CPSC 121 Midterm 1
Tuesday, February 12th, 2013

Name: _____ Student ID: _____

Signature: _____ Section (circle one): Morning Afternoon

- You have 70 minutes to write the 8 questions on this examination. A total of 50 marks are available.
- **Justify all of your answers.**
- You are allowed to bring in one hand-written, double-sided 8.5 x 11in sheet of notes, and nothing else.
- Keep your answers short. If you run out of space for a question, you have written too much.
- The number in square brackets to the left of the question number indicates the number of marks allocated for that question. Use these to help you determine how much time you should spend on each question.
- Use the back of the pages for your rough work.
- **Good luck!**

Question	Marks
1	
2	
3	
4	
5	
6	
7	
8	
Total	

UNIVERSITY REGULATIONS:

- Each candidate should be prepared to produce, upon request, his/her UBC card.
- No candidate shall be permitted to enter the examination room after the expiration of one half hour, or to leave during the first half hour of the examination.
- CAUTION: candidates guilty of any of the following, or similar, dishonest practices shall be immediately dismissed from the examination and shall be liable to disciplinary action.
    1. Having at the place of writing, or making use of, any books, papers or memoranda, electronic equipment, or other memory aid or communication devices, other than those authorised by the examiners.
    2. Speaking or communicating with other candidates.
    3. Purposely exposing written papers to the view of other candidates. The plea of accident or forgetfulness shall not be received.
- 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.

[1] 1. Do you want your tutorial attendance to count towards your grade?

If you answered 'YES', then 1% of your final course mark will be based on your tutorial attendance (# attended divided by total number minus 2, but no more than full credit). Online quizzes will be worth 5%. If you answered 'NO', then tutorial attendance is worth nothing in your mark, and online quizzes count for 6% of your final course mark.

[7] 2. Determine the validity of the following arguments *using rules of inference*. You may use inference rules from class or one of the texts (Epp or Rosen), or you may use a logical equivalence from class or the texts. You must state what inference rule or logical equivalence you use at each step.

1. $\sim p \rightarrow (u \vee v)$
2. $s \rightarrow \sim q$
3. $q \wedge (p \rightarrow r)$
4. $\sim u$
5. $\sim r \vee s$

$\therefore v$

[4] 3. What is the decimal value of 1001010 if the sequence of bit is interpreted as

[2] a. A 7 bit, unsigned integer?

[2] b. A 7 bit, signed (two's complement) integer?

i	2^i
0	1
1	2
2	4
3	8
4	16
5	32
6	64
7	128
8	256
9	512
10	1024
11	2048

[6] 4. Given the following definitions:

- S: the set of all canadian senators.
- T: the set of all canadian province and territories.
- $C(x)$: senator x has been charged with a crime.
- $B(x, y)$: senator x was born in province or territory y.
- $P(x, y)$: senator x belongs to political party y.

translate each of the following predicate logic statements into English. To obtain full marks, your English translation will need to sound reasonably natural.

[3] a. $\forall x \in S, (C(x) \land P(x, \text{"Conservative"})) \rightarrow \sim B(x, \text{"Yukon"})$

[3] b. $\forall x \in S, \forall y \in S, (C(x) \land C(y)) \rightarrow \forall t \in T, \sim B(x, t) \lor \sim B(y, t)$

[9] 5. Given the same definitions as for the previous question (rewritten here for convenience):

- S: the set of all canadian senators.
- T: the set of all canadian province and territories.
- $C(x)$: senator x has been charged with a crime.
- $B(x, y)$: senator x was born in province or territory y.
- $P(x, y)$: senator x belongs to political party y.

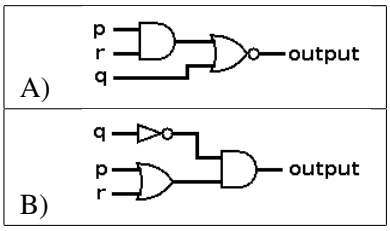
translate each of the following English sentences into predicate logic.

[3] a. No liberal senator was born in Alberta.

[3] b. Only senators from Québec can belong to the Bloc Québécois.

[3] c. Senators from at least two different provinces or territories have been charged with a crime.

[9] 6. Here are five propositions or circuits:



C)	$((p \oplus q) \vee r)$
D)	$\exists x \in D, \forall y \in D, K(x,y) \wedge \sim(R(x) \vee S(x))$
E)	$\exists x \in D, \exists y \in D, \sim R(x) \wedge \sim S(x) \wedge K(x,y)$

Each of the propositions below is logically equivalent to one of propositions or circuits (A) through (E). In each case, state which of (A) through (E) it is logically equivalent to, and then prove the logical equivalence.

[5] a. $(p \to q) \to (r \wedge \sim q)$

[5] b. $\sim \forall x \in D,\ (\exists y \in D,\ K(x,y)) \to (R(x) \vee S(x))$

[6] 7. Short Answers

[3] a. To determine whether or not a 64-bit binary integer n is 0, a computer needs to OR all of n's bits together. If the output of the OR gate is false, then the integer is 0. If only two-input and three-input OR gates are available, many of them will need to be connected to deal with n. Should we connect them as a chain or as a tree? Justify your answer briefly.

[3] b. Suppose that you want to prove that two propositions with variables p, q, r, s and t are **not** logically equivalent. What would the shortest (and simplest) such proof look like?

[8] 8. Design a circuit that takes as input two two-bit unsigned integers a_1a_0 and b_1b_0, and outputs the minimum x_1x_0 of the two inputs. For instance, if the first input is 2 ($a_1 = 1$ and $a_0 = 0$) and the second input is 1 ($b_1 = 0$ and $b_0 = 1$) then the output should be 01. Hints:

- One of the two outputs x_1, x_0 is very easy to compute (only one gate is needed).
- To compute the second output, you will need to consider two cases; deal with each case separately and then combine them at the end.

You may use AND, NAND, NOR, NOT, OR and XOR gates, as well as multiplexers.