(please print in INK) Student Name _____ ID _____

CS 3EA3 Software Correctness and Specifications - Fall 2008 - Dr. Ivan Bruha
Midterm Test: Oct 2008 - Duration: 45 minutes

Notes:
• The weight of every question is written indicated in brackets next to question number.
• For questions (1-7), you have a generalized multiple-choice questions (MCQ), i.e. given a few answers for a question, zero or one or more questions could be correct. If you do not mark ALL correct answers you'll get 0 (zero) for that question.
• If you need more space, or need a scrap space, please use the back of the sheet.

Question (1) [2 marks]

DeMorgan's Law for propositional calculus states (where t(A) is the interpretation of A)
a. $\neg(p \Rightarrow q) \Rightarrow \ p \wedge \neg q$
b. $p \Rightarrow (p \Rightarrow p)$
c. $t(q \wedge \neg q) = 0$
d. $t(\neg(\emptyset \Rightarrow \Sigma)) = 0$

correct answer: nothing

Question (2) [2 marks]

Given in some system, B |— G if and only if B |= G. This is system is
a. incomplete
b. complete
c. first order
d. semantically incorrect

correct answer: b

Question (3) [2 marks]

$p \vee p$ is syntactically equivalent to
a. p
b. $p \vee p$
c. $\neg\neg p$
d. $p \wedge p$
e. $\neg p \wedge p$

correct answer: a,b,c,d
rationale: saying p v p is syntactically equivalent to saying only p or saying $p \wedge p$ or $\neg\neg p$.

Question (4) [2 marks]

By deduction lemma, if p |— p, then
a. |— p ⇒ p
b. |— ¬p ⇒ p
c. p is false
d. p is true
e. |— p

correct answer: a

Question (5) [2 marks]

The following formula, (p ∨ ¬q) ∧ (¬p ∨ ¬q), is
a. in term form
b. in disjunctive normal form
c. in conjunctive normal form
d. in literal form
e. in predicate form

correct answer: c

Question (6) [2 marks]

The CNF form for the following formula, ¬p, is
a. ¬p ∧ ¬p
b. (¬p ∨ ¬p) ∧ (¬p ∨ ¬p)
c. p
d. ¬p
e. ¬¬p

correct answer: d
rationale: see the procedure NEG() to eliminate negation in conversion. ¬p is left as it is.

Question (7) [2 marks]

The DNF form for the following formula, ¬p, is
a. ¬p ∧ ¬p
b. (¬p ∧ ¬p) ∨ (¬p ∧ ¬p)
c. p
d. ¬p
e. ¬¬p

correct answer: d

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rationale: see the procedure NEG() to eliminate negation in conversion. ¬p is left as it is.

Question (8) [10 marks]

Given the following propositional statement:
$(\neg p \wedge \neg(p \Rightarrow q))$

A. Construct a truth table for the above formula and state whether it is a tautology or not
B. From truth table, derive CNF and DNF for the above formula

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solution:

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p	q	$(\neg p \wedge \neg(p \Rightarrow q))$
T	T	F
T	F	F
F	T	F
F	F	F

A. it is not a tautology (a tautology means T in every model)

B.
CNF:

$(\neg p \vee \neg q) \wedge (\neg p \vee q) \wedge (p \vee \neg q) \wedge (p \vee q)$

which is the special case of CNF where all F's

DNF:

F

(saying "nothing" is accepted also but inaccurate)

Question (9) [11 marks]

Define the following:

A. syntax system
B. inconsistent set of formulas
C. consistent set of formulas
D. semantic system
E. semantically valid formula
F. tautology
G. complete system

definitions are given in the course slides (transparencies part 1).

Note: B,C are dual. E,F are the same

Question (10) [10 marks]

Consider the following three English sentences:
S1: If I write the test and do well, I will get pass grade.
S2: I did not get pass grade.
S3: Thus, either I did not write the test or I did not do well.

Using the three propositional symbols: W denotes "I write the test", D denotes "I do well", and P denotes "I get pass grade", answer the following:

A. Convert S1, S2, S3 into three sentences in Propositional Logic.
B. Construct the proof: S1, S2 |= S3 (Hint: build a truth table)

A.

S1: $(W \wedge D) \Rightarrow P$
S2: $\neg P$
S3: $(\neg W \vee \neg D)$

"Thus" has no meaning.

B.

P	W	D	$(W \wedge D) \Rightarrow P$	$\neg P$	$(\neg W \vee \neg D)$	
T	T	T	T	F	F	
T	T	F	T	F	T	
T	F	T	T	F	T	
T	F	F	T	F	T	
F	T	T	F	T	F	
F	T	F	T	T	T	<---- every model that satisfies both
F	F	T	T	T	T	<---- premises (i.e. interpretation = T)
F	F	F	T	T	T	<---- satisfies the consequence

So from truth table and the shown models we infer S1, S2 |= S3