Midterm Examination 1
GEM 1501: Problem Solving for Computing

Thursday 20.02.2014, duration half an hour

Matriculation Number: _______________

Rules
This test carries 10 marks and consists of 5 questions. Each questions carries 2 marks; full marks for a correct solution; a partial solution can give a partial credit.

Question 1 [2 marks].
The input of a function f consists of for bits x_3, x_2, x_1, x_0 and it computes one bit y such that $y = 1$ if and only if the value of the binary number $x_3x_2x_1x_0$, that is, the number $8 * x_3 + 4 * x_2 + 2 * x_1 + x_0$, is a square number. So $f(1, 0, 0, 1)$ should be 1 as the input represents the square number nine and $f(1, 1, 0, 0)$ should be 0 as the input represents the number twelve which is not a square. Give the formula which computes y from x_3, x_2, x_1, x_0 or draw the corresponding circuit. The connectives (gates) permitted are AND, OR, NOT, XOR, NAND and NOR.

Question 2 [2 marks].
Write down a basic html page which contains a JavaScript program to compute the following: On loading, it prompts for one input x, computes $y = x * x$ and outputs the value y, either by alert or by writing into the document. The html page should have a title and the JavaScript program should be included into the body of the page. Please give the full code of your page.

Question 3 [2 marks].
Blaise Pascal, Charles Babbage and Herman Hollerith each constructed mathematical machines. Describe which of these machines were completed, what functionalities they had and how successful they were for solving computation problems of their time.

Question 4 [2 marks].
Write a JavaScript function which computes the sum of the cubes from 0 to x, so the output y should be $0^3 + 1^3 + 2^3 + \ldots + x^3$.

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function cubesum(x)
  { var y; var z;




    return(y); }
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Question 5 [2 marks].
Assume that a function f satisfies $f(0) = 3$ and $f(1) = 3 + f(0)$ and

$$f(n+1) = 3 + f(0) + f(1) + \ldots + f(n)$$

for all n. Determine the exact order of f and check the correct box (exactly one):

- ☐ $f(n) \in \Theta(n)$; ☐ $f(n) \in \Theta(n^2)$; ☐ $f(n) \in \Theta(n^3)$;
- ☐ $f(n) \in \Theta(n^4)$; ☐ $f(n) \in \Theta(2^n)$; ☐ $f(n) \in \Theta(3^n)$.

Furthermore, check all boxes for which the below statement is true:

- ☐ $f(n) \in O(n)$; ☐ $f(n) \in O(n^2)$; ☐ $f(n) \in O(n^3)$;
- ☐ $f(n) \in O(n^4)$; ☐ $f(n) \in O(2^n)$; ☐ $f(n) \in O(3^n)$.

Write a few lines how you determined which of the above choices applied.

END OF EXAMINATION.