1 Equivalencies

Prove the following equivalencies by using the formal semantic of the branching time logic (CTL):

- $\exists \lozenge \Phi \equiv \neg \forall \Box \neg \Phi$
- $\exists (\Phi \cup \Psi) \equiv (\Phi \lor \exists \circ (\exists \Phi \cup \Psi))$

2 Formalizing Descriptions

Write CTL formulas for these English specifications.

- The system should not give up the control of critical section 1 and gain the control of critical section 2 simultaneously.
- The system cannot release the hold of the critical section without signalling the release.
- The system should not lose a request to access the critical section and it should always be possible to grant the access.

3 Satisfiability

Come up with transition systems that satisfy these CTL formulas or reason why there is no such system.

- $\exists \lozenge \neg \Phi \land \forall \Phi$
- $(\exists \Box \exists \circ \Phi) \land (\forall \lozenge \neg \Phi)$
- $(\forall \neg (\Phi \cup \neg \Phi)) \land (\exists \lozenge \forall \neg \Phi)$
- $(\exists a \cup (\exists \neg b \cup b)) \land (\exists \neg a \cup (\exists b \cup \neg b))$