Market Driven Systems (FRTN20)

Exercise 2

Last updated: 2014

1. Let x and y be Boolean variables. Prove that

$$\bar{x}\bar{y} + x\bar{y} + \bar{x}y = \bar{x} + \bar{y}$$

2. An automaton has one binary state q ($q = 0$ or $q = 1$) and a binary input u ($u = 0$ or $u = 1$). If the automaton is in the state $q = 0$ it transits to state $q = 1$ if and only if $u = 1$. If the state is $q = 1$ a transition to state $q = 0$ occurs if and only if $u = 0$.

a. Draw a Boolean truth table showing how the next state q^+ depends on the current state q and the current input u. Use the format shown in the table below.

q^+	q	u

b. Relate q^+ to q and u through a Boolean algebra. Simplify as far as you can.

c. Draw a state chart with vertices corresponding to $q = 0$ and $q = 1$ and arcs labeled either $u = 0$ or $u = 1$, connecting the vertices.

3. Are the nets in Figure 1 Petri nets? For the ones which are Petri nets indicate:

a. The transitions which are enabled.

b. The markings after firing.

c. The transitions which are still enabled after firing.

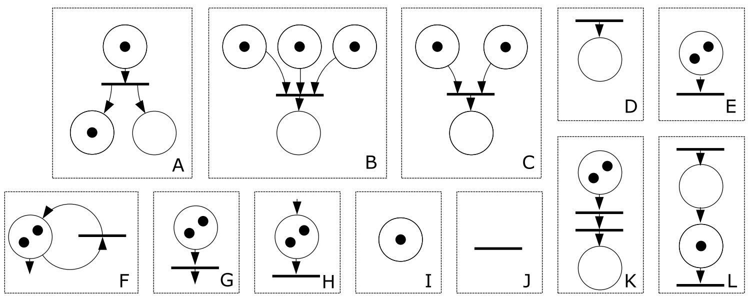

Figure 1

4. For each of the Petri nets in Figure 2 answer the questions

a. Is it bounded?

b. Is it live?

c. Is it deadlock-free?

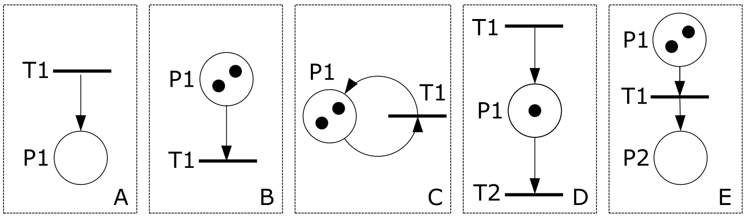

Figure 2

5. When its 'production' is complete (production of one part at a time) a *producer* deposits the part produced in a buffer, if there is any room in this buffer, whose capacity is three units. As soon as he or she has deposited it, he or she starts to produce another part. A *consumer*, upon finishing consumption (one part at a time) removes a part from the buffer if this is not empty.

Represent the functioning of this system by a Petri net with an initial marking corresponding to Figure 3.

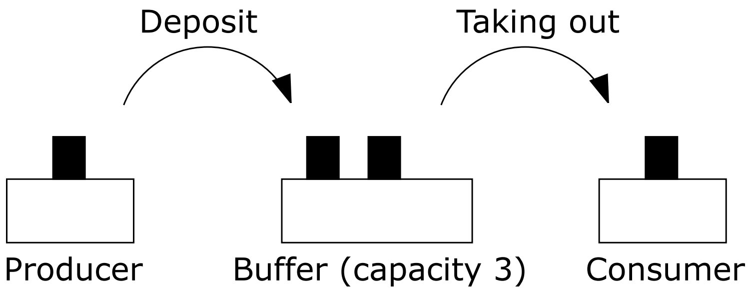

Figure 3

6. What happens if the logical signal, `b`, becomes true in the functional diagrams in Figure 4.

7. An on-off controller is used to control a buffer tank. The buffer tank is shown in Figure 5.

The controller works as follows:

- The sequence is initialized in a waiting position. When the logical input signal, `start`, becomes true (start-button is pushed) the sequence starts.
- The input valve, V-in, is opened.
- When the level passes above 1.05 m. i.e., when the sensor H-high is true, the input valve is closed.
- The input valve is opened again when the level decreases to 0.95 m, i.e., when the sensor H-low is false.

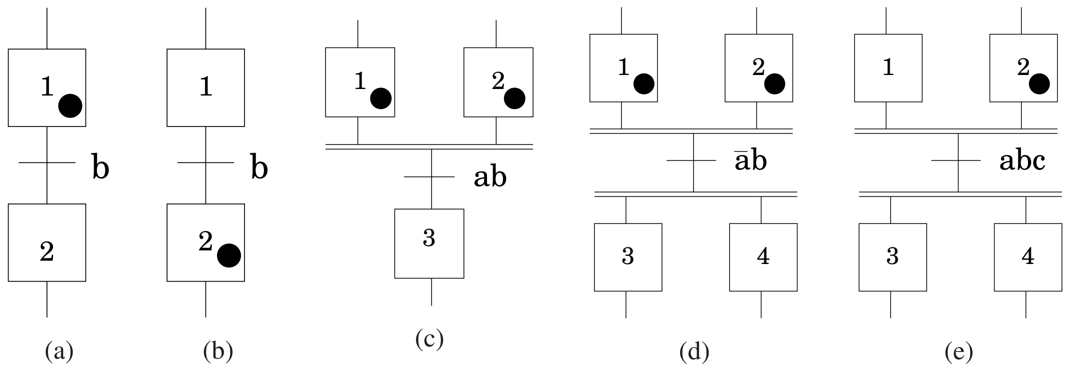

Figure 4: The five Grafcet diagrams in Problem 6.

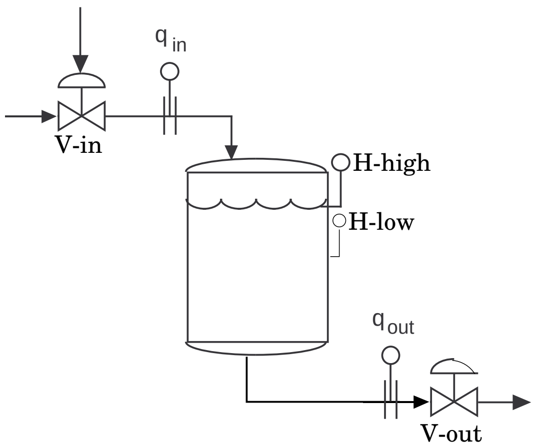

Figure 5: The buffer tank in Problem 7.

Describe the on-off controller in a Grafcet diagram.

8. Make a Grafcet diagram that describes a sequence for an automatic gas chromatograph (GC). The GC takes a sample with a certain sampling interval. On each sample two separate measurements are made with two different non-destructing detectors which are external equipment. This is the specification of the sequence:

1. The sequence is initialized in a waiting position. When the signal `START` becomes true then the GC sequence is started.
2. When the sequence is started, the GC makes a sample by the output signal `SAMPLE`. There is an additional equipment that makes the sampling.
3. When the sampling is done, indicated by the input signal `DONE`, the detections are done in parallel.
4. Detector 1 can start after 10 seconds (indicator `T1`) and its detection takes 15 seconds (indicator `T2`). The detector is started by the signal `D1`.
5. Detector 2 can start after 20 seconds (indicator `T3`) and its detection takes 45 seconds (indicator `T4`). The detector is started by the signal `D2`.
6. When the detections are finished a new sample can be made after 2 minutes (indicator `T5`).

9. A truck H is able to move between positions A and B (Figure 6). The presence at A is represented by the Boolean variable $a = 1$. Likewise $b = 1$ when the truck is at B. An order is given to the truck H by button m ($m = 1$ when this button is pressed). The rest position (initial state) is A. The outputs of the control system are R ($R = 1$, movement to the right), L ($L = 1$, movement to the left).

Using Grafcet, describe the logic controllers corresponding to the following cases:

a. When $m = 1$, truck H sets off towards point B and then returns to point A. If $m = 1$ when truck H arrives at point A, it sets off for a new cycle ABA. Otherwise it stops. And so on.

b. When the variable m changes from 0 to 1 (just when the button is pressed), truck H sets off for a cycle ABA. Whatever the value of m may be when truck H arrives at point A, it stops and waits for the next change of variable m from 0 to 1.

c. Same as **a**, with in addition the counting of the number of ABA cycles carried out from initialization (counter C).

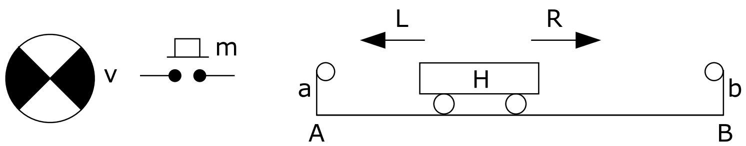

Figure 6

10. A drill carries out a drilling cycle which is controlled by Boolean variables d, h, m, f, b and p (see Figure 7) which are the inputs of the logic controller to be described by Grafcet (they are at 1 when there is contact). The outputs of this logic controller are the Boolean variables M, D and R (which are equal to 1 when the corresponding motors are running). The cycle begins when button d is pressed, if there is a part present. The parts to be drilled may be of two types, namely low or high parts.

When the part is low, the cycles is as follows. From the start of the cycle, we start up the lowering motor and the motor rotating the spindle bearing the drill. When contact f is reached, the spindle rises again up to contact h, at which point the rotations stops.

When the part is high (which is identified by the fact that contact b occurs before the half-way travel contact m), the spindle rises again up to contact h when contact m is reached, after which it is lowered to contact f before rising again in the same conditions as in the short cycle corresponding to a low part.

Prior to restarting a new cycle, the part already drilled must have been removed and replaced.

Describe the functioning of the logic controller by a Grafcet.

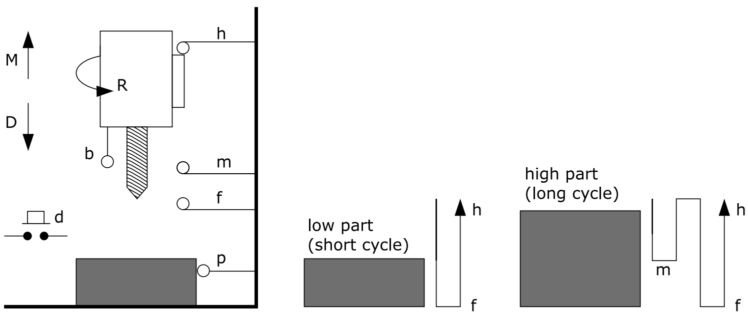

Figure 7