CS154

Name: ________________________ Date: ____________

Note: The purpose of the following questions is:

• *Enhance learning*	• *Summarized points*	• *Analyze abstract ideas*

Class 0: Models of Computation

1. [Slide 3] Show the abstract model of digital computer for computing the function

$$f(x) = x^3$$

2. [Slide 8] Define Automaton. Give schematic representation of general Automaton.

   An **automaton** is an abstract model of a digital computer. As such, every automaton includes some essential features. It has a mechanism for reading input. It will be assumed that the **input** is a string over a given alphabet, written on an input file, which the automaton can read but not change. The input file is divided into cells, each of which can hold one symbol. The input mechanism can read the input file from left to right, one symbol at a time. The input mechanism can also detect the end of the input string (by sensing an end-of-file condition). The automaton can produce output of some form. It may have a temporary **storage** device, consisting of an unlimited number of cells, each capable of holding a single symbol from an alphabet (not necessarily the same one as the input alphabet). The automaton can read and change the contents of the storage cells. Finally, the automaton has a **control unit**, which can be in any one of a finite number of **internal states**, and which can change state in some defined manner.

3. The general model covers all the automata we will discuss in this class. A finite-state control will be common to all specific cases, but differences will arise from the way in which the output can be produced and the nature of the temporary storage. As we will see, the nature of the temporary storage governs the power of different types of automata.

   [Slide 12] What is the difference between the following, give an example and schematic representation of each

   a. Finite Automata
   b. Pushdown Automata
   c. Turing Machine

4. In terms of operating automation, define the following terms:

   next-state or transition function, configuration, move

   An automaton is assumed to operate in a discrete timeframe. At any given time, the control unit is in some internal state, and the input mechanism is scanning a particular symbol on the input file. The internal state of the control unit at the next time step is determined by the **next-state** or **transition function**. This transition function gives the next state in terms of the current state, the current input symbol, and the information currently in the temporary storage. During the transition from one time interval to the next, output may be produced or the information in the temporary storage changed. The term **configuration** will be used to refer to a particular state of the control unit, input file, and temporary storage. The transition of the automaton from one configuration to the next will be called a **move**.

5. What is the diffidence between deterministic automata and nondeterministic automata?

   It will be necessary to distinguish between deterministic automata and nondeterministic automata. A deterministic automaton is one in which each move is uniquely determined by the current configuration. If we know the internal state, the input, and the contents of the temporary storage, we can predict the future behavior of the automaton exactly. In a nondeterministic automaton, this is not so. At each point, a nondeterministic automaton may have several possible moves, so we can only predict a set of possible actions. The relation between deterministic and nondeterministic automata of various types will play a significant role in our study.

6. In terms of automata, what is the difference between accepter and transducer?

   An automaton whose output response is limited to a simple "yes" or "no" is called an accepter. Presented with an input string, an accepter either accepts the string or rejects it. A more general automaton, capable of producing strings of symbols as output, is called a transducer.

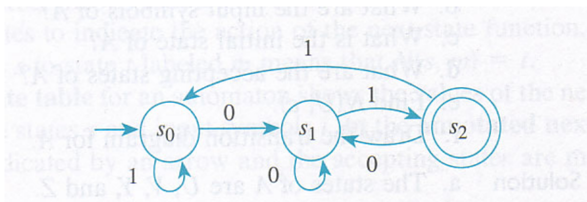
7. [Example] Consider a Vending Machine that accepts only nickels and dimes. Everything costs 20 cents. Consider the *state* of the vending machine, model the state by how much money has been deposited. Give schematic representation of vending machine state model.

8. [Example] You are to find the state-machine diagram for the following electronic vending-machine specification. The vending machine sells soda for $1.50 per bottle. The machine accepts only D ($1 bills) and Q (quarters = 25¢). When the sum of money is greater than $1.50, i.e., two $1 bills, the machine returns change in the coin return (two quarters). When $1.50 has been paid, the machine lights an LED to indicate that a soda flavor may be selected. The choices by pushbutton are C (Cola), L (Lemon soda), O (Orange soda), and R (Root Beer). When one pushbutton is pushed, the selected soda is dispensed and the machine returns to its initial state. One other feature is that an LED comes on to warn the user that two quarters are not available for change, so if a second $1 bill is inserted, no change will be given.

(a) Find the state-machine diagram for the soda vending machine as specified.

(b) The specification as given is not very user friendly. Rewrite it to provide a remedy for every possible situation that the user might encounter in using the machine.

9. [Example] Consider the following model:
    a. Identify the following: Initial State – Final State
    b. What happens if we input 01?
    c. What about 0111?



Reading:

An Introduction to Formal Language and Automata, Peter Linz, 5th edition, sec 1.2 (page 26-27)