ORDRE DES INGÉNIEURS DU QUÉBEC

NOVEMBER 2016 SESSION

Open-book examination
Calculators : only authorized models
Duration : 3 hours

14-IF-A2 Digital System Design

1) Design a combinational circuit to convert a 3-bit input value, X_0, X_1, X_2 into a 4-bit output value Y_0, Y_1, Y_2, Y_3 with the following translation table:

X_0, X_1, X_2	Y_0, Y_1, Y_2, Y_3
000 (0_{10})	0 0 0 0
001 (1_{10})	0 0 0 1
010 (2_{10})	0 0 1 0
011 (3_{10})	0 1 0 0
100 (4_{10})	1 0 0 0
101 (5_{10})	1 1 0 0
110 (6_{10})	1 1 1 0
111 (7_{10})	1 1 1 1

a) Draw K Maps of the outputs Y_0, Y_1, Y_2, Y_3 **(10 points)**

b) Design the circuit using elementary gates **(10 points)**

2) Design a synchronous circuit with 3 outputs, Y_0, Y_1 and Y_2, with the following behavior for each clock pulse:

If the input X = 0 rotate one bit right the binary value represented by Y_0, Y_1 and Y_2 and if the input X = 1 rotate one bit left the binary value represented by Y_0, Y_1 and Y_2.

The initial value of Y_0, Y_1 and Y_2 can be any value between 000 (0_{10}) and 111 (7_{10}) and is setup with a load mechanism outside the scope of this problem.

a) Draw the full state diagram of this circuit **(10 points)**

b) Design the circuit with D flip-flop(s) **(20 points)**

c) Propose an alternate design with standard MSI devices like register latches, counters, adders (and also some gates) etc… **(10 points)**

3) Give the major reason why the serial interfaces are more used than parallel interfaces on microcomputer systems. Find an argument to the level of connectivity of micro-electronic chips. **(10 points)**
4) Why synchronous buses allow higher communication speed between the various circuits of a microcomputer? Explain your answer by comparison with asynchronous communication buses. **(10 points)**
5) Explain what is the fan-out capability of a logic gate. How in practice we're facing this limitation? **(10 points)**
6) Explain briefly the principle of operation of static and dynamic RAM memory. What is the main advantage of the dynamic memory? What is their main disadvantage? **(10 points)**