Master of Science in Computer Science - University of Camerino
Systems Verification Lab A. Y. 2018/2019
Written Test of 17th July 2019 (Appello V)
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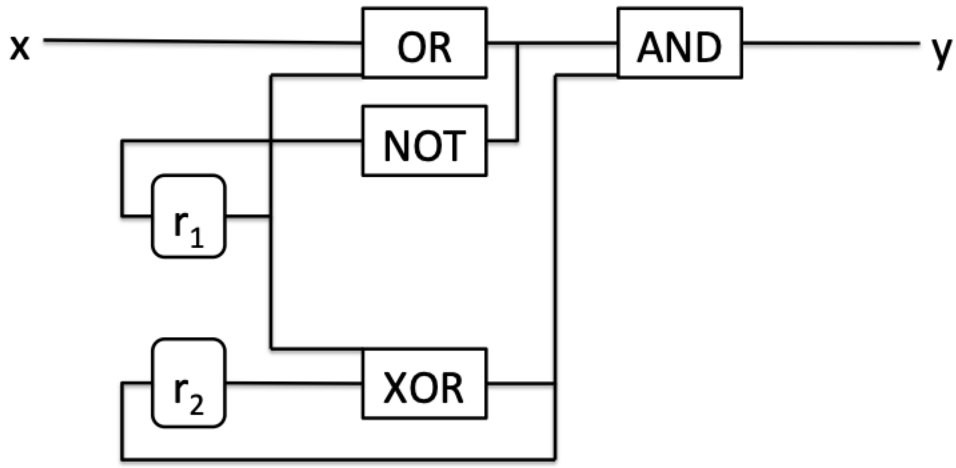
EXERCISE 1 (8 points)

Consider the following circuit.



Draw the transition system describing the behaviour of the circuit. Use $AP = \{y\}$ as set of atomic propositions to label states. Registers are initialised to 0.

EXERCISE 2 (8 points)

Consider the atomic propositions $AP = \{P, Q, R\}$ and the following linear time properties:

(a) P always holds the step before Q holds unless R holds together with Q, in which case P may hold or not.

(b) Q holds only finitely many times and whenever Q holds also R holds.

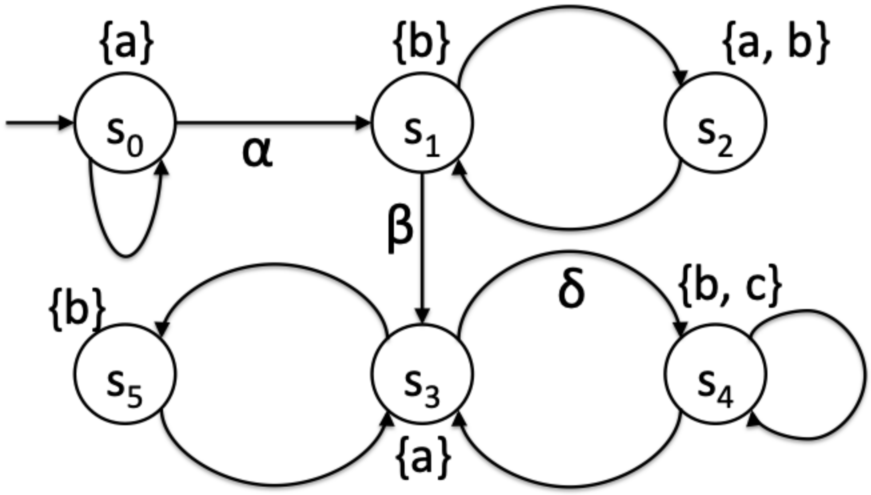
(c) Whenever P holds then Q and R will hold together afterwards (or immediately).

For each property:

1. formalise it using set expressions and first order logic;
2. formalise it in LTL (you can use the operators next, until, box and diamond, together with all boolean connectives);
3. tell if it is a safety, liveness or mixed property. In case it is a pure safety property provide an NFA for the language of the **minimal bad prefixes**.

EXERCISE 3 (8 points)

Consider the following transition system TS on $AP = \{a, b, c\}$.



Decide whether or not the following LTL formulas:

$$\varphi_0 = \Box\Diamond b \qquad \varphi_1 = \Box(a \to \bigcirc(a \vee b))$$
$$\varphi_2 = \Box\Diamond c$$

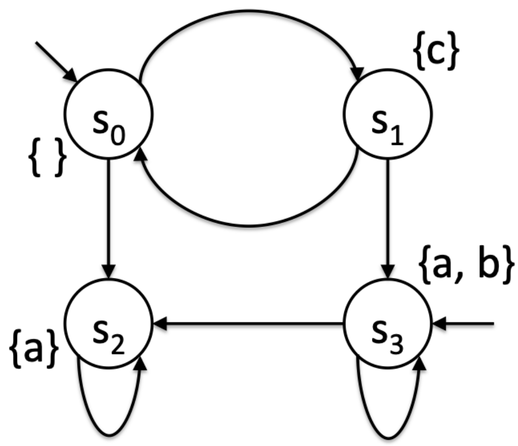
are satisfied by TS under the following fairness conditions (to be considered separately):

$$\psi_0^{\text{fair}} = (\{\}, \{\}, \{\}) \qquad \psi_1^{\text{fair}} = (\{\}, \{\{\alpha, \beta, \delta\}\}, \{\})$$
$$\psi_2^{\text{fair}} = (\{\}, \{\}, \{\{\alpha, \beta, \delta\}\})$$

Justify your answers! In case the answer is no, provide a counterexample.

EXERCISE 4 (8 points)

Consider the following transition system TS on $AP = \{a, b, c\}$.



Decide whether or not the following CTL formulas:

$$\phi_0 = \forall\Diamond b \qquad \phi_1 = \exists\Diamond c$$
$$\phi_2 = \forall\Box(c \to \exists\Diamond a) \qquad \phi_3 = \forall\Box\forall\Diamond(a \vee c)$$

are satisfied by TS. Justify your answers! When possible, provide a counterexample or a witness.