EECS 20. Midterm No. 1
March 7, 2002.

Please use these sheets for your answer and your work. Use the backs if necessary. **Write clearly and put a box around your answer, and show your work.**

Print your name and lab TA's name below

Name: ______________________________

Lab TA: ______________________________

Problem 1:

Problem 2:

Problem 3:

Problem 4:

Total:

1. **15 points.** Consider state machines A, B and C, described below by their state space, input alphabet, output alphabet, and state transition diagram.

   Let

   $$\textit{Set1} = \{T, F, \textit{absent}\}$$

   $$\textit{Set2} = \{1, 0, \textit{absent}\}$$

   State machine A:

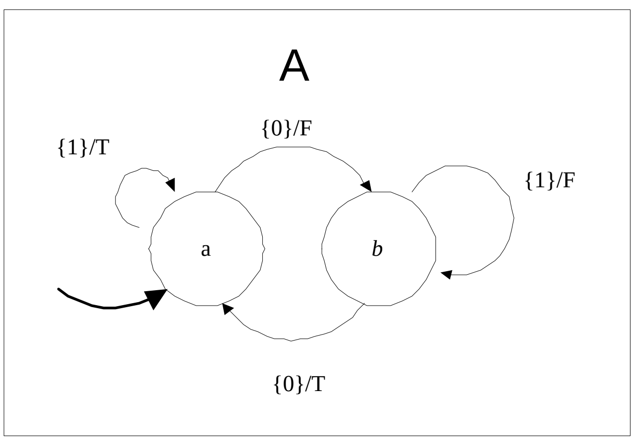
   $$\textit{Inputs} = \textit{Set2},\ \textit{Outputs} = \textit{Set1},\ \textit{States} = \{a, b\}$$

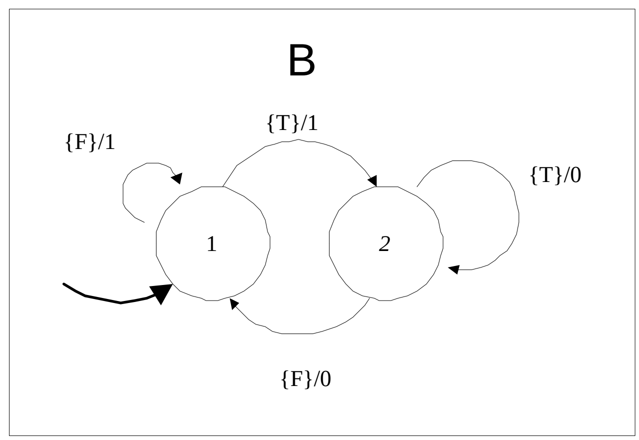
   State machine B:

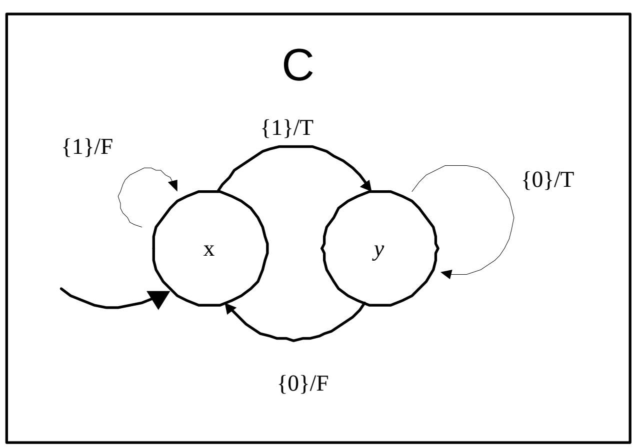
   $$\textit{Inputs} = \textit{Set1},\ \textit{Outputs} = \textit{Set2},\ \textit{States} = \{1, 2\}$$

   State machine C:

   $$\textit{Inputs} = \textit{Set2},\ \textit{Outputs} = \textit{Set1},\ \textit{States} = \{x, y\}$$

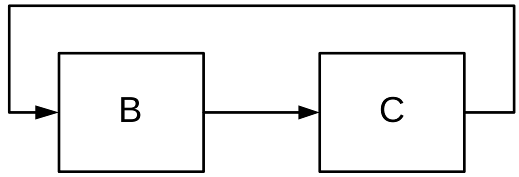




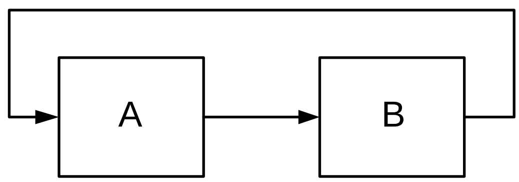


Classify whether these compositions are well-formed. Explain your answer.

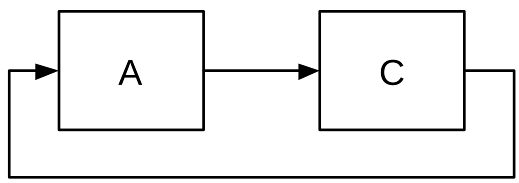
(a)*Well-formed* or *not well-formed*



(b)*Well-formed* or *not well-formed*



(c)*Well-formed* or *not well-formed*



2. **20 points.** Consider the following state machine A:

Inputs={0,1,reset,absent}

Outputs={0,1,absent}

States = {a,b,c,d}

initialState = *a*

update function is given by the following table of values of (*nextState*, *output symbol*) under speci£ed input symbol

current state	0	1	reset	absent
a	(b,0)	(c,0)	(a,0)	(a,absent)
b	(a,0)	(c,0)	(a,0)	(b,absent)
c	(b,0)	(d,0)	(a,0)	(c,absent)
d	(d,0)	(a,1)	(a,0)	(d,absent)

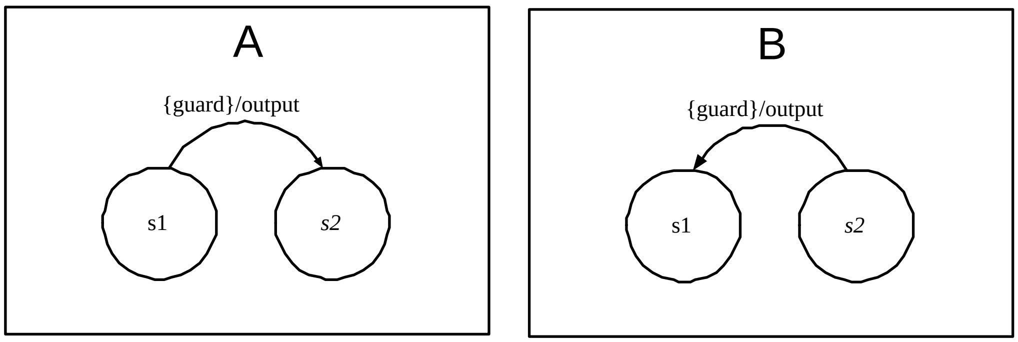
(a) Draw the state transition diagram for state machine A.

(b) Construct a simpler state machine which is bisimilar to A. Give *Inputs, Outputs, States, initialState*, and a state transition diagram for this state machine.

(c) What is the bisimulation relation between the state machines in part (a) and (b)?

(d) Provide the state transition diagram of a one-state non-deterministic state machine which simulates A.

3. **20 points.** Consider a general £nite state machine A with a certain set of *Inputs, Outputs, States, initialState* and state transition diagram. Now construct a new FSM B with the same set of *Inputs, Outputs, States* and *initialState*, but with the arrows in the state transition diagram reversed; i.e., the direction of every arc in B is the reverse of the corresponding arc in A. The £gure below illustrates this for one speci£c arc of A and the corresponding arc of B .



(a) Does the arc-reversed machine B always make sense? That is, can we always de£ne it via a £nite state machine model? Explain.

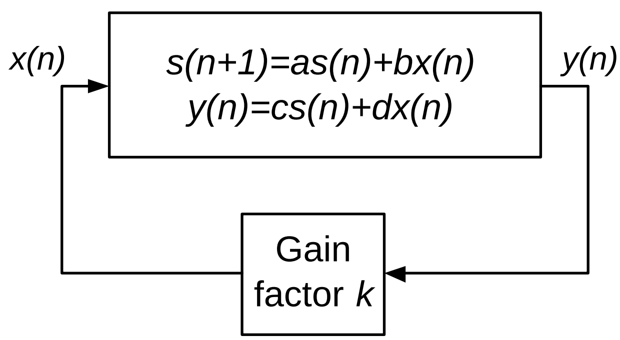
(b) Is B always deterministic if A is? Prove or give a counterexample.

4. **10 points.** Consider a discrete-time system with one input port, one output port and one state. The current input, current output, and current state are denoted by $x(n)$, $y(n)$, and $s(n)$, respectively. The equations describing this system are:

$$s(n+1) = as(n) + bx(n)$$
$$y(n) = cs(n) + dx(n)$$

Furthermore, the output is multiplied by a feedback gain factor k and fed back as input.

$$x(n) = ky(n).$$



Derive conditions on the values of a, b, c, d, k under which the system is well-formed.

Use this page for over¤ow