the system shown in figure below using SystemC-AMS. This system is constructed using 4 modules (A, B, C, D). Module A and D are TDF modules. Module B is an ELN module and Module C is a TDF module that receives five samples at each activation step and creates only one sample. Module E is a discrete event module. Consider a time step value of 15 US for module C. Define time step values for all ports and modules of the system. Define rate and delay attributes for the ports if needed. Define a scheduling for this system.



SystemC-AMS Design

4. In this Problem you are to design a DTMF decoder. Whenever you hit a number on a telephone touch pad, a unique tone is generated. Each tone is actually a sum of two sinusoids, and the resulting signal is called a dual-tone multifrequency (or DTMF) signal. Figure 1 shows the frequencies generated for each button. For instance, if the "6" button is pressed, the telephone will generate a signal which is the sum of a 1336 Hz and a 770 Hz sinusoid.

Frequencies	1209 Hz	1336 Hz	1477 Hz
697 Hz	1	2	3
770 Hz	4	5	6
852 Hz	7	8	9
941 Hz	*	0	#

Figure 1 DTMF encoding table for touch tone dialing. When any key is pressed, the tones of the corresponding row and column are generated.

We will call the set of all seven frequencies listed in this table the DTMF frequencies. These frequencies were chosen to minimize the effects of signal distortions. Notice that none of the DTMF frequencies is a multiple of another.

There a number of steps to perform when decoding DTMF signals. The first two steps allow us to determine the strength of the signal at each of the DTMF frequencies. We first employ a bank of bandpass filters with center frequencies at each of the DTMF frequencies. Then, we process the output of each bandpass filter to give us an indication of the strength of each filter's output. The third step is to "detect and decode." From the filter output strengths, we detect whether or not a DTMF signal is present. If it is not, we refrain from decoding the signal until a tone is detected. Otherwise, we select the two filters with the largest output strengths and use this information to determine which key was pressed. A block diagram of the DTMF decoder can be seen in Figure 2.

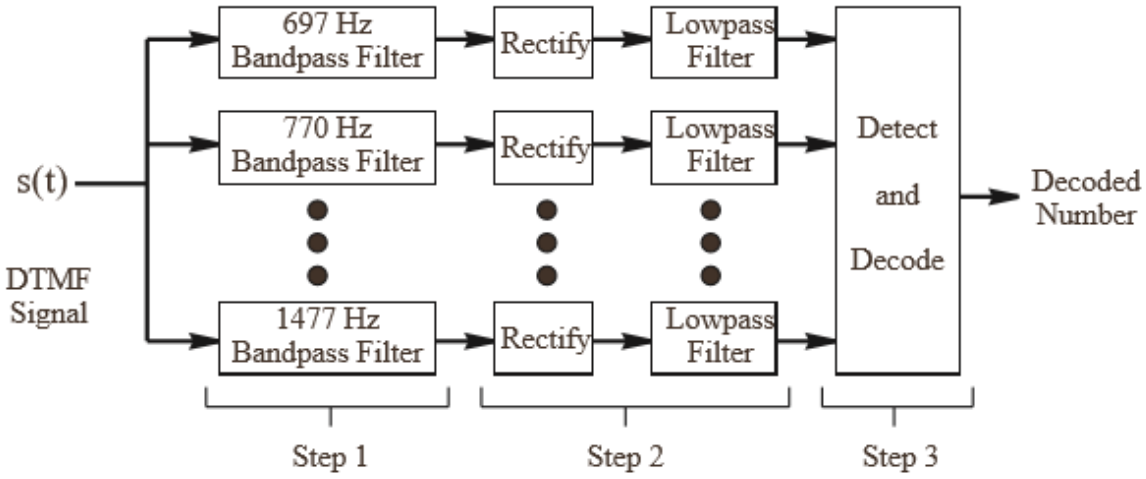


Figure 2 A block diagram of the DTMF decoder system. The input is a DTMF signal, and the output is a string of numbers corresponding to the original signal

Design the Bandpass filters in LSF Model computation, Rectifier modules and Lowpass filters in TDF model computation, and Detect and Decode module in Discrete event modeling. Show the prototype of all modules (ports, converters, modules, …).