

**Doctorate Entry Examination (D-LMD – 2015/2016)**

12/10/2015

**Major:** Telecommunications and Computer Engineering

**Note:** Answer only one topic (Topic 1 or Topic 2)

<b>Topic 2:</b> Computer System Engineering	<b>Version:</b> B	Time Duration: 2h:00
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**Exercise 1 : (5 points)**

- a) The impulse response of a linear phase FIR filter starts at the values:  
 $h[0] = 0.25, h[1] = -0.5, h[2] = 0.75.$

For each of the four filter types, find the coefficients of the smallest order FIR filter that satisfies this condition.

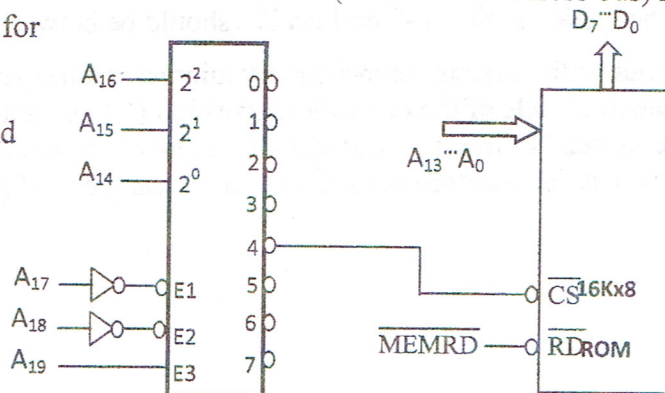
- b) What is the main difference between the DFT of a signal and its discrete-time Fourier transform?  
 c) Find the 12-point discrete Fourier transform (DFT) of the following sequence:

$$x[n] = \sin\left[\frac{\pi}{3}n\right] \cos\left[\frac{2\pi}{3}n\right]$$

**Exercise 2: (5 points)**

**A.** Figure below shows a 16-Kbyte ROM connected to a 16-bit (with 20-bit address bus) microprocessor via a 3:8 decoder. Find the address range for

- (a) Output 4 of the decoder  
 (b) Output 2 of the decoder and  
 (c) Output 7 of the decoder



**B. Write a small paragraph for each of the following question**

1. Contrast a memory-mapped I/O system with an I/O-mapped-I/O system.
2. What are the main differences between polled I/O and interrupt-driven I/O?

**C.**

1. State the three design styles used to write the VHDL code of the architecture.
2. What does SoPC stand for?
3. Why Nios II and MicroBlaze are called soft core processors?
4. What does VHDL stand for? Compared to schematic capture, state the advantages using VHDL as a design entry.

### Exercise 3: (5 points)

The binomial coefficient  $c(n, k)$ , where  $n$  and  $k$  are integers with  $0 \leq k \leq n$  and  $n > 0$ , can be defined in two equivalent manners:

1.  $c(n, k) = \frac{n!}{k!(n-k)!}$  or

2.  $c(n, k) = \begin{cases} 1 & \text{if } k = 0 \text{ or } k = n \\ c(n-1, k) + c(n-1, k-1) & \text{otherwise} \end{cases}$

- Write a non recursive C/C++ function that accepts as parameters two integers  $n$  and  $k$  with  $0 \leq k \leq n$  and  $n > 0$  and returns  $c(n, k)$ .
- Write a recursive C/C++ function that accepts as parameters two integers  $n$  and  $k$  with  $0 \leq k \leq n$  and  $n > 0$  and returns  $c(n, k)$ .
- As far as the time complexity is concerned, which implementation is better: the recursive or the non recursive?

#### Important Notes:

- For questions a. and b., you are only asked to write a function and not a whole program.
- For question c., your answer must be justified.

### Exercise 4: (5 points)

A microcontroller system is used to track the temperature of a container. This measured by an analogue sensor and converted to a digital value. A green LED is connected to Pin 0 of Port B, a red LED is connected to Pin 2 of Port B, and a blue LED is connected to Pin 3 of Port B. The red LED should be turned on when the temperature is greater than MAX value, the blue LED should be on when the temperature is less than MIN value, and the green LED should be on when the temperature is between MIN and MAX. To set the MIN and MAX values, switches are connected to Port H as follows:

MIN = the value on pins 0 -3 on Port H (should be between 0 and 15)

MAX = 15 + the value on pins 4 -7 on Port H (should be between 15 and 30)

- Draw a circuit of the system (consider any microcontroller you know).
- Write a pseudo C code of the controller algorithm (It does not have to be fully functional code).
- Extend the system's circuit to transfer the temperature measurement data serially to a local PC. Specify which serial interface is used and how it can be configured for data transmission.