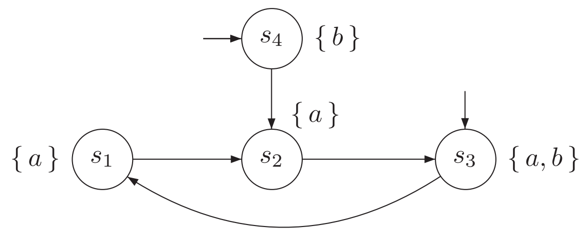
FIXPOINTS

Problem 1

For the following transition system,



Determine which states satisfy each given LTL formula below:

(a) $\bigcirc\, a$

(b) $\bigcirc \bigcirc \bigcirc\, a$

(c) $\Box\, b$

(d) $\Box \Diamond\, a$

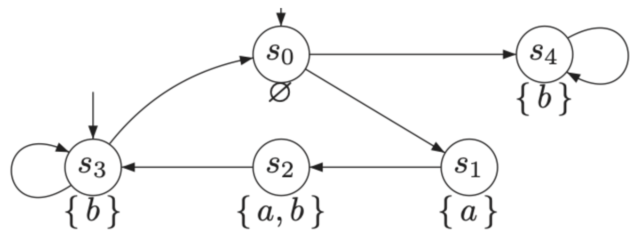
(e) $\Box\, (b \,\mathsf{U}\, a)$

(f) $\Diamond\, (a \,\mathsf{U}\, b)$

Problem 2

For the following transition system and the given formulas, determine which states satisfy each given formula:

$$\begin{aligned}
\Phi_1 &= \forall(a \,\mathsf{U}\, b) \vee \exists \bigcirc (\forall\Box\, b) \\
\Phi_2 &= \forall\Box\, \forall(a \,\mathsf{U}\, b) \\
\Phi_3 &= (a \wedge b) \rightarrow \exists\Box\, \exists \bigcirc \forall(b \,\mathsf{W}\, a) \\
\Phi_4 &= (\forall\Box\, \exists\Diamond\, \Phi_3)
\end{aligned}$$



Problem 3

Consider the following three simple constraints about three unknown LTL formulas F, G, and H:

$$F \equiv a \vee G$$
$$G \equiv b \wedge \bigcirc F$$

Find (standard non-recursive) LTL formulas to stand for F and G above such that the constraints are satisfied and the formulas represent the *smallest* set of paths satisfying the constraints.

(a) $F \equiv$

(b) $G \equiv$

What if we are interested in the formulas representing the *largest* set of paths satisfying the constraints?

(a) $F \equiv$

(b) $G \equiv$