EECS 20. Midterm No. 1
October 7, 2004.

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 day and time below

Name: _____

Lab day and time: _____

Problem 1:

Problem 2:

Problem 3:

Problem 4:

Problem 5:

Total:

1. **10 points** Let $[\mathit{Nats}_0 \to \{0,1\}]$ be the input and output signal spaces. Construct a machine whose input-output function is:

$$\forall x, \forall n, F(x)(n) = \begin{cases} 0, \text{ if } (x(n-2), x(n)) = (1,1), \\ 1, \text{ otherwise} \end{cases}$$

Note $x(n-2)$ in specification of F.

2. **10 points. 2points for each part.**

(a) Using the notation $[X \rightarrow Y]$ for a signal space write down the signal space for:

i. *Voices*, comprising all analog voice signals of duration 1 second.

ii. *SampledVoices*, comprising the signals obtained by sampling analog voice 8,000 times per second.

iii. *DigitalVoices*, comprising sampled voice signals whose magnitude is represented by an 8-bit integer.

iv. *Texts*, comprising the set of all English sentences.

(b) A *VoiceRecognizer* is a system that converts digial voice into text. What is the range and domain of this system?

3. **30 points. 5 points for each part.** Indicate whether the following statements are true or false. There is no partial credit.

(a) Suppose P, Q, R are true assertions. Then

$$\neg[[\neg P \vee Q] \wedge [P \vee [R \wedge \neg P]]] \text{ is true}$$

(b) If set A has 4 elements, its power set $P(A)$ has $4! = 24$ elements.

(c) The function $f : [0, 1] \to [0, 1]$ given by

$$\forall x, \quad f(x) = e^{-x}$$

has a unique fixed point.

(d) If sets X and Y have m and n elements respectively, the set $[X \to Y]$ has $m \times n$ elements.

(e) There is no deterministic state machine with $Inputs = Outputs = \{0, 1\}$ whose input-output function F is given by: for all input signals x, the output signal $F(x)$ is

$$\forall n \in Nats_0, \quad F(x)(n) = x(n + 1) \tag{1}$$

(f) There is a non-deterministic state machine with $Inputs = Outputs = \{0, 1\}$ whose *Behaviors* include $(x, F(x))$ for any input signal x, and $F(x)$ given by (1).

4. **20 points. 10 points for each part.** Suppose A, B are non-deterministic state machines with *Inputs* and *Outputs* equal to $\{0, 1\}$,

$$\begin{aligned} A &= (\mathit{States}_A, \mathit{possibleUpdates}_A, \mathit{init}_A) \\ B &= (\mathit{States}_B, \mathit{possibleUpdates}_B, \mathit{init}_B) \end{aligned}$$

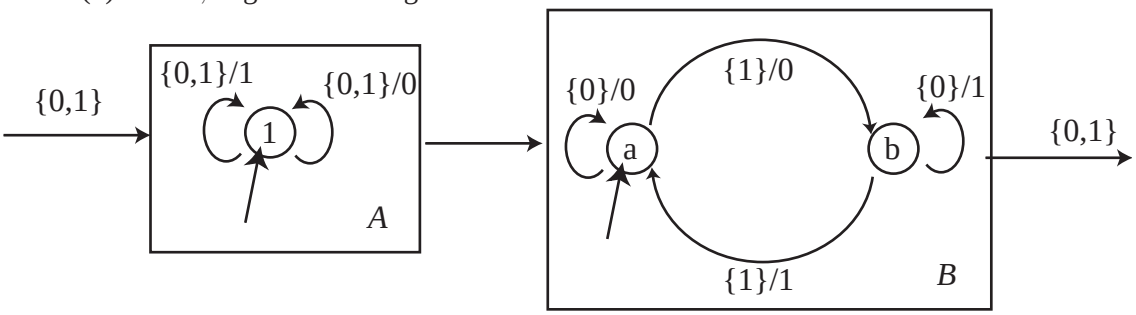
Let C be the cascade composition of A and B.

C has the same *Inputs* and *Outputs* as A, B. Denote the other elements of C by

$$C = (\mathit{States}_C, \mathit{possibleUpdates}_C, \mathit{init}_C).$$

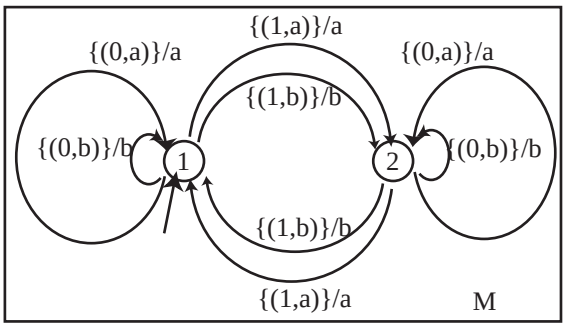
(a) Express these in terms of the elements of A, B.

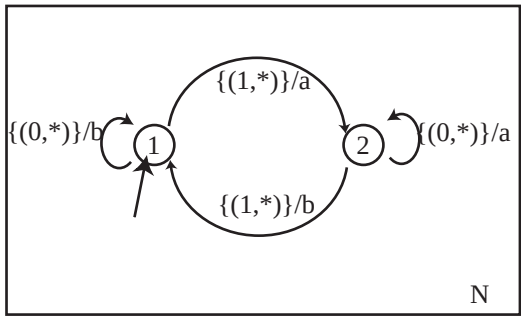
(b) For A, B given in the figure below

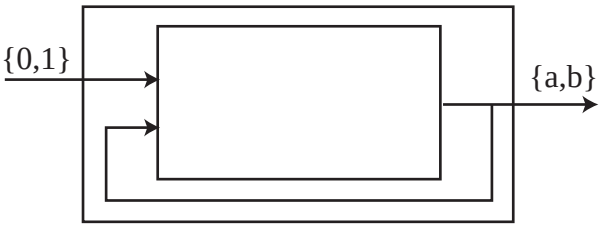


express C as a state diagram.

5. **20 points. 10 points each part.** M and N are machines with *Input* $= \{0,1\} \times \{a,b\}$ and *Outputs* $= \{a,b\}$.







Feedback composition

(a) Suppose a feedback connection is placed around M as shown above. Is the resulting composition well-formed? If it is, draw the transition diagram for the composite machine below.

(b) Repeat part 5a for N.

Use this page for overflow