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10SCS21

Second Semester M.Tech. Degree Examination, June 2012
Formal Models in Computer Science

Time: 3 hrs. Max. Marks:100

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

1 a. Discuss the aim and importance of logic in computer science. **(04 Marks)**

b. Use $\neg$, $\rightarrow$, $\wedge$ and $\vee$ to express the following declarative sentences in propositional logic in each case state what your respective propositional atoms p, q, etc. mean:

i) If a request occurs, then either it will eventually be acknowledged, or the requesting process won't ever be able to make progress.

ii) If dick met Jane yesterday, they had a cup of coffee together, or they took a walk in the park.

iii) Today it will rain or shine, but not both. **(06 Marks)**

c. Use mathematical induction to show that:

$1^2 + 2^2 + 3^2 + ... + x^2 = \frac{x(x+1)(2x+1)}{6}$, for all natural numbers $x \geq 1$. **(10 Marks)**

2 a. State modus ponens and modus tollens rule. **(04 Marks)**

b. Prove the validity of the following sequents:

i) $(p \wedge q) \wedge r \vdash p \wedge (q \wedge r)$

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

iii) $\vdash (p \rightarrow q) \vee (q \rightarrow r)$ using LEM. **(10 Marks)**

c. Compute CNF (NNF (IMPL-FREE ($\neg$ (p $\rightarrow$ ($\neg$ (q $\wedge$ ($\neg$ p $\rightarrow$ q))))))). **(06 Marks)**

3 a. Find appropriate predicates and their specification to translate the following into predicate logic:

i) All red things are in the box ii) Only red things are in the box

iii) A boy won every prize iv) No lecture was attended by any student. **(08 Marks)**

b. Define term and formula in predicate logic. **(04 Marks)**

c. Let ϕ be $\exists x$ (p (y, z) $\wedge$ ($\forall y$ ($\neg$Q (y, x) VP (y, z)))), where P and Q are predicate symbols with two arguments.

i) Draw the parse tree of ϕ.

ii) Identify all bound free variables leaves in ϕ. **(08 Marks)**

4 a. What are the advantages and limitations of predicate logic? **(04 Marks)**

b. Prove the validity of the sequent

$\forall x (P(x) \wedge Q(x)) \vdash \forall x P(x) \wedge \forall x Q(x)$ in predicate logic, where P and Q have axity 1. **(06 Marks)**

c. What are the micro models of software and benefits provided by a system model? **(10 Marks)**

5 a. Discuss the classification of approaches to verification of correctness of computer systems. **(05 Marks)**

b. What is LTL? Give the syntax of LTL and an example of LTL formula and its parse tree. **(08 Marks)**

c. Write the parse tree for the following CTL formulas:

i) EF EG P $\rightarrow$ AF r ii) AG (q $\rightarrow$ EG r). **(07 Marks)**

6 a. Discuss the important equivalences between CTL formulas. **(06 Marks)**
b. What is CTL *? Give its syntax. **(08 Marks)**
c. Explain the NUSMV model checker. **(06 Marks)**

7 a. Why should we specify and verify code? **(08 Marks)**
b. Define a Hoare triple. **(05 Marks)**
c. Use the proof rule for assignment and logical implication as appropriate to show the validity of:
$\vdash_{par}$ (T) y = x; y x + x + y; (y = 3.x). **(07 Marks)**

8 a. What is the z notation? Discuss its different aspects and benefits. **(10 Marks)**
b. Give the syntax of qualified expressions in the z-notation. **(06 Marks)**
c. Identify the free and bound occurrences of variable x in the expression given below:
$x = 3 \wedge \forall x : N. 0 \leq x$. **(04 Marks)**

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