CPSC 121: Models of Computation
Quiz #1: Section **BCS**, 2009 February 4/5

Name: _____ Student ID: _____

Signature: _____

- You have **30 minutes** to write the 4 questions on this quiz.
- A total of **16 marks** are available. You may want to complete what you consider to be the easiest questions first!
- Ensure that you clearly indicate a single legible answer for each question.
- You are allowed a single 8.5" x 11" reference sheet. The sheet must have your name on it and may contain any content you like. Otherwise, no notes, aides, or electronic equipment are allowed.
- Good luck!

UNIVERSITY REGULATIONS

1. Each candidate must be prepared to produce, upon request, a UBCcard for identification.

2. Candidates are not permitted to ask questions of the invigilators, except in cases of supposed errors or ambiguities in examination questions.

3. No candidate shall be permitted to enter the examination room after the expiration of one-half hour from the scheduled starting time, or to leave during the first half hour of the examination.

4. Candidates suspected of any of the following, or similar, dishonest practices shall be immediately dismissed from the examination and shall be liable to disciplinary action:

   - having at the place of writing any books, papers or memoranda, calculators, computers, sound or image players/recorders/transmitters (including telephones), or other memory aid devices, other than those authorized by the examiners;
   - speaking or communicating with other candidates; and
   - purposely exposing written papers to the view of other candidates or imaging devices. The plea of accident or forgetfulness shall not be received.

5. Candidates must not destroy or mutilate any examination material; must hand in all examination papers; and must not take any examination material from the examination room without permission of the invigilator.

6. Candidates must follow any additional examination rules or directions communicated by the instructor or invigilator.

1 Describing Relationships with Predicate Logic [4 marks]

Definitions: Let I be the set of all valid input text. Let P be the set of all valid Java programs. Let Runs(p, i) mean that program p runs to completion on input text i. (In other words, we start up program p and then type in the input text i. If the program ever stops, it runs to completion. If it never stops for some reason, then it does not run to completion.)

Using these definitions, translate the following statement into predicate logic:

Every program has at least one input on which it runs to completion and at least one input on which it does not run to completion.

2 Critiquing Propositional Logic Proofs [4 marks]

Consider the following propositional logic proof. Some steps in the proof are invalid. Circle the step or steps that are invalid and explain why they are invalid.

(Note: any explanation that clearly describes a flaw in the step is acceptable, but the easiest explanations will typically indicate how a logical equivalence or rule of inference was applied inappropriately.)

1.	$(s \wedge q) \rightarrow m$	premise
2.	$\sim p$	premise
3.	$p \vee s$	premise
4.	$r \rightarrow (r \vee q)$	premise
5.	s	elimination (disjunctive syllogism) on 2 and 3
6.	$\sim r \vee (r \vee q)$	definition of conditional on 4
7.	$(\sim r \vee r) \vee q$	associativity on 6
8.	$T \vee q$	negation on 7
9.	q	identity on 8
10.	$s \wedge q$	conjunction on 5 and 9
11.	m	modus ponens on 10 and 1

3 Number Representation [4 marks]

You are designing a banking system that must accurately track positive balance amounts in dollars and cents. The application uses 64 bits for each balance. Give one advantage of each proposed representation below or indicate that the representation is *unacceptable* and briefly explain why.

(Hint: factors to consider include the range of numbers that can be represented and the difficulty of performing operations such as displaying values and simple arithmetic.)

1. Use an unsigned 64-bit binary number for the balance in *cents*. So, a $10 balance would be represented as 1000 cents.

2. Use an unsigned 57-bit binary number to represent the dollars part of the balance and an unsigned 7-bit binary number to represent the cents (using only the numbers 0–99, never 100–127).

3. Use an unsigned binary number with a fractional part—in which the "decimal point" is between the 7th and 8th bit from the right—to represent the whole balance. So, the 64-bit binary number:

0000000000000000000000000000000000000000000000000000001000000

would be interpreted as:

0000000000000000000000000000000000000000000000000000000.1000000

or $0.50.

4 Circuit Design [4 marks]

Design a "matching" circuit using only inverters and two-input AND, OR, and XOR gates. The circuit has three inputs: a "primary" input p and two "matching" inputs m_1 and m_2. It should output a 2-bit (unsigned) binary number indicating how many of m_1 and m_2 have the same truth value as p.