Assignments for General CS 2 (320201)

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For Course Purposes Only

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Contents

Quiz 1: Natural Numbers(Given Sep. 14.)

12pt

Problem 1.1 (Addition Definition)
Give the two basic rules that define the "addition" operation. Provide examples along with and a mathematical representation for each rule stated. Use the unary representation of numbers (e.g. o for 0, $s(o)$ for 1 and so on).

Quiz 2: Unary natural numbers(Given Sep. 15.)

6pt

Problem 2.1 (Peano's induction axiom)
State Peano's induction axiom and discuss what it can be used for.

6pt

Problem 2.2 (Natural numbers)
Prove or refute that $s(s(o))$ and $s(s(s(o)))$ are unary natural numbers and that their successors are different.

Quiz 3: Relation properties(Given Sep. 22.)

12pt

Problem 3.1 (Lists)

Write an SML function that returns the greatest positive number in a list. If there are no positive numbers in the list it should return 0.

Examples:

```
max [1,3,-2];
val it = 3 : int

max [-1,-2];
val it = 0 : int
```

Quiz 4: SML(Given Sep. 29.)

12pt

Problem 4.1 (Lists)
Write an SML function that returns the sum of the last 2 elements of a list of integers. If the list has less than 2 elements simply return the sum of all elements.

Quiz 5: Abstract data types(Given Oct. 6.)

12pt

Problem 5.1 (ADTs and Ground Constructor Terms)
Given the ADT

$$\langle \{\mathbb{A}, \mathbb{B}\}, M \rangle$$

write down the constructor declarations, i.e. the set M such that the following are ground constructor terms of the respective sorts:

ground constructor term	sort
$g(a, c(a, b))$	$\mathbb{B}$
$f(g(d(a, e)))$	$\mathbb{A}$
$c(b, f(g(b, a)))$	$\mathbb{A}$

Quiz 6: Codes & Boolean Expressions(Given Nov. 2.)

4pt

Problem 6.1 (Prefix codes)
What is a prefix code?

8pt

Problem 6.2: Let $e := (\overline{x1} * x2 + \overline{x1 + x2} * (x3 + x4))$ and $\varphi := [F/x1], [T/x2], [F/x3], [T/x4]$, compute the value $\mathcal{I}_\varphi(e)$, tracing all computational steps.

Quiz 7: Call by value(Given Nov. 20.)

12pt

Problem 7.1 (Call by Value)
Explain the concept of a "call-by-value" programming language in terms of evaluation order. Give an example program where this affects evaluation and termination, explain it.

Quiz 8: QMC(Given Nov. 16.)

12pt

Problem 8.1 (Practising Quine McCluskey)

Use the algorithm of Quine-McCluskey to determine the minimal polynomial of the following function:

$x1$	$x2$	$x3$	f
F	F	F	F
F	F	T	F
F	T	F	T
F	T	T	F
T	F	F	T
T	F	T	T
T	T	F	F
T	T	T	T

Quiz 9: Boolean Expressions(Given Nov. 10.)

12pt

Problem 9.1 (Evaluating Expressions)

Given $\varphi_1 := ([\mathsf{T}/x_1], [\mathsf{F}/x_2], [\mathsf{F}/x_3])$ and $\varphi_2 := ([\mathsf{F}/x_1], [\mathsf{T}/x_2], [\mathsf{F}/x_3])$ write a boolean expression containing the variables x_1, x_2 and x_3 that evaluates to T under φ_1 and to F under φ_2. Show the evaluation of your expression under the two assignments step by step.

Quiz 10: Normal forms and Landau sets(Given Nov. 17.)

6pt

Problem 10.1 (CNF and DNF)
Write the CNF and DNF of the boolean function that corresponds to the truth table below.

x_1	x_2	x_3	f
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

6pt

Problem 10.2 (Landau sets)
Order the landau sets below by specifying which ones are subsets and which ones are equal (e.g.: $O(a) \subset O(b) \subset O(c) \equiv O(d) \subset O(e) \dots$)

$$O(n^2);\ O((n)!);\ O(|\sin n|);\ O(n^n);\ O(1);\ O(2^n);\ O(2n^2 + 2^{72})$$

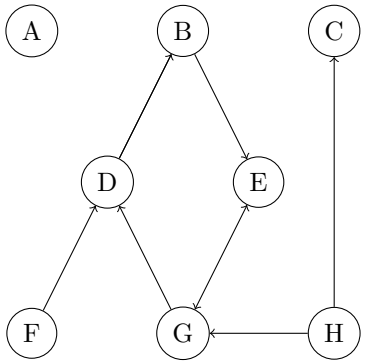
Quiz 11: Graphs(Given Dec. 7.)

12pt

Problem 11.1 (Directed Graph)
We call a graph connected, iff for any two nodes n_1 and n_2 there is a path starting at n_1 and ending at n_2.

a. Look at the directed graph bellow. How many initial, terminal nodes and paths does it have?

b. Complete the graph by adding directed edges such that it becomes a connected and for each node n, $indeg(n) = outdeg(n)$. How many initial and terminal nodes does your graph have now?



Quiz 12: Calculi and boolean expressions(Given Dec. 1.)

6pt

Problem 12.1 (Calculus Properties)
Explain briefly what the following properties of calculi mean:

- correctness
- completeness

6pt

Problem 12.2 (Properties of boolean expressions)
In the table below mark the properties that each of the expressions has.

	valid	satisfiable	falsifiable	unsatisfiable
$(x_1 + x_2) * \overline{x_1}$				
$(x_1 + x_2) * (\overline{x_1} * \overline{x_2})$				
$x_1 * x_2 + (\overline{x_1} + \overline{x_2})$				