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10SCS21

Second Semester M.Tech. Degree Examination, December 2012

Formal Models in Computer Science

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

1 a. Prove the validity of the following sequent and its converse :
$P \wedge (q \vee r) \vdash (p \wedge q) \vee (p \wedge r)$ **(06 Marks)**

b. Explain four useful derived rules of natural deduction from propositional logic. **(04 Marks)**

c. Prove that for every well formed propositional logic formula, number of left brackets is equal to the number of right brackets, using structural induction. **(05 Marks)**

d. Explain CNF and DISTR along with giving pseudo – code, where CNF means conjunctive normal form and DISTR represents distributivity. **(05 Marks)**

2 a. Explain with examples, Horn clauses and satisfiability of a Horn formula. **(05 Marks)**

b. Justify the need for predicate logic over propositional logic, using examples. **(03 Marks)**

c. List and explain various data in a model M of the pair (F, P). **(04 Marks)**

d. Prove the validity of the quantifier equivalence given by :
$\neg \forall x P(x) \dashv\vdash \exists x \neg P(x)$. **(08 Marks)**

3 a. Prove that the sequent given below is valid $(\exists x \phi) \vee (\exists x \psi) \vdash \exists x (\phi \vee \psi)$. **(06 Marks)**

b. Explain with examples, concatenation of words and prefix ordering of words for a model M. **(05 Marks)**

c. Explain semantic entailment in predicate logic, with two examples. **(09 Marks)**

4 a. Explain key features of Alloy analyzer. **(08 Marks)**

b. Show with code snippets, how a component, fact, fun and a PDS are modeled in Alloy. (PDS : Package Dependency System). **(08 Marks)**

c. Write a note on undicidability of predicate logic. **(04 Marks)**

5 a. Explain win a simple example, how transition system model for a system can be built for verifying, using LTL. **(06 Marks)**

b. Explain the following six sentences in LTL – (Linear Time Temporal Logic) :

i) It is impossible to get to a state where 'started' holds, but 'ready' does not hold.

ii) For any state, if a request for some resource occurs, then it will be eventually acknowledged.

iii) A certain process is enabled infinitely often on every computation path.

iv) What ever happens, a certain process will eventually be permanently deadlocked.

v) If the process is enabled infinitely often, then it runs infinitely often.

vi) A lift, traveling upwards, at the third floor, does not change its direction when it has passengers wishing to go to the 6th floor by pressing corresponding option. **(06 Marks)**

c. Write an SMV program for verifying a 3 bit counter, with an LTL spec for checking carryout of the most significant bit. **(05 Marks)**

d. What are the differences between synchronous and asynchronous composition in SMV? **(03 Marks)**

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

6 a. Explain the syntax of computational tree logic using BNF representation. **(06 Marks)**

b. What is CTL*? Explain with a diagram, how CTL* improves over LTL and CTL?**(08 Marks)**

c. Mention why the following six are not well – formed formulas, based on the syntax of CTL.

i) EFG r ii) A ¬ G ¬ p iii) F [r U q] iv) EF (r U q) v) A E F r

vi) A [(r U q) $\wedge$ (p U r)]. **(06 Marks)**

7 a. Explain with an illustration of factorial program, the proof calculus for total correctness and mention how it is different form that for partial correctness. **(10 Marks)**

b. What is programming by contract? **(03 Marks)**

c. Illustrate 'contract', with an example of computing 'n choose k' i.e $\binom{n}{k}$ in combinatorics. **(07 Marks)**

8 a. Explain Z – notations with details about various aspects. **(04 Marks)**

b. Prove using Z – notation, the de Morgan's law which states that negation of a disjunction is the conjunction of negations. **(06 Marks)**

c. Prove using predicate logic rules in Z notation, the formula given by :

$(\forall x : a . p \wedge q) \Rightarrow (\forall x : a . p) \wedge (\forall x : a . q)$ **(06 Marks)**

d. Write a short note on Frame work for software verification. **(04 Marks)**

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