CS-171, Intro to A.I. — Quiz#3 — Winter Quarter, 2012 — 20 minutes

YOUR NAME AND EMAIL ADDRESS: ________________________________

YOUR ID: ________ ID TO RIGHT:________ ROW:_____ NO. FROM RIGHT:_____

1. (30 pts total, 5 pts each) RESOLUTION. Apply resolution to each of the following pairs of clauses, then simplify. Write your answer in Conjunctive Normal Form (CNF), or write "None" if no resolution is possible.

See Section 7.5.2 and Figure 7.13

1.a. (1 pt) (P Q ¬R S) (P ¬Q W X). ______(P ¬R S W X)________________.

1.b. (1 pt) (P Q ¬R S) (¬P). ______(Q ¬R S)________________

Order of literals within clauses does not matter.

1.c. (1 pt) (¬R) (R). ______( )______**"FALSE" is OK**________________.

1.d. (1 pt) (P Q ¬R S) (P R ¬S W X). ______(P Q ¬R R W X) **also OK** (P Q S ¬S W X) .

"TRUE" is OK

1.e. (1 pt) (P ¬Q R ¬S) (P ¬Q R ¬S) ______None________________

1.f. (1 pt) (P ¬Q ¬S W) (P R ¬S X) ______None________________

2. (30 pts total, 5 pts each) LOGIC-TO-ENGLISH. For each of the following FOL sentences on the left, write the letter corresponding to the best English sentence on the right. Use these intended interpretations: (1) "Student(x)" is intended to mean "x is a student." (2) "Quiz(x)" is intended to mean "x is a quiz." (3) "Got100(x, y)" is intended to mean "x got 100 on y."

See Section 8.2.6

B	∀s∃q Student(s) ⇒ [Quiz(q) ∧ Got100(s, q)]	A	For every quiz, there is a student who got 100 on it.
E	∃q ∀s Quiz(q) ∧ [Student(s) ⇒ Got100(s, q)]	B	For every student, there is a quiz on which that student got 100.
A	∀q∃s Quiz(q) ⇒ [Student(s) ∧ Got100(s, q)]	C	Every student got 100 on every quiz.
F	∃s ∀q Student(s) ∧ [Quiz(q) ⇒ Got100(s, q)]	D	Some student got 100 on some quiz.
C	∀s∀q [Student(s) ∧ Quiz(q)] ⇒ Got100(s, q)	E	There is a quiz on which every student got 100.
D	∃s∃q Student(s) ∧ Quiz(q) ∧ Got100(s, q)	F	There is a student who got 100 on every quiz.

****** TURN PAGE OVER. QUIZ CONTINUES ON THE REVERSE ******

3. (10 pts total, -2 each error, but not negative) CONJUNCTIVE NORMAL FORM (CNF). Convert the following logical sentence to Conjunctive Normal Form. **Show your work.**

$$\mathbf{B \Leftrightarrow (P \Rightarrow Q)}$$

See Section 7.5.2

1. Eliminate $\Leftrightarrow$, replacing $\alpha \Leftrightarrow \beta$ with $(\alpha \Rightarrow \beta) \wedge (\beta \Rightarrow \alpha)$.

   $(B \Rightarrow (P \Rightarrow Q)) \wedge ((P \Rightarrow Q) \Rightarrow B)$

2. Eliminate $\Rightarrow$, replacing $\alpha \Rightarrow \beta$ with $\neg\alpha \vee \beta$.

   $(\neg B \vee (P \Rightarrow Q)) \wedge (\neg(P \Rightarrow Q) \vee B)$

   $(\neg B \vee (\neg P \vee Q)) \wedge (\neg(\neg P \vee Q) \vee B)$

3. Move $\neg$ inwards using de Morgan's rules:

   $(\neg B \vee \neg P \vee Q) \wedge ((P \wedge \neg Q) \vee B)$

4. Apply distributive law ($\wedge$ over $\vee$) and flatten:

   $(\neg B \vee \neg P \vee Q) \wedge (P \vee B) \wedge (\neg Q \vee B)$

5. write each clause (disjunct) as a sentence in KB:

   $(\neg B \vee \neg P \vee Q)$

   $(P \vee B)$

   $(\neg Q \vee B)$

5. (5 pts each, 30 pts total) LOGIC TERMINOLOGY. In each of the following, KB is a set of sentences, {} is the empty set of sentences, and S is a single sentence. Recall that |= is read "entails" and that |- is read "derives."

S = Sound.	**U** = Unsound.
C = Complete.	**I** = Incomplete.
Sat = Satisfiable.	**Unsat** = Unsatisfiable.
V = Valid.	**N** = None of the above.

For each blank below, write in the key above that corresponds to the best term.

5a. Let S be given in advance. Suppose that {} |= S. Then S is ____**V**____ .

5b. Let S be given in advance. Suppose that for some KB1, KB1 |= S; but that for some other KB2, KB2 |= ¬S. Then S is ________**Sat**_____.

5c. Suppose that for any KB and any S, whenever KB |= S then KB |- S.
Then the inference procedure is ___________**C**______.

5d. Suppose that for some KB and some S, KB |- S but not KB |= S.
Then the inference procedure is ___________**U**_______.

5e. Suppose that for some KB and some S, KB |= S but not KB |- S.
Then the inference procedure is ___________**I**___..

5f. Suppose that for any KB and any S, whenever KB |- S then KB |= S.
Then the inference procedure is ___________**S**______ .