Problem 1 [25 points]

On the model of Algorithm 4.2 (page 17) of the CAV book (by Henzinger and Alur, see link on web page), write an algorithm that performs the existential quantification of a variable. The algorithm takes a BDD $B$ and an index $i$, and returns a BDD $C$ with $r(C) = \exists x_i.r(B)$.

Problem 2 [25 points]

Recall that if $B$ is a propositional formula (represented as a BDD) defining a set of states, then Post($B$) is the BDD denoting the set of successors of $B$. In formulas, if $C = \text{Post}(B)$ then

$$C' = \exists V.(B \land T)$$

where $V$ is the set of all variables, and $T$ is the transition relation.

- **Part 1 [10 points]**. Write an algorithm that, given BDDs $A, B, C, D$, checks whether there is a path that goes from $A$ to $D$ by visiting a state of $B$ or $C$. Note that visiting a state of both $B$ and $C$, while going from $A$ to $D$, is fine.

- **Part 2 [15 points]**. Write an algorithm that, given BDDs $A, B, C, D$, checks whether there is a path that goes from $A$ to $D$ by visiting a state of either $B$ or $C$, but not both. In other words, we want to know whether from $A$ we can reach $D$ by visiting one, and only one, of $B$ and $C$.

1  Problem 3 [25 points]

Do Exercise 4.10 (page 9) of the CAV book (and comment on the time complexities).

2  Problem 4 [25 points]

Do Exercise 4.16 (page 13) of the CAV book.

3  Problem 5 [25 points]

*Extra credit problem.* Do Exercise 4.13 (page 12) of the CAV book. Give a proof of the size bounds for the BDDs.