



UNIVERSITY OF TEHRAN

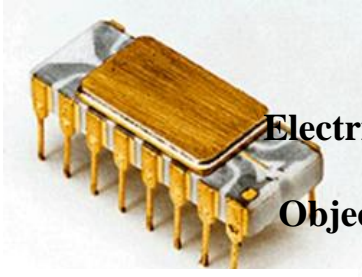
Electrical and Computer Engineering Department

ECE (8101) 432

Object Oriented Modeling of Electronic Circuits

Spring 97-98

Midterm Exam

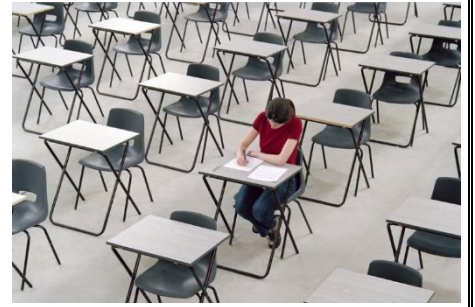


The first microprocessor, Intel 4004, 2250 transistors, 108Khz, 1971.

First Name: _____

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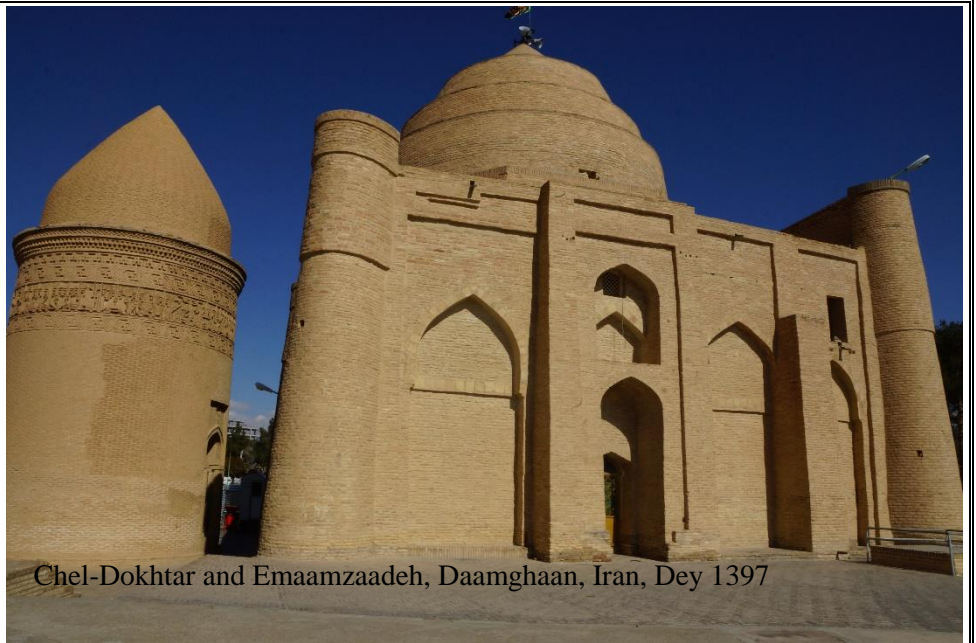
Problem 1. _____ / 25

Problem 2. _____ / 25

Problem 3. _____ / 25

Problem 4. _____ / 25

Total: _____ / 100



Chel-Dokhtar and Emaamzaadeh, Daamghaan, Iran, Dey 1397

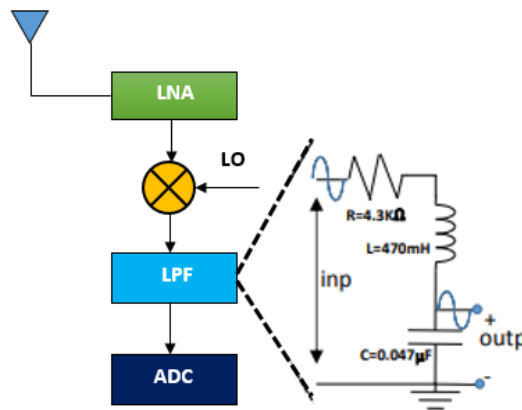
Regulations:

- * DO NOT USE LAPTOPS
- * EXTRA SHEETS WILL NOT BE ACCEPTED
- * THIS IS AN OPEN NOTE OPEN SLIDE EXAM
- * YOU MUST SHOW COMPLETE WORK ON ALL PROBLEMS
- * YOU HAVE EXACTLY 165 MINUTES FOR WORKING ON THIS TEST
- * WHERE CODES REPEAT, USE OFG THREE DOTS IS ALLOWED TO IMPLY REPEATITYION

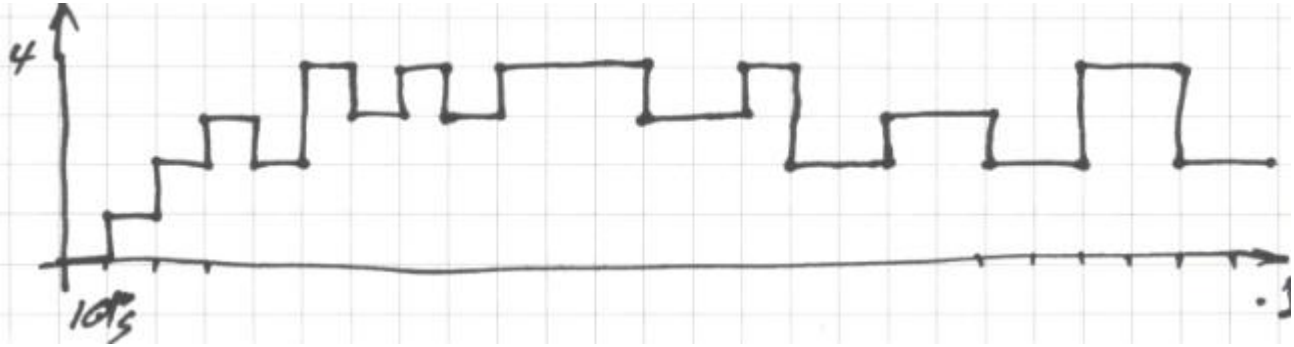


YOU ARE TRUSTED AND BY SIGNING HERE YOU ARE INDICATING THAT THIS EXAM IS YOUR OWN WORK ONLY: Signature:

1. A Low Pass Filter (LPF) is used in an RF receiver as shown in in the RF block diagram below. You are to describe a second-order low pass filter in SystemC-AMS as used in the block diagram shown. This RLC circuit uses $L=470$ mH, $R=4.3$ K Ω , and $C=0.047$ μ F. The cutoff frequency of the filter is 1 KHz. Write the RLC circuit in SystemC-AMS ELN model of computation. Enclose this in an SC_MODULE. Adjust the parameters of the design considering the cutoff frequency.



2. Derive the Laplace transfer function of the LPF of Problem 1. **A)** Model this LTF in SystemC-AMS using TDF model of computation described by the numerator and denominator coefficients. Since the cut off frequency of the filter is 1 KHz set the sample rate of your TDF module to 0.10 ms. **B)** Enclose the description of Part A in an `sc_main` and apply test data according to the input waveform shown below. Show the expected output of the filter emphasizing on the timing of the output and not as much on the amplitude of the output waveform.



3. You are to describe a cosine calculator engine (CCE) that takes positive inputs between 0 and $\pi/2$ and calculates the cosine of this input. Your description should mimic its RTL handshaking and signaling. The input and output of the cosine engine are real numbers. The description should match the signaling described here, but the functionality should be described according to the algorithm shown below. This means that you do not have to design the RT level hardware of the datapath.

The CCE will be ready to take its input from *inCCE* when its *readyCCE* output is 1. During this time *outCCE* will have the result of the last cosine calculation. To start a new cosine calculation, a positive pulse must be issued on the CCE's *startCCE* input. At this time, CCE will start the calculation, de-assert its *readyCCE* output, and when completed, it will assert its *readyCCE* output, while the *outCCE* will hold the cosine calculation results. CCE performs the following for x between 0 and π .

$$\cos x = \sum_{n=0}^{\infty} \frac{(-1)^n}{(2n)!} x^{2n} = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \dots$$

A partial SystemVerilog description for implementation of functionality of CCE is shown below. Use this as a suggestion or starting point.

```
expr = 1;
term = 1;
for ( i = 1; i <=15; i=i+2 ) begin
    term = term * xin * ( 1 / i );
    term = term * xin * ( 1 / (i+1) );
    expr = (negate) ? (expr-term) : (expr+term);
end
```

Write the complete SystemC description of CCE.

Hint: you can use the first handshaking example described in class for adjusting the signaling of CCE. The example was presented as introduction to SystemC channels.

4. Write templated interfaces and a SystemC channel for a buffer channel with `put(...)` and `get(...)` functions. The initiator invokes `put(...)` to put data into the channel. The data is only put in the channel if the channel is empty. The target invokes `get(...)` to get the data placed in the channel. This happens if a data has been placed in the channel that has not been used (i.e., not get) before. The `put(...)` and `get(...)` functions also provide a timeout that will return with a -1 if the time allowed in the arguments of these functions elapses without being able to put or get.