1. See Figure 1 for labelled transition system
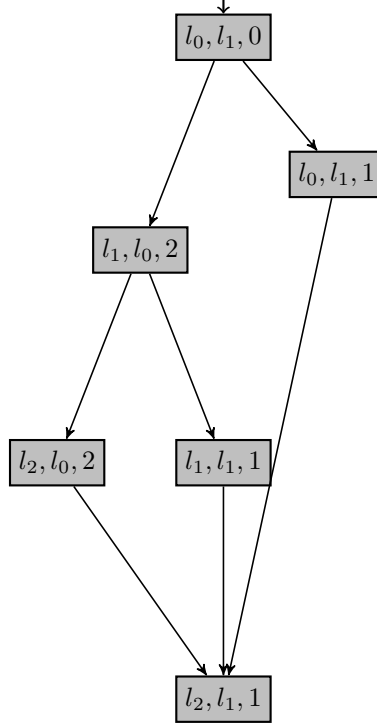

Figure 1: Question 1 Transition System

2.

3. We first negate the safety property, Ψ, giving us $\neg\Psi$ in Equation 2. Constructing a NFA of this property gives us $\mathcal{A}_{\neg\Psi}$ shown in Figure 3. The product of M and $\mathcal{A}_{\neg\Psi}$, $M \otimes \mathcal{A}_{\neg\Psi}$ is shown in Figure 4. This graph has an accept state so therefore this property does not hold for the LTS M.
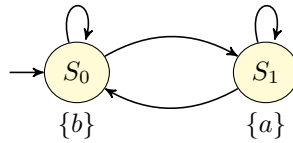
$$\Psi = \Box\,(a \rightarrow \bigcirc\Box b) \tag{1}$$

Figure 2: LTS-M

$$\neg\Psi = \neg\Box(a \to \bigcirc\Box b)$$
$$\equiv \Diamond\neg(a \to \bigcirc\Box b)$$
$$\equiv \Diamond\neg(\neg a \vee \bigcirc\Box b)$$
$$\equiv \Diamond(a \wedge \neg \bigcirc \Box b) \qquad (2)$$
$$\equiv \Diamond(a \wedge \bigcirc\neg\Box b)$$
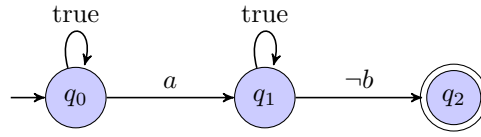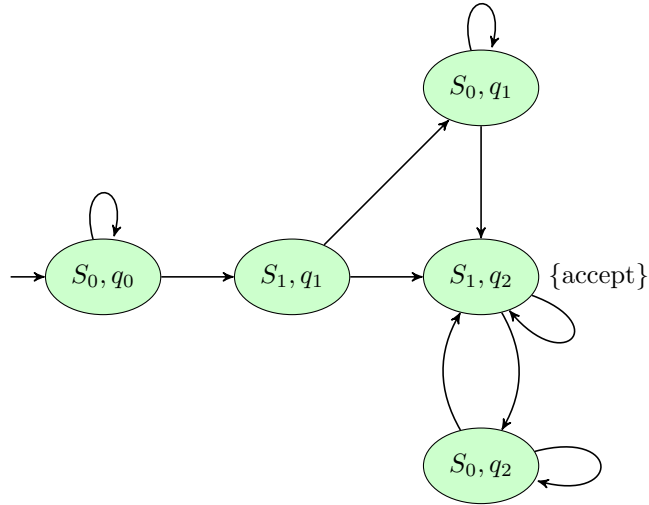$$\equiv \Diamond(a \wedge \bigcirc\Diamond\neg b)$$

Figure 3: NFA-$\mathcal{A}_{\neg\Psi}$

Figure 4: $M \otimes \mathcal{A}_{\neg\Psi}$