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Quizzes for General CS I (320101) Fall 2011

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For Course Purposes Only

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Assignment 1: Introductory quiz(Given Sep. 12. 2011)

6pt

Problem 1.1 (GenCS Grading)
State the components of the overall grade of the GenCS course and discuss their intention.

6pt

Problem 1.2 (Diagram)
Discuss the three components of computation, by referring to the diagram below:

../slides/gencs/tikz/data-alg-machine

Assignment 2: Peano axioms and Induction(Given Sep. 19. 2011)

Problem 2.1 (Peano's induction axiom) 6pt

State Peano's induction axiom and discuss what it can be used for. 6pt

Problem 2.2 (Zero is not one)

Prove or refute that $s(o)$ is different from o.

Note: Please use **only** the Peano Axioms for this proof.

Assignment 3: Sets and Math Talk(Given Sep. 26. 2011)

12pt

Problem 3.1 (Talking about Sets)

Given the following sets

1. $A = \{a, b, c, d, e\}$
2. $B = \{d, f, h\}$
3. $C = \{d, f, g, i\}$

Define each of the following operations on sets **in math talk** and apply it to the given sets:

1. intersection:

   $A \cap B$
2. union:

   $B \cup C$
3. set difference:

   $A \backslash B$

Finally, define n-fold Cartesian product **in math talk** and find $\#(A \times B \times C)$.

Assignment 4: SML(Given Oct. 3. 2011)

12pt

Problem 4.1 (Square the list)

Write an SML function squareList that takes an int list and returns the list with every element squared.

Example:

```
- squareList [1, 4, 3, 10];
val it = [1, 16, 9, 100] : int list;
```

Note: $x^2 = x * x$

Assignment 5: Higher-order SML functions(Given Oct. 10. 2011)

6pt

Problem 5.1 (Sentence with spaces)
Write an SML function that given a list of strings returns the sentence consisting of those strings separated by spaces. You must use at least one of foldl/foldr/map functions in your implementation.

For example

```
- spacedSentence(["This","is","a","spaced","sentence"]);

val it = "This is a spaced sentence" : string
```

6pt

Problem 5.2 (Guess the function)
Explain what the following SML function does and what it returns.

```
fun whatFunction(ls) =
        foldl (fn (x,(a,b,c)) => if c > x then (a+1,a,x) else (a+1,b,c))
              (1,0,hd(ls))
              (tl(ls));
```

Assignment 6: Abstract Data Types(Given Oct. 23. 2011)

12pt

Problem 6.1 (SML and ADTs)

You are given the following SML datatype which describes an ADT for boolean expressions:

datatype bool = true | false;
datatype expr = **and of** expr∗expr | not **of** expr | fb **of** bool;

1. Write down the formal ADT definition that describes this SML datatype.
2. Given the SML expression below, determine whether it represents a valid ground constructor term for an expression or not:

   and(not(fb(true)),false)

Note: Be sure to give complete explanations which reference the three base rules of the ground constructor terms!

Assignment 7: Abstract Procedures and Programming with effects(Given Nov. 07. 2011)

12pt

Problem 7.1 (Programming with effects)

1. Write down two SML functions that compute the following sequences. Make sure that the user does not try to access a negative index (i.e. $n < 0$) or the square root takes a negative argument by raising exceptions.

$$a_n = \begin{cases} 2.0 & \text{if } n = 0 \\ \sqrt{b_{n-1}} + a_{n-1} & \text{else} \end{cases}$$

$$b_n = \begin{cases} 1.0 & \text{if } n = 0 \\ 3.0 \times a_{n-1} - b_{n-1} & \end{cases}$$

Note: The two sequences are mutually recursive, i.e. they call each other.

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2. Explain what would happen if you would not use exceptions in your functions from the point of view of termination.

Assignment 8: Formal Languages and Codes(Given Nov. 14. 2011)

12pt

Problem 8.1 (Codes)
You are given the alphabets $A := \{\mathtt{a}, \mathtt{b}, \mathtt{c}, \mathtt{d}, \mathtt{e}\}$ and $B := \{:, ;,)\}$, and the function $c\colon A \to B^+$, with:

$$
\begin{aligned}
c(a) &=;) \\
c(b) &=:)) \\
c(c) &=;) :) \\
c(d) &=;)) \\
c(e) &=) :))
\end{aligned}
$$

1. Please encode the string "bbaceda" using c.
2. Is c a character code? Please state why or give a counter-example.
3. Check whether c is a prefix code. If not, explain why, and modify the codewords of c such that it becomes a prefix code.
4. Check whether the extension of the original code c given above is a string code. Explain your reasoning.

Assignment 9: Boolean Algebra(Given Nov. 20. 2011)

12pt

Problem 9.1 (Evaluating Expressions)
Given the expression $E := \overline{\overline{x_0} * (x_1 + x_2)}$

Your tasks are:

1. If $\varphi := [\mathsf{F}/x_0], [\mathsf{T}/x_1], [\mathsf{F}/x_2]$, evaluate the expression using the evaluation function $\mathcal{I}_\varphi(E)$ and showing the whole computation.

2. Write down the truth table for the expression.

Assignment 10: Normal Forms and Landau Sets(Given Nov. 28. 2011)

8pt

Problem 10.1 (CNF and DNF)

Write the CNF and DNF of the boolean function that corresponds to the truth table below. In addition, state the costs of the resulting CNF and DNF expressions.

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

4pt

Problem 10.2 (Landau Sets)

Determine for the following functions f and g whether $f \in O(g)$, or $f \in \Omega(g)$, or $f \in \Theta(g)$, explain your answers.

f	g
$\log(n^4)$	$4n$
$\log(n^4)$	$\log(n)$
$(n+1)^2(n^2-6)$	n^4
$\log_2(5n)$	$n^{\log_n(5)}$

Assignment 11: QMC and Hilbert Calculus(Given Dec. 5. 2011)

9pt

Problem 11.1 (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	T
F	T	F	F
F	T	T	T
T	F	F	T
T	F	T	T
T	T	F	F
T	T	T	F

3pt

Problem 11.2 (Propositional Logic with Hilbert Calculus)
Consider the Hilbert-style calculus given by the axioms

1. $K := P \Rightarrow Q \Rightarrow P$
2. $S := (P \Rightarrow Q \Rightarrow R) \Rightarrow (P \Rightarrow Q) \Rightarrow P \Rightarrow R$

and the rules:

1. $\dfrac{\mathbf{A} \Rightarrow \mathbf{B} \quad \mathbf{A}}{\mathbf{B}}$MP
2. $\dfrac{\mathbf{A}}{[\mathbf{B}/X](\mathbf{A})}$Subst

Prove or refute that $\mathbf{C} \Rightarrow \mathbf{C}$.