Final Exam

Tuesday May 9
120 minutes – Open book and notes

1. *[20 points]*
   You are given the following English sentence: "There is a tourist who has seen every room of a museum" and these translations into predicate calculus:

   1. $\forall x \forall y \forall z[[Tourist(x) \land Museum(y) \land Room(z, y)] \Rightarrow Seen(x, y)]$
   2. $\exists x\, Tourist(x) \land \exists y\, Museum(y) \land [\forall z\, Room(z, y) \Rightarrow Seen(x, z)]$
   3. $\forall x \forall y[[Tourist(x) \land Museum(y)] \Rightarrow \exists z[Room(z, y) \land Seen(x, y)]]$
   4. $\exists x\, Tourist(x) \land \exists y\, Museum(y) \land \exists z\, Room(z, y) \land Seen(x, z)]$

   1. Is there a statement that represents the English sentence well? If yes, specify which one it is. If no, please write the correct logical sentence.
   2. For each of the logical sentences above write in English what the logical sentence is actually saying.

2. *[30 points]*
   You are given the following action schemas:

   Action ($LoadJoeLondon$,
   PRECOND: $AtPlaneLondon \land AtJoeLondon$
   EFFECT: $InPlaneJoe \land \neg AtJoeLondon$)
   Action ($UnloadJoeParis$,
   PRECOND: $AtPlaneParis \land InPlaneJoe$
   EFFECT: $AtJoeParis \land \neg InPlaneJoe$)
   Action ($MovePlaneLondonParis$,
   PRECOND: $AtPlaneLondon$
   EFFECT: $AtPlaneParis \land \neg AtPlaneLondon$)

   Initial state: $InPlaneJoe \land AtPlaneLondon$

   Goal: $AtJoeParis$

   1. Draw the planning graph. marking all the mutexes and their type.
   2. Is the problem solved at level $S1$? If not, is it solved at level $S2$? How?

3. *[10 points]*
   You are given these CNF expressions in predicate calculus, where arguments in capital case (Apple, Book, Cat) are constants, and lower case letters are variables:

TURN TO THE NEXT PAGE FOR MORE QUESTIONS

1. $\neg F(u, x) \lor \neg B(x)$
2. $\neg G(w) \lor \neg F(w, y) \lor F(y, z)$
3. $F(Apple, Book)$
4. $G(Apple)$

Use resolution with refutation to prove that $\neg B(Cat)$ is entailed by the knowledge base.

4. *[20 points]*
Represent using a semantic network the following knowledge: "Apples are fruits which grow on apple trees. Apple trees produce red apples. Yesterday John picked apples from his apple tree. John ate the apples he picked from his apple tree. The apples that John ate were green. Things that people eat are food."

Given the semantic network you built, explain briefly how a program would answer the following questions:

1. What is the color of the apples produced by John's apple tree?
2. Are apples food?

5. *[20 points]*
Answer these questions explaining your reasoning briefly but precisely.

1. Suppose you solve the Traveling Salesman Problem using a search algorithm that at each step goes to the closest city not yet visited. Will the algorithm find the optimal solution? If yes, why? If not, why not?
2. Under what conditions does Breadth First Search find an optimal solution?
3. Can a genetic algorithm work if there is no fitness function? Explain briefly what is the role of the fitness function.
4. What are the main factors that affect the computational complexity of planning algorithms?
5. Ontologies distinguish "stuff" from "things". Give 2-3 examples of stuff and 2-3 of things. Is oil a kind of stuff or not? What about a liter of oil?

6. Extra Credit *[10 points]*
You are given a planning graph where at level i there are two actions, a_1 and a_2, which are not mutually exclusive. Answer briefly but precisely:

1. Can those two actions be in a mutex at level j, where $j < i$?
2. Can those two actions be in mutex at level j, where $j > i$?

YOU REACHED THE END OF THE EXAM