Assignment 2

due February 11 1998 (9:30 AM)

Question 1

Design a controller for a coin-operated widget-vending machine. The machine's a coin detector can detect nickels, dimes and quarters.

The coin detector has two output lines encoded as follows:

00	no coin detected
01	nickel
10	dime
11	quarter

The vending machine has an electrically-driven widget-release mechanism. A widget costs 30 cents. The machine does not give change or have a coin return.

The candy release mechanism will deliver one candy each time its control line goes from zero to one.

Identify the inputs and outputs for this controller. Identify a set of states for the controller and draw the state transition diagram. Write out a tabular description of the state machine. Derive the logic equations for all of the logic functions required to implement the controller. Draw a schematic diagram of the controller using AND/OR/NOT gates and D flip–flops.

You may assume a 1 kHz clock signal is available (show where it would be connected in the circuit). You may also assume that the clock signal resets the coin detector so that the coin detector signals are only non-zero for one clock cycle per coin.

How long will the candy release signal be high (equal to one) in your particular design?

Hint: your controller needs to keep track of the amount collected.

Question 2

In this question you will design a digital logic controller for a ski lift. This lift must operate at a slower-than-normal speed for the first 1.5 seconds after starting to reduce the start-up shock on the skiers already on the lift.

The lift operator has two pushbuttons available: `START` (or "`X`") and `STOP` (or "`Y`"). Each pushbutton generates a logic 1 signal when it is being pushed and 0 if it is not being pushed. The lift should start when the `START` button is pushed. If the lift is already running at either slow or normal speed the `START` button has no effect. The lift should be stopped immediately when the `STOP` button is pushed regardless of the current speed.

The lift motor has two speeds and is controlled by two logic signals: `RUN` and `SLOW`. When `SLOW` is logic 1 the motor will run at slow speed and when `SLOW` is 0 the motor will run at normal speed. However, the motor only runs when the `RUN` signal is logic 1. When the `RUN` signal is logic 0 the motor stops.

A timer circuit is available for your controller. The timer has one logical input (`RESET`) and one logical output, (`TIME` or "`Z`"). When the `RESET` signal goes from 0 to 1 the `TIME` signal becomes 0. The `TIME` signal goes back to 1 after a delay of 1.5 seconds following the last 0-to-1 transition of the `RESET` signal.

Design a digital logic controller for the ski lift. Include the following:

1. a state transition diagram for the controller showing the possible states, the values of the outputs for each state and the transition conditions. Transition conditions resulting in no change of state need not be shown.
2. a table showing the outputs for each state.
3. a tabular description of the state transition diagram showing the state, the input conditions, and the next state. You may use the value `x` to indicate "don't care."
4. the sum-of-products boolean expressions for each output signal and for each signal necessary to determine the next state. You need not simplify your expressions.

5. a schematic diagram for the controller that uses only D flip-flops, NOT inverters and multiple-input AND and OR gates. Use standard symbols for the gates. Assume a clock signal of sufficiently high frequency is available and show how it would be connected.